RCA SEMICONDUCTOR DEVICES

Not Recommended For New Equipment Design

2N104	2N708
2N109	2N914
2N139	2N1010
2N140	2N1177
2N175	2N1178
2N176	2N1179
2N215	2N1180
2N218	2N1384
2N219	2N1525
2N220	2N1527
2N351	2N1631
2N370	2N1708
2N371	2N2205
2N372	2N2938
2N376	3N98
2N396A	3N99
2N405	40217
2N407	40218
2N409	40219
2N410	40220
2N411	40221
2N412	40222

40264

This bulletin gives basic data for RCA Semiconductor Devices Not Recommended for New Equipment Design.

(1) This bulletin includes Devices which have been used extensively, but are not expected to be used in future equipment designs.

(2) Devices which are no longer being manufactured by RCA and are available only to the extent of limited inventory.

(3) Devices which have been extensively used but have recently been superseded by improved devices.

(4) Devices which have recently been discontinued and are not available from RCA.

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RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
File No.14 3-67
Supersedes issue dated 11-66

RCA SEMICONDUCTOR DEVICES NOT RECOMMENDED FOR NEW EQUIPMENT DESIGN

Type	DESCRIPTION		MAXIMUM RATINGS						CHARACTERISTICS AND OPERATING CONDITIONS														For New Equipment Design Refer To–	
	Polarity & Structure	Package	V_{CBO}	I_C	P_T @ °C			Operating Temperature Range	MAX. I_{CBO}	MIN. h_{fe} or h_{FE}			MAX. $V_{CE(sat)}$		TYP. f_T or f_{hfb}	TYP. C_{ob}	MAX. θ_{J-A}	TYP. G_p at f		MAX. THD at P_o		RCA TYPE	File No.
			V	A	T_A	T_{MF}	W	°C	μA	Min.	V_{CE} V	I_C mA	V	I_C mA	MHz	pF	°C/W	dB	MHz	%	W		
2N104	P-N-P Germanium Alloy	TO-40	-30	-0.05	25	-	0.15	-65 to +70	-10	44	-6	-1	-	-	0.7	40	0.4/mW	32.4	-	-	-	2N217	52
2N109	P-N-P Germanium Alloy	TO-40	-35	-0.15	25	-	0.165	-65 to +71	-14	75	-1	-50	-	-	1	-	-	33	0.001	10	0.16	2N217	52
2N139	P-N-P Germanium Alloy	TO-40	-16	-0.015	25	-	0.035	-65 to +70	-6	48	-9	-1	-	-	4.7	9.5	-	30.4	0.455	-	-	2N1638 or 40262	118 79
2N140	P-N-P Germanium Alloy	TO-40	-16	-0.015	25	-	0.08	-65 to +71	-6	75	-9	-0.6	oscillator injection voltage = 100 mV at f = 1 MHz		10	9.5	-	32	1	-	-	2N1639 or 40261	118 79
2N175	P-N-P Germanium Alloy	TO-40	-10	-0.002	25	-	0.05	-65 to +50	-12	65	-4	-0.5	-	-	0.85	-	-	43	-	-	-	2N2613	51
2N176	P-N-P Germanium Alloy	TO-3	-40	-3	-	80	10	-65 to +90	-3000	63	-2	-500	-	-	-	-	1/W	35.5	0.001	4	2	2N2869/ 2N301	53
2N215	P-N-P Germanium Alloy	TO-1	Electrically identical with type 2N104, but utilizes JEDEC TO-1 package																			2N217	52
2N218	P-N-P Germanium Alloy	TO-1	Electrically identical with type 2N139, but utilizes JEDEC TO-1 package																			2N1638 or 40262	118 79
2N219	P-N-P Germanium Alloy	TO-1	Electrically identical with type 2N140, but utilizes JEDEC TO-1 package																			2N1639 or 40261	118 79
2N220	P-N-P Germanium Alloy	TO-1	Electrically identical with type 2N175, but utilizes JEDEC TO-1 package																			2N2613	51
2N351	P-N-P Germanium Alloy	TO-3	-40	-3	-	80	10	-65 to +90	-3000	65	-2	-700	-	-	-	-	1/W	33.5	0.001	5	4	2N2869/ 2N301	53
2N370●	P-N-P Germanium Drift-Field	TO-7	-24	-0.01	25	-	0.08	-65 to +71	-20	60	-12	-1	-	-	30	1.7	-	31	1.5	-	-	40242	95

●Limited to extent of inventory.

Type	Polarity Structure	Package	V	A	T_A	T_{MF}	W	°C	μA	Min.	V_{CE} V	I_C mA	V	I_C mA	MHz	pF	°C/W	dB	MHz	%	W	RCA TYPE	File No.
2N371●	P-N-P Germanium Drift-Field	TO-7	-24	-0.01	25	-	0.08	-65 to +71	-20	*80*	*-12*	*-1*	-	-	30	-	-	-	-	-	-	40244	95
2N372●	P-N-P Germanium Drift-Field	TO-7	-24	-0.01	25	-	0.08	-65 to +71	-20	60	-12	-1	-	-	30	1.7	-	31	1.5	-	-	40243	95
2N376	P-N-P Germanium Alloy	TO-3	-40	-3	-	80	10	-65 to +90	-3000	78	-2	-700	-	-	-	-	1/W	35	0.001	5	4	2N2869/ 2N301	53
2N396A	P-N-P Germanium Alloy	TO-5	-30	-0.2	25	-	0.2	-65 to +85	-6	15	-0.35	-200	-0.2	-50	5(min)	20(max)	(t_d = 0.2; t_r = 0.65; t_s = 0.8; t_f = 0.4) μs max. at I_C = -10 mA, I_{B1} = $-I_{B2}$ = 1 mA.					2N388*	23
2N405	P-N-P Germainum Alloy	TO-40	-20	-0.035	25	-	0.15	-65 to +71	-14	35	-6	-1	-	-	0.65	40	-	43	-	-	-	2N406	59
2N407	P-N-P Germanium Alloy	TO-40	-20	-0.07	25	-	0.15	-65 to +71	-14	65	-1	-50	-	-	-	-	-	33	0.001	10	0.16	2N408	59
2N409	P-N-P Germanium Alloy	TO-40	-13	-0.015	25	-	0.08	-65 to +71	-10	48	-9	-1	-	-	6.7	9.5	-	38.8	0.455	-	-	2N1638 or 40262	118 79
2N410	P-N-P Germanium Alloy	TO-1	Electrically identical with type 2N409, but utilizes JEDEC TO-1 package																			2N1638 or 40262	118 79
2N411	P-N-P Germanium Alloy	TO-40	-13	-0.015	25	-	0.08	-65 to +71	-10	75	-9	-0.6	Osc. Inj. mV = 100 @f=1 MHz		10	9.5	-	32	1	-	-	2N1639 or 40261	118 79
2N412	P-N-P Germanium Alloy	TO-1	Electrically identical with Type 2N411, but utilizes JEDEC TO-1 package																			2N1639 or 40261	118 79
2N708●	N-P-N Silicon Planar	TO-18	40	Dissipation Limited	25	-	0.36	-65 to +200	0.025	15	1	10	0.4	10	*300(min)*	6(max)	480/W	-	-	-	-	2N3261	93
2N914●	N-P-N Silicon Planar	TO-18	40	Dissipation Limited	25	-	0.36	-65 to +200	0.025	10	5	500	0.7	200	*300(min)*	6(max)	480/W	t_{on}, t_{off} = 40 nS max.@ V_{CC} = 5 V, I_C = 200 mA, I_{B1} = 40 mA, I_{B2} = -20 mA				2N3261	93
2N1010	N-P-N Germanium Alloy	TO-1	10	0.002	25	-	0.02	-65 to +55	10	*35*	*3.5*	*0.3*	-	-	2	-	-	-	-	-	-	2N2613♦ or 40233♦	51 71
2N1177	P-N-P Germanium Drift-Field	TO-45	-30	-0.01	25	-	0.08	-65 to +71	-12	100	-12	-1	-	-	140	2	-	14	100	.	-	40242	95
2N1178	P-N-P Germanium Drift-Field	TO-45	-30	-0.01	25	-	0.08	-65 to +71	-12	40	-12	-1	-	-	140	2	-	14	100	-	-	40244	95

●Limited to extent of inventory.

*Germanium n-p-n type.

RCA SEMICONDUCTOR DEVICES NOT RECOMMENDED FOR NEW EQUIPMENT DESIGN

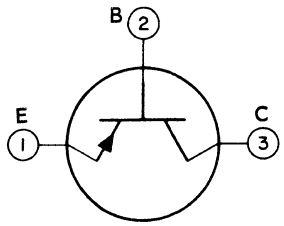
Type	DESCRIPTION		MAXIMUM RATINGS						CHARACTERISTICS AND OPERATING CONDITIONS														For New Equipment Design Refer To–	
	Polarity & Structure	Package	V_{CBO}	I_C	P_T @ °C			Operating Temperature Range	MAX. I_{CBO}	MIN. h_{fe} or h_{FE}			MAX. $V_{CE(sat)}$		TYP. f_T or f_{hfb}	TYP. C_{ob}	MAX. θ_{J-A}	TYP. G_p at f		MAX. THD at P_o		RCA TYPE	File No.
			V	A	T_A	T_{MF}	W	°C	μA	Min.	V_{CE} V	I_C mA	V	I_C mA	MHz	pF	°C/W	dB	MHz	%	W		
2N1179	P-N-P Germanium Drift-Field	TO-45	-30	-0.01	25	-	0.08	-65 to +71	-12	80	-12	-1	Osc. Inj. mV = 125 @ 100 MHz		140	2	-	17	100	-	-	40243	95
2N1180	P-N-P Germanium Drift-Field	TO-45	-30	-0.01	25	-	0.08	-65 to +71	-12	80	-12	-1	-	-	100	2	-	35	10.7	-	-	40245 or 40246	95 95
2N1384	P-N-P Germanium Drift-Field	TO-11	-30	-0.5	25	-	0.24	-65 to +85	-8	20	-0.5	-200	-	-	35	-	250	-	-	-	-	-	-
2N1525	P-N-P Germanium Drift-Field	TO-40	Electrically identical with type 2N1524, but utilizes JEDEC TO-40 package																			2N1524	111
2N1527	P-N-P Germanium Drift-Field	TO-40	Electrically identical with type 2N1526, but utilizes JEDEC TO-40 package																			2N1526	111
2N1631	P-N-P Germanium Drift-Field	TO-40	-34	0.01	25	-	0.08	-65 to +71	-16	*80*	*-12*	*-1*	-	-	45	2	0.4/mW	47.7	1.5	-	-	2N1632	111
2N1708▲	N-P-N Silicon Planar	TO-46	25	0.2	25	-	0.3	-65 to +175	0.025	20	1	10	0.35	50	*200*	6(max)	(t_{on} = 40 ns, t_{off} = 75 ns) max. at V_{CC} = 3 V, I_C = 10 mA, I_{B1} = 3 mA, I_{B2} = -1 mA.					2N3261	111
2N2205	N-P-N Silicon Planar	TO-18	Electrically identical with type 2N1708, but utilizes JEDEC TO-18 package																			2N3261	93
2N2938	N-P-N Silicon Planar	TO-52	25	0.5	25	-	0.3	-65 to +175	0.025	25	0.35	10	0.4	50	*690*	3.5	(t_{on} = 30 ns, t_{off} = 30 ns) max. at V_{CC} = 6 V, I_C = 50 mA, I_{B1} = 2.5 mA, I_{B2} = -2.5 mA.					2N3261	93
3N98●	Silicon "MOS" Transistor N-Channel Depletion Type	TO-72	V_{DS} = 32 V I_D = 15 mA		85	-	0.15	-65 to +85	$I_{DS(off)}$ = 50 pA typ. @ V_{DS} = 6 V, V_{GS} = -9 V				$r_{DS(on)}$ = 900 Ω typ. @ V_{DS} = 6 V, V_{GS} = 9 V		g_{fs} = 1500 μmho typ. @ V_{DS} = 12 V, V_{GS} = 0 V, f = 1 kHz.		NF = 7 dB typ. @ V_{DS} = 12 V, V_{GS} = 0 V, f = 1 kHz			40460 & 40461	231
3N99●			V_{DS} = 32 V I_D = 15 mA		85	-	0.15	-65 to +85	$I_{DS(off)}$ = 50 pA typ. @ V_{DS} = 6 V, V_{GS} = -9 V				$r_{DS(on)}$ = 800 Ω typ. @ V_{DS} = 6 V, V_{GS} = 9 V		g_{fs} = 2000 μmho typ. @ V_{DS} = 12 V, V_{GS} = 0 V, f = 1 kHz		NF = 7 dB typ. @ V_{DS} = 12 V, V_{GS} = 0 V, f = 1 kHz				232

▲Discontinued. ●Limited to extent of inventory.

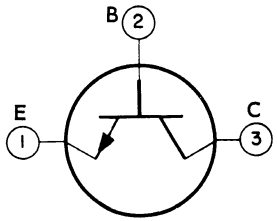
Type	Polarity Structure	Package	V	A	T_A	T_{MF}	W	°C	μA	Min.	V_{CE} V	I_C mA	V	I_C mA	MHz	pF	°C/W	dB	MHz	%	W	RCA TYPE	File No.
40217●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N706, but utilizes JEDEC TO-18 package																			2N3261	93
40218●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N706A, but utilizes JEDEC TO-18 package																			2N3261	93
40219●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N708, but utilizes JEDEC TO-18 package																			2N3261	93
40220●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N834, but utilizes JEDEC TO-52 package																			2N3261	93
40221●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N914, but utilizes JEDEC TO-52 package																			2N3261	93
40222●	N-P-N Silicon Planar	TO-52	Electrically identical with type 2N2205, but utilizes JEDEC TO-52 package																			2N3261	93
40264●	N-P-N Silicon	TO-66	300	0.1	-	70	4	-65 to +150	100	30	10	50	-	-	25	5	20/W	-	-	10	1	40424 & 40425	79

●Limited to extent of inventory. ♦Germanium P-N-P Type. ♦Silicon N-P-N Type.

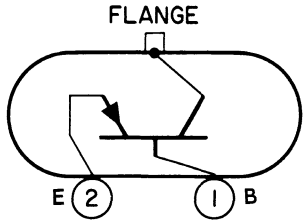
TERMINAL DIAGRAMS



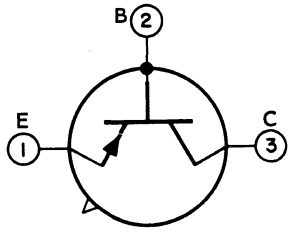
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2N219 2N412
2N1384



2N1010

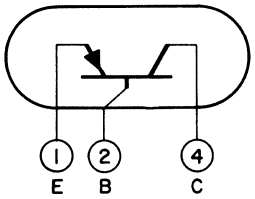


2N176
2N351
2N376

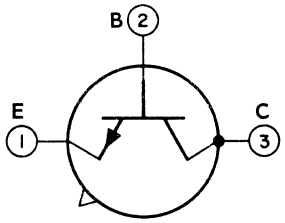


2N396A

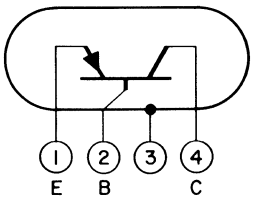
TERMINAL DIAGRAMS



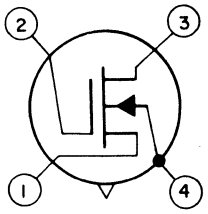
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2N109 2N409
2N139 2N411
2N140 2N1525
2N175 2N1527
2N405 2N1631



2N708 40217
2N914 40218
2N1708 40219
2N2205 40220
2N2938 40221
40222

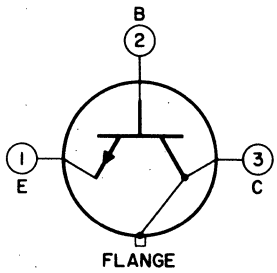


2N370 2N1177
2N371 2N1178
2N372 2N1179
2N1180



Lead 1 – Source
Lead 2 - Insulated Gate
Lead 3 - Drain
Lead 4 - Bulk (Substrate) and Case

3N98
3N99



40264

GERMANIUM POWER TRANSISTORS

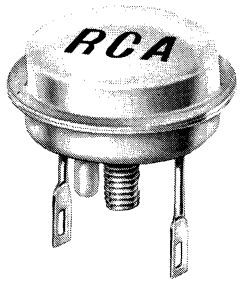
2N173 Family

File No. 8

The transistors in the RCA-2N173 family are alloy-junction germanium p-n-p types utilizing the JEDEC TO-36 single-ended stud-mounted package. These transistors are intended for a wide variety of applications in industrial and military equipment requiring transistors having high voltage, current, and dissipation ratings. They are particularly useful in power-switching, regulator, dc-to-dc converter, chopper, power-supply, and relay-actuating circuits, and in low-frequency oscillator and audio-amplifier service.

The JEDEC TO-36 stud-type package provides positive heat-sink contact and has a cold-weld seal to insure reliable performance under severe environmental conditions.

For Power-Switching and Amplifier Service



2N173
2N174
2N277
2N278
2N441
2N442
2N443
2N1099
2N1100
2N1358
2N1412

JEDEC TO-36

These transistors are designed to pass rigorous environmental tests specified in MIL-S-19500B such as:

- Temperature Cycling
- Thermal Shock
- Moisture Resistance
- Impact Shock
- Vibration Fatigue
- Vibration Noise
- Reduced Barometric Pressure (15 mm of Hg)

Maximum Ratings, *Absolute-Maximum Values:*

	2N277 2N441	2N278 2N442	2N173 2N443	2N174 2N1358	2N1099	2N1412	2N1100	
COLLECTOR-TO-BASE VOLTAGE: With emitter-to-base reverse bias of -1.5 volts.	-40	-50	-60	-80	-80	-100	-100	volts
EMITTER-TO-BASE VOLTAGE. . .	-20	-30	-40	-60	-40	-60	-80	volts
COLLECTOR CURRENT.	-15	-15	-15	-15	-15	-15	-15	amp
EMITTER CURRENT.	15	15	15	15	15	15	15	amp
BASE CURRENT	-4	-4	-4	-4	-4	-4	-4	amp
TRANSISTOR DISSIPATION: At case temperature of 25° C and for operation with heat sink (See Rating Chart Fig. 1)	← 150 →							watts
CASE TEMPERATURE: Operating.	← -65 to +100 →							°C
Storage.	← -65 to +100 →							°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N173 Family 6/66
Reprinted from 1CE-214A 2/61

These power transistors may be subdivided into groups by their ratings and characteristics as follows:

Typical Power-Supply Voltage	28 or 12 volts — For applications involving high transient voltages	2N174, 2N1099, 2N1100, 2N1358, 2N1412
	12 volts — For applications involving low transient voltages	2N173, 2N277, 2N278, 2N441, 2N442, 2N443
Maximum Collector-to-Base Volts (V_{CB})	-40	2N277, 2N441
	-50	2N278, 2N442
	-60	2N173, 2N443
	-80	2N174, 2N1099, 2N1358
	-100	2N1100, 2N1412
Maximum Transistor Dissipation (Watts)	150	2N173, 2N174, 2N277, 2N278, 2N441, 2N442, 2N443, 2N1099, 2N1100, 2N1358, 2N1412
DC Current-Transfer Ratio (h_{FE})	20-40	2N441, 2N442, 2N443
	25-50	2N1099, 2N1100, 2N1358, 2N1412
	35-70	2N173, 2N277, 2N278, 2N1099

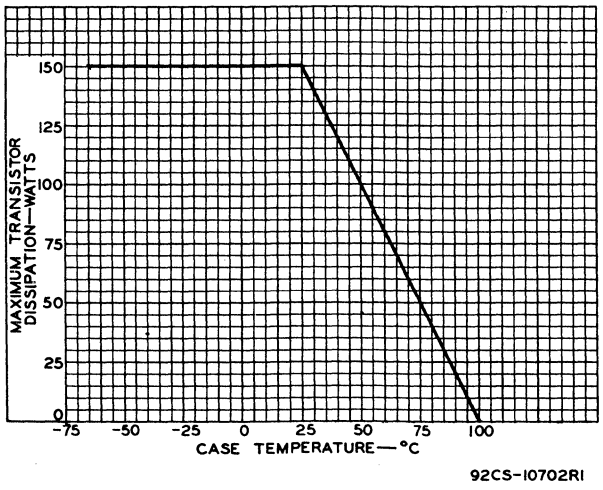


Fig. 1 - Rating Chart for Types 2N173, 2N174, 2N277, 2N278, 2N441, 2N442, 2N443, 2N1099, 2N1100, 2N1358, and 2N1412.

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ELECTRICAL CHARACTERISTICS, *Case Temperature = 25° C unless otherwise specified.*

Characteristic	Symbol	TEST CONDITIONS: DC Voltage (volts) V_{CB}	V_{CE}	V_{EB}	DC Current (amperes) I_C	I_E	LIMITS: Type 2N173 Min.	Typical	Max.	Type 2N174 Min.	Typical	Max.	Type 2N277 Min.	Typical	Max.	Type 2N278 Min.	Typical	Max.
Collector-Cutoff Current	I_{CBO}	-2				0		-100			-100			-100			-100	
		-30				0												
		-40				0								-2	-4			
		-50				0											-2	-4
		-60				0		-2	-4									
		-80				0					-2	-4						
		-100				0												
		★				0			-15			-15			-15			-15
Emitter-Cutoff Current	I_{EBO}			-20	0									-1	-4			
				-30	0												-1	-4
				-40	0			-1	-4									
				-60	0						-1	-4						
				-80	0													
DC Current Transfer Ratio†	h_{FE}		-2		-5		35		70	25		50	35		70	35		70
			-2		-12			25			20			25			25	
Base-to-Emitter Voltage†	V_{BE}		-2		-5			-0.65			-0.65	-0.9		-0.65			-0.65	
Emitter-to-Base Voltage	V_{EB}	-40				0									-1			
		-50				0												-1
		-60				0												
		-80				0		-0.15	-1			-1						
		-100				0												
Collector-to-Emitter Saturation Voltage:† With base current = -2 amperes	$V_{CE(sat)}$				-12			-0.3	-0.7		-0.3	-0.7		-0.3			-0.3	-0.7
Collector-to-Emitter Breakdown Voltage: With base connected to emitter	BV_{CES}				-0.3		-50			-70			-40			-45		
With base open	BV_{CEO}				-0.3 / -1▲		-45	-50		-55			-25	-40		-30	-45	
Punch-Through Voltage	V_{PT}						-60			-80			-40			-50		
Beta-Cutoff Frequency†	$f_{\alpha e}$		-6		-5			10			10			10			10	
Thermal Resistance: Junction-to-case	R_T							0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5
Thermal Capacity: For pulses of 1 to 10 milliseconds								0.075			0.075			0.075			0.075	

★ At case temperature of 71° C and value of V_{CB} shown for I_{CBO} = -4 ma.

▲ Tested by sweep method to prevent excessive heating of collector junction.

□ At V_{CB} = 12 volts and I_C = 1 amp.

† Measured in a common-emitter circuit, base input.

‡ V_{BE} at V_{CB} = -2 volts, I_C = 1.2 amp; 0.35 (typical), 0.5 (maximum).

Typical Operation in Power-Switching Service:

At a Case Temperature of 25° C
Common-Emitter Circuit, Base Input

DC Supply Voltage	-12	volts
DC Base Bias Voltage	6	volts
"On" DC Collector Current	-12	amp
"Turn-On" Base Current	-2	amp
"Turn-Off" Base Current	0	amp
Switching Time:		
Rise Time	15	μsec
Fall Time	15	μsec

LIMITS																				Units
Type 2N441			Type 2N442			Type 2N443			Type 2N1099			Type 2N1100			Type 2N1358			Type 2N1412			
Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	
	-100			-100			-100			-100			-100			-100	-200		-100		μa
																-4■	-6■				ma
	-2	-4																			ma
				-2	-4																ma
							-2	-4													ma
										-2	-4					-2	-4				ma
		-15			-15			-15			-15		-2	-4					-2	-4	ma
	-1	-4												-15			-15			-15	ma
				-1	-4																ma
							-1	-4		-1	-4					-4■	-6■				ma
																					ma
													-1	-4		-1	-4		-1	-4	ma
																					ma
20		40	20		40	20		40	35		70	25		50	25	35		25		50	
	20			20			20			25			20		40●	55●	80●		20		
	-0.65			-0.65			-0.65	-0.9		-0.65	-0.9		-0.65	-0.9	‡	-0.65	-0.9		-0.65	-0.8	volt
		-1																			volt
					-1																volt
								-1													volt
										-0.15	-1					-0.15	-1				volt
														-1						-1	volt
	-0.3			-0.3			-0.3	-1		-0.3	-0.7		-0.3	-0.7		-0.3	-0.7		-0.3	-0.7	volt
-40			-45			-50			-70			-80			-70			-80			volts
-25	-40		-30	-45		-45	-55		-55	-60		-65			-40			-65			volts
-40			-50			-60			-80			-100			-80			-100			volts
	10			10			10			10			10		100□				10		Kc
	0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5		0.35	0.5	°C/watt
	0.075			0.075			0.075			0.075			0.075			0.075			0.075		watt-sec/°C

■ At case temperature of 71° C.
● At I_C = 1.2 amp.

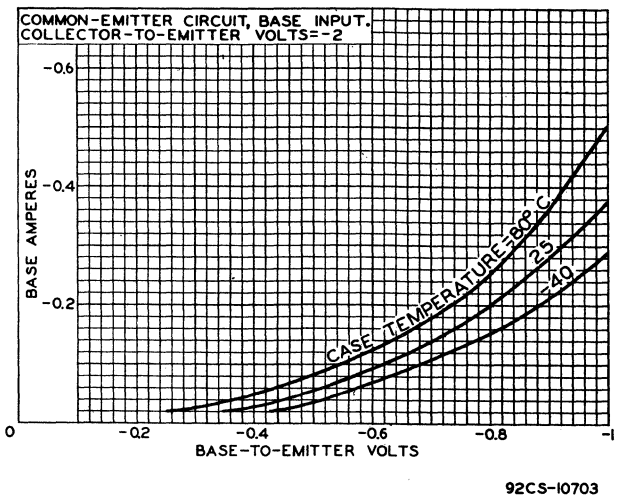


Fig. 2 – Typical Characteristics for Types 2N173, 2N277, 2N278, and 2N1099.

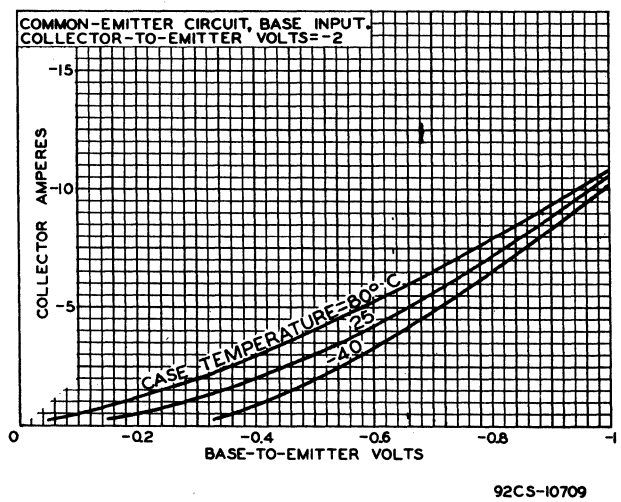


Fig. 3 – Typical Characteristics for Types 2N173, 2N277, 2N278, and 2N1099.

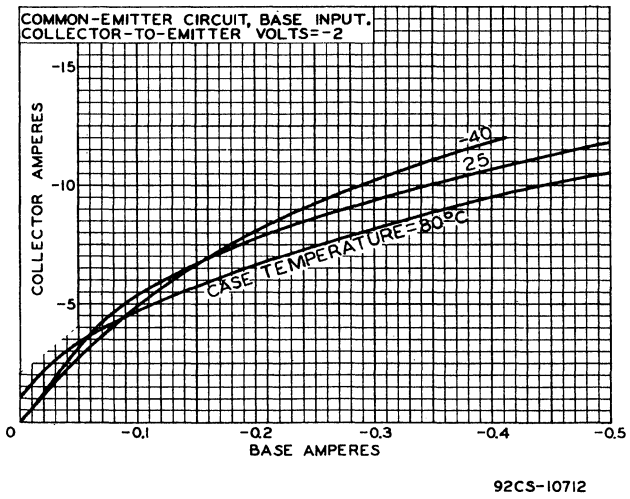


Fig. 4 - Typical Characteristics for Types 2N173, 2N277, 2N278, and 2N1099.

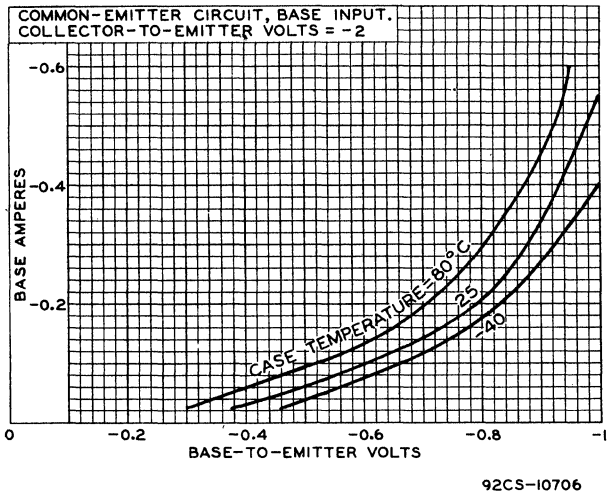


Fig. 5 - Typical Characteristics for Types 2N174, 2N1100, 2N1358, and 2N1412.

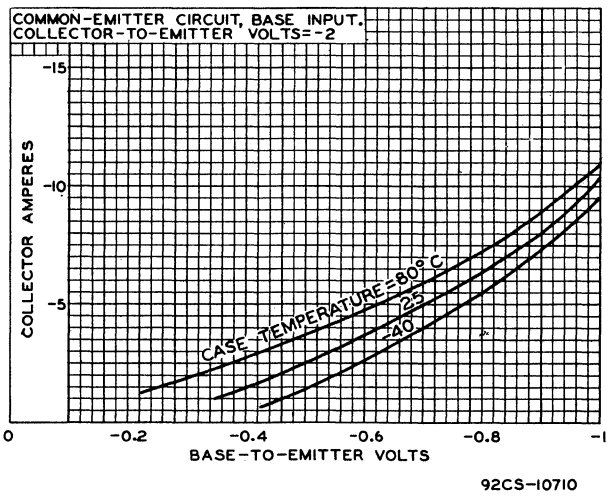


Fig. 6 - Typical Characteristics for Types 2N174, 2N1100, 2N1358, and 2N1412.

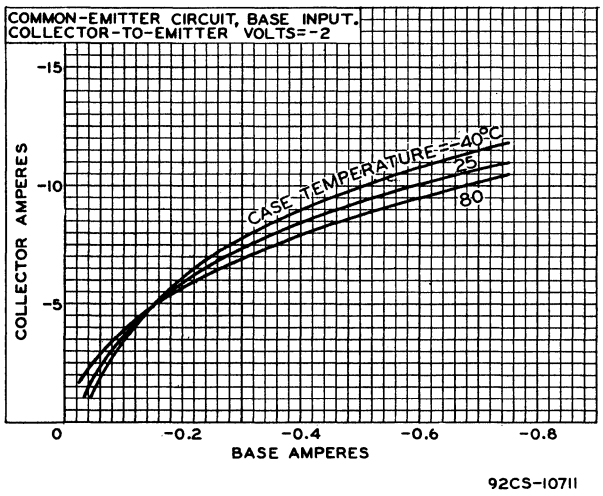


Fig. 7 - Typical Characteristics for Types 2N174, 2N1100, 2N1358, and 2N1412.

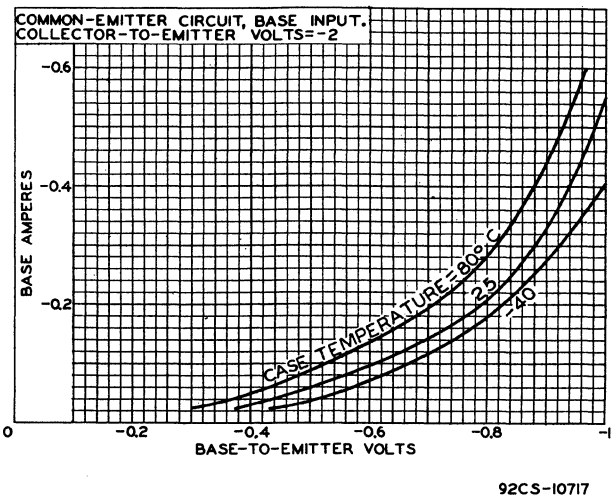


Fig. 8 - Typical Characteristics for Types 2N441, 2N442, and 2N443.

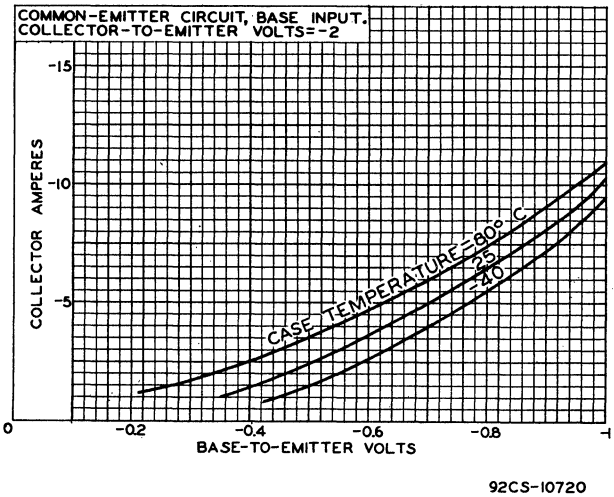


Fig. 9 - Typical Characteristics for Types 2N441, 2N442, and 2N443.

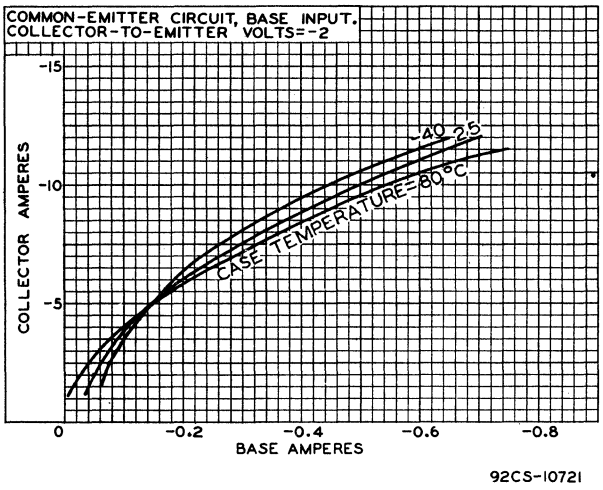


Fig. 10 - Typical Characteristics for Types 2N441, 2N442, and 2N443.

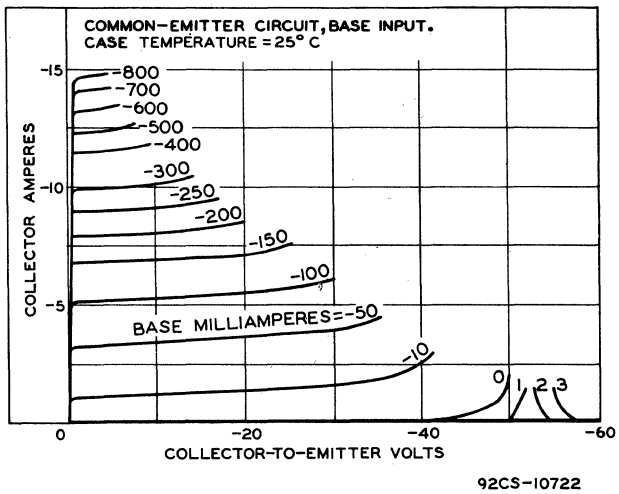


Fig. 11 - Typical Characteristics for Type 2N173.

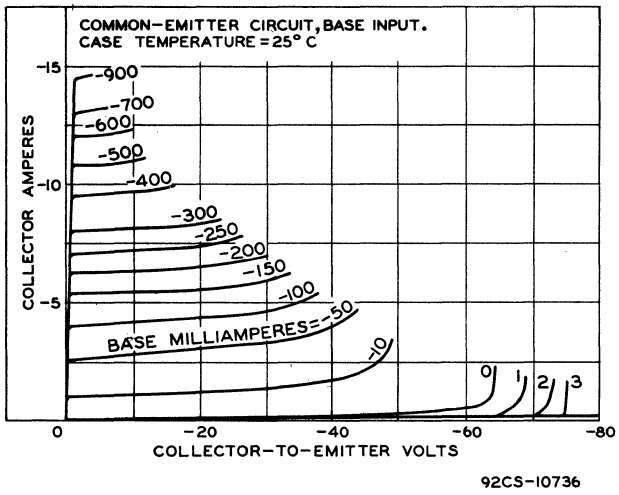


Fig. 12 - Typical Characteristics for Types 2N174 and 2N1358.

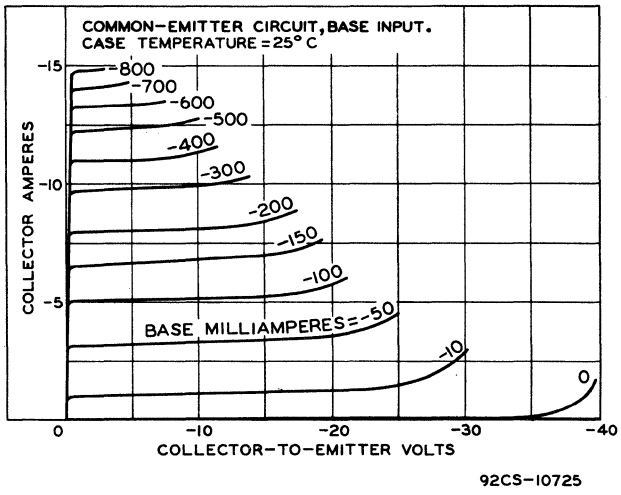


Fig. 13 - Typical Characteristics for Type 2N277.

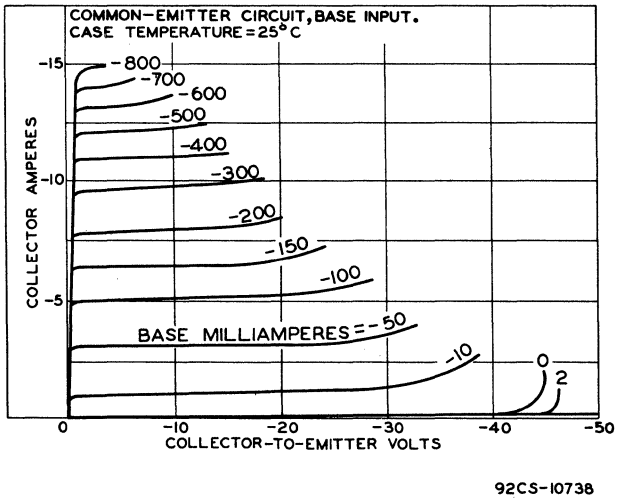


Fig. 14 - Typical Characteristics for Type 2N278.

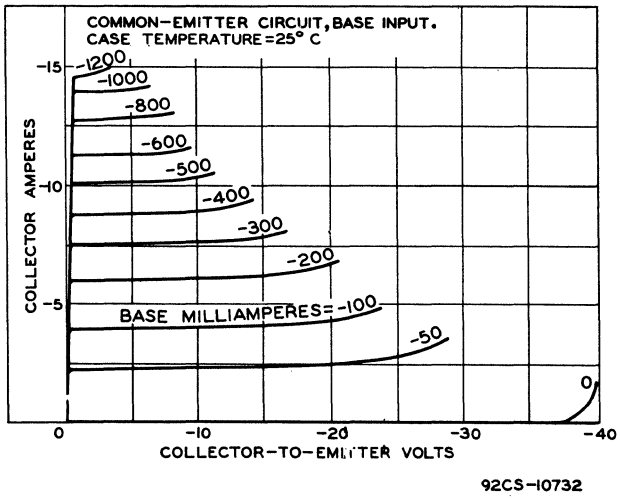


Fig. 15 - Typical Characteristics for Type 2N441.

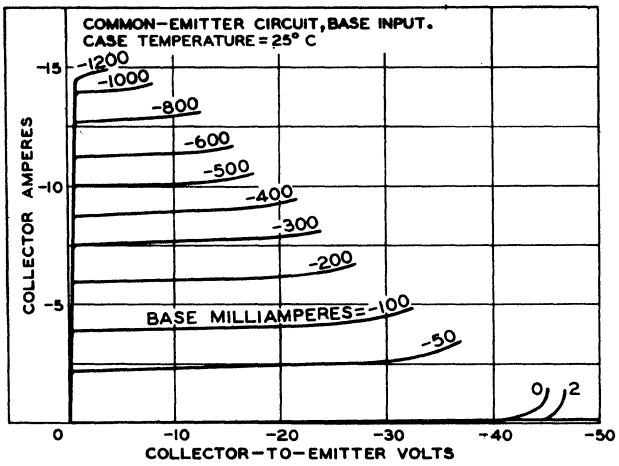


Fig.16 - Typical Characteristics for Type 2N442.

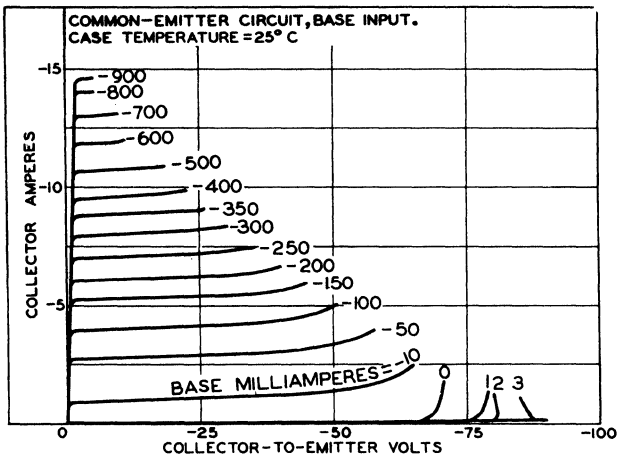


Fig.17 - Typical Characteristics for Types 2N1100 and 2N1412.

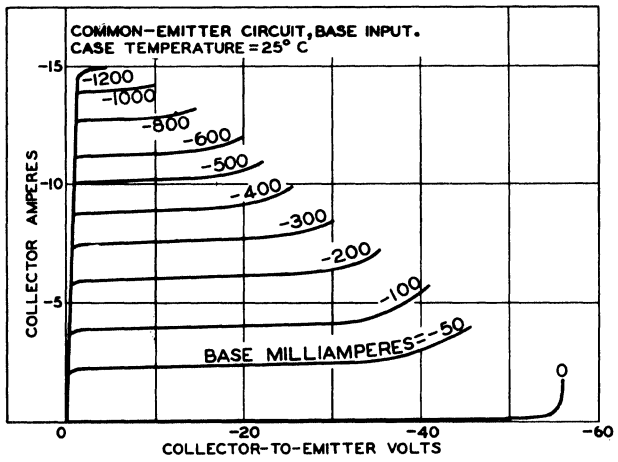


Fig.18 - Typical Characteristics for Type 2N443.

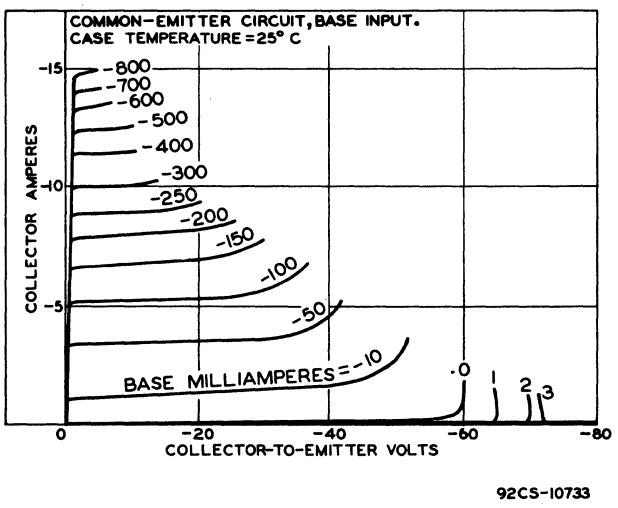
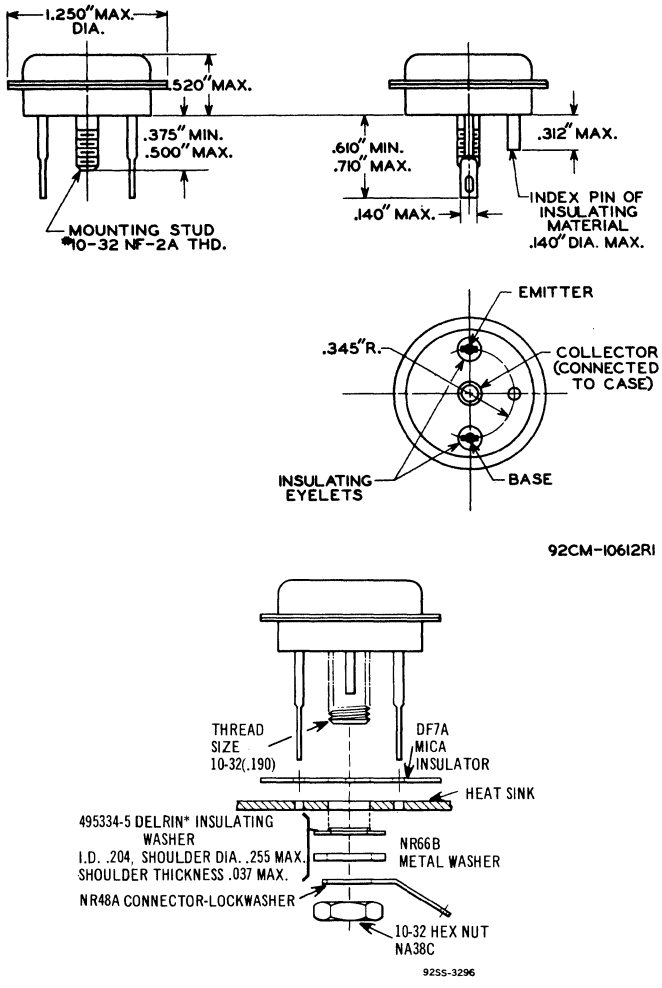


Fig.19 - Typical Characteristics for Type 2N1099.

DIMENSIONAL OUTLINE
JEDEC No. TO-36



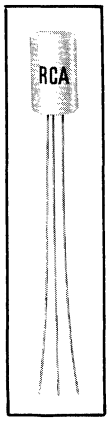
*REGISTERED TRADEMARK OF E.I. DUPONT DE NEMOURS & CO.

Suggested Mounting Arrangement.


RCA

GERMANIUM P-N-P TRANSISTOR

For AF-Amplifier Applications in Consumer-Product Equipment



JEDEC TO-1

RCA-2N217 is an alloy-junction transistor of the germanium pnp type especially suitable for use in large-signal audio frequency applications such as class B amplifier service and high-gain class A driver amplifier service. The RCA-2N217 transistor has characteristics which permit the design of amplifiers having high power sensitivity, low distortion, high power efficiency, and low battery drain. These characteristics make the 2N217 highly desirable for use in battery-operated portable transistorized receivers.

RCA-2N217 features exceptional stability, excellent uniformity of characteristics, substantially linear beta over the entire range of collector current, and a low collector cutoff current which makes it possible to achieve high circuit efficiency and minimize idling currents.

In a typical class B push-pull amplifier circuit, the 2N217 can provide a typical power gain of 33 dB and a power output of 300 milliwatts.

FEATURES

- excellent uniformity of characteristics
- low leakage currents:
  I_{CBO} = -7 μA max. at V_{CB} = -30 V
  I_{EBO} = -7 μA max. at V_{EB} = -10 V
- hermetically sealed JEDEC TO-1 package

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-35 max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-25 max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-12 max. V
COLLECTOR CURRENT, I_C	-0.15 max. A
TRANSISTOR DISSIPATION, P_T:	
At ambient temperatures: up to 25°C	165 max. mW
At ambient temperatures: above 25°C	Derate at 2.75 mW/°C
At case temperatures: up to 25°C	600 max. mW
At case temperatures: above 25°C	Derate at 10 mW/°C
TEMPERATURE RANGE:	
Operating	71 max. °C
Storage	-65 to +85 °C
LEAD TEMPERATURE (During Soldering):	
At distances not closer than 1/16" to seating surface, for 10 seconds max.	255 °C

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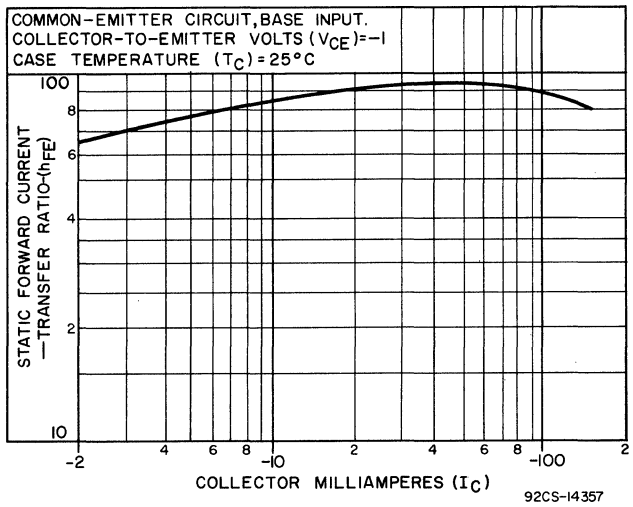


Fig. 1 - Typical DC Beta Characteristic for Type 2N217.

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Printed in U.S.A.
2N217 12-66
Supersedes issue dated 9-58

ELECTRICAL CHARACTERISTICS, at an Ambient Temperature, T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS						LIMITS			Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N217			
		V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-30				0		-	-	-7	μA
Emitter-Cutoff Current	I_{EBO}			-10	0			-	-	-7	μA
Collector-to-Emitter Breakdown Voltage	BV_{CEO}				-1		0	-25	-	-	V
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.05	0		-35	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0	0.007		-12	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				-50		-5	-	-	-0.15	V
Base-to-Emitter Voltage	V_{BE}		-1		-50			-0.2	-	-0.4	V
Small-Signal Forward Current-Transfer Ratio (Measured at 1 kHz)	h_{fe}		-6		-1			50	-	150	
Static Forward Current-Transfer Ratio	h_{FE}		-1		-50			65	-	120	
Collector-to-Base Output Capacitance (Measured at 0.5 MHz)	C_{obo}		-6			1		20	-	60	pF
Small-Signal Input Impedance	h_{ie}		-6			1		1000	-	4000	Ω

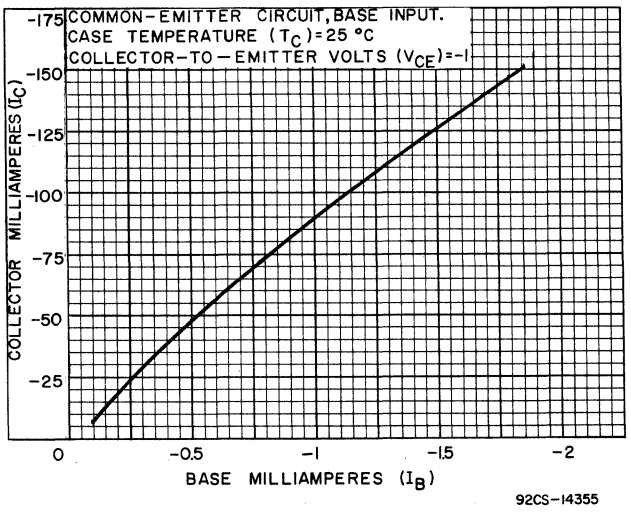


Fig.2 - Typical Current-Transfer Characteristic for Type 2N217.

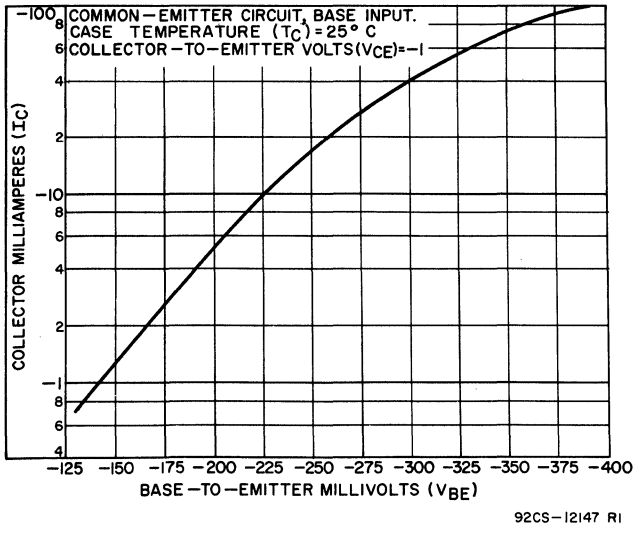


Fig.3 - Typical Transfer Characteristic for Type 2N217.

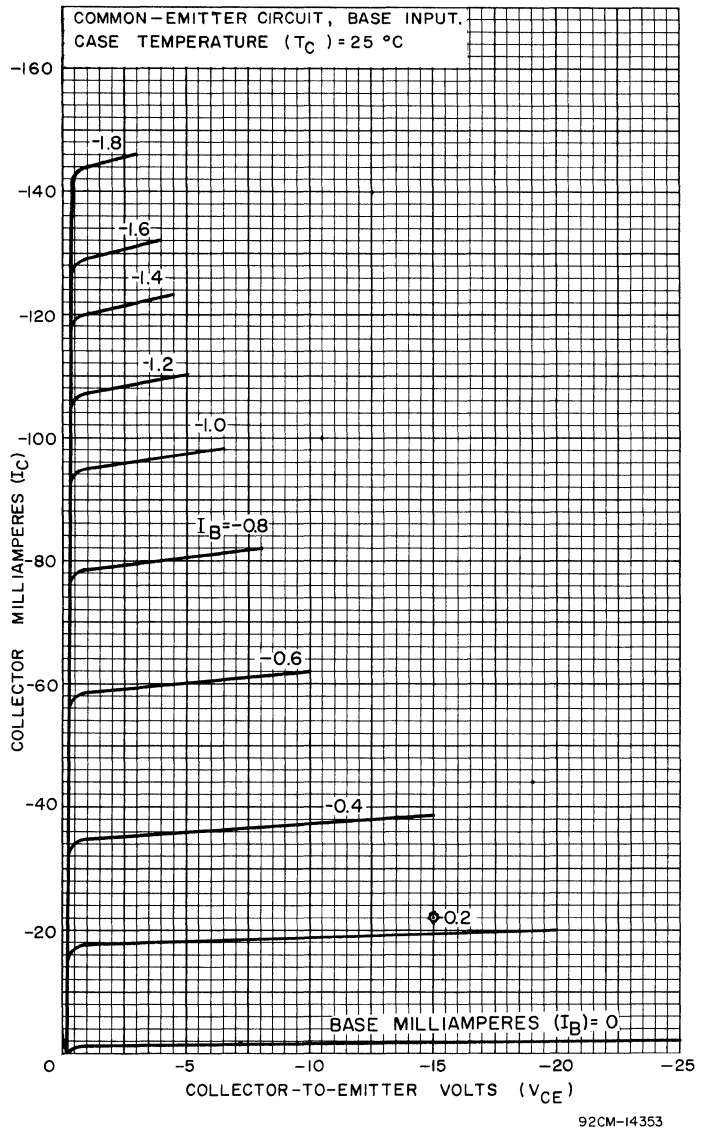


Fig.4 - Typical Collector Characteristics for Type 2N217.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

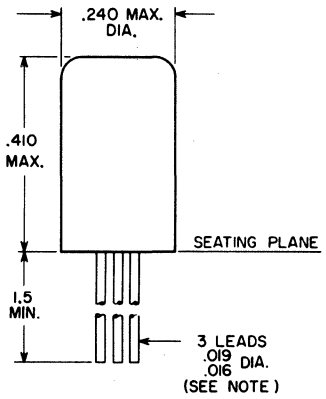
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variations, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

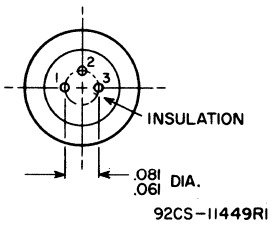
The 2N217 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connections to the base, emitter, and collector leads of the device may be soldered directly to the leads provided such connections are made at least 1/16 inch from the seating surface of the transistor, and provided care is taken to conduct excessive heat away from the lead seals during soldering. Failure to observe these precautions will result in cracking of the lead seals and permanent damage to the transistor.

DIMENSIONAL OUTLINE

JEDEC No. TO-1





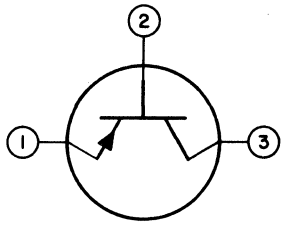
92CS-11449RI

DIMENSIONS IN INCHES

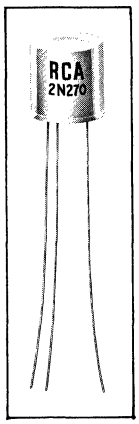
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM

LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR



GERMANIUM PNP TRANSISTOR



For AF-Amplifier Applications in Consumer-Product and Industrial Equipment

RCA-2N270 is an alloy-junction transistor of the germanium pnp type intended primarily for use in large-signal af-amplifier applications. RCA-2N270 features excellent uniformity of characteristics, low collector cut-off current and good linearity of beta over a wide range of collector currents.

The 2N270 is a hermetically sealed 3-lead device utilizing the JEDEC TO-7 case, and has all leads insulated from the case.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-25 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-12 max.	V
COLLECTOR CURRENT, I_C	-150 max.	mA
EMITTER CURRENT, I_E	150 max.	mA
TRANSISTOR DISSIPATION, P_T:		
At ambient temperatures up to 25°C	250 max.	mW
At ambient temperatures above 25°C. Derate at	4.17	mW/°C
TEMPERATURE RANGE:		
Operating	71 max.	°C
Storage	-65 to +85	°C
LEAD TEMPERATURE (During Soldering):		
At distances not closer than 1/16" to seating surface, for 10 seconds max.	230	°C

FEATURES

- high collector current capability: I_C = 150 mA max.
- high dissipation capability: P_T = 250 mW max. at T_A = 25°C
- good linearity of dc beta over a wide collector current range
- hermetically sealed JEDEC TO-7 case

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N270 12-66
Supersedes issue dated 10-58

ELECTRICAL CHARACTERISTICS AT $T_A = 25^oC$

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS			UNITS
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	TYPE 2N270			
		V	V	V	mA	mA	min.	typ.	max.	
Collector-Cutoff Current	I_{CBO}	-30				0	-	-	-16	μA
Emitter-Cutoff Current	I_{EBO}			-12	0		-	-	-12	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.016	0	-30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEX}			-5	-0.016		-25	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0	0.012	-12	-	-	V
Static Forward-Current Transfer Ratio	h_{FE}		-1		-150		50	70	140	
Gain-Bandwidth Product	f_T		-12		-2		-	1	-	MHz
Extrinsic Base-Lead Resistance	$r_{bb'}$		-12		-2		-	-	150	Ω
Thermal Resistance: (Junction-to-Ambient)	θ_{JA}						-	-	0.240	$^oC/W$

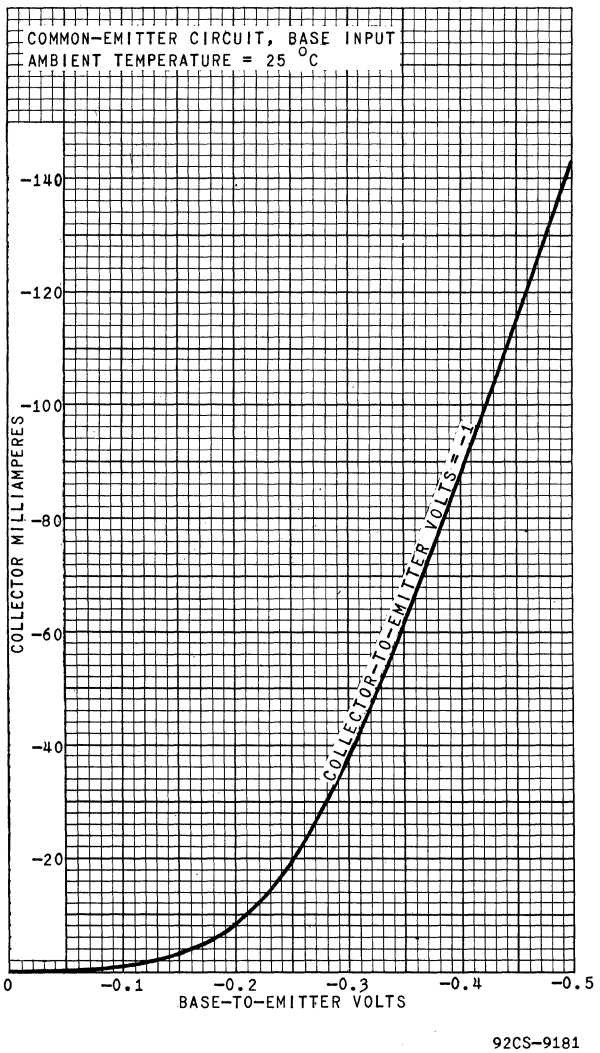


Fig. 1 - Typical Transfer Characteristic.

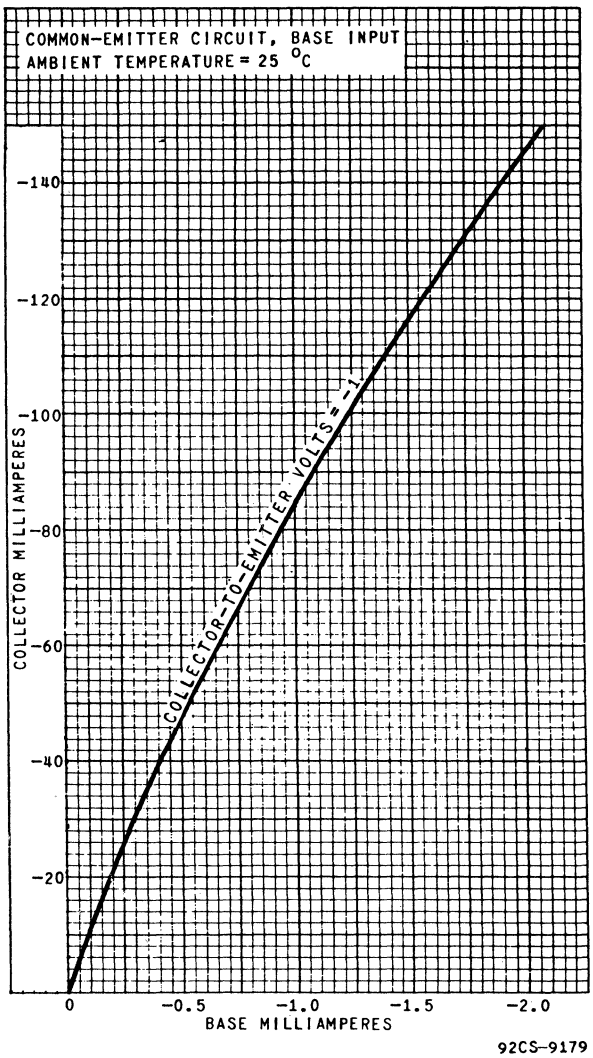


Fig. 2 - Typical Current Transfer Characteristic.

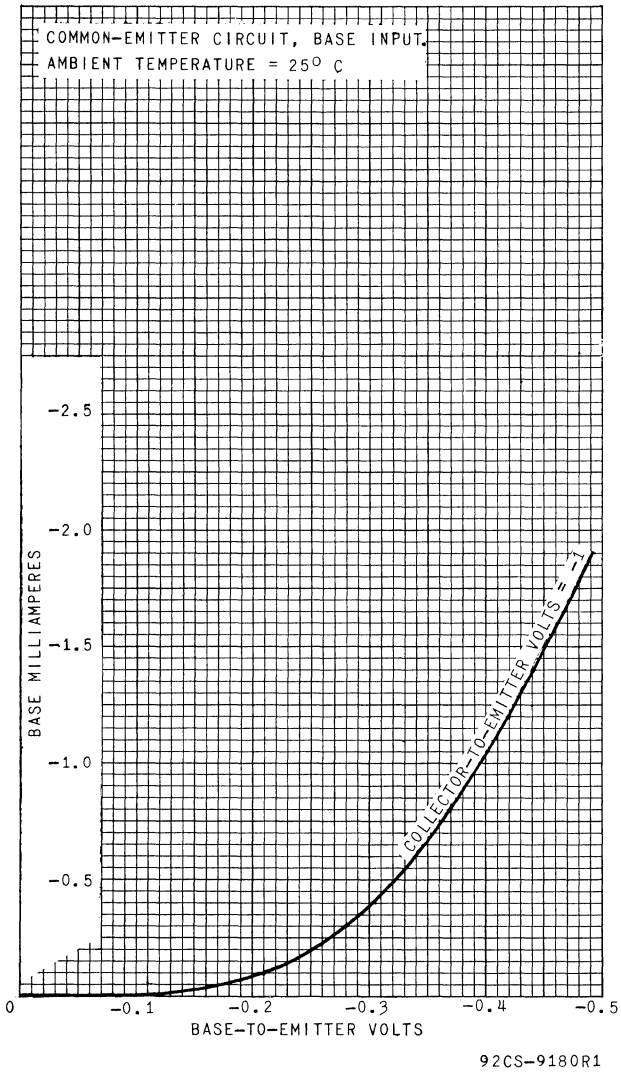


Fig. 3 - Typical Input Characteristic.

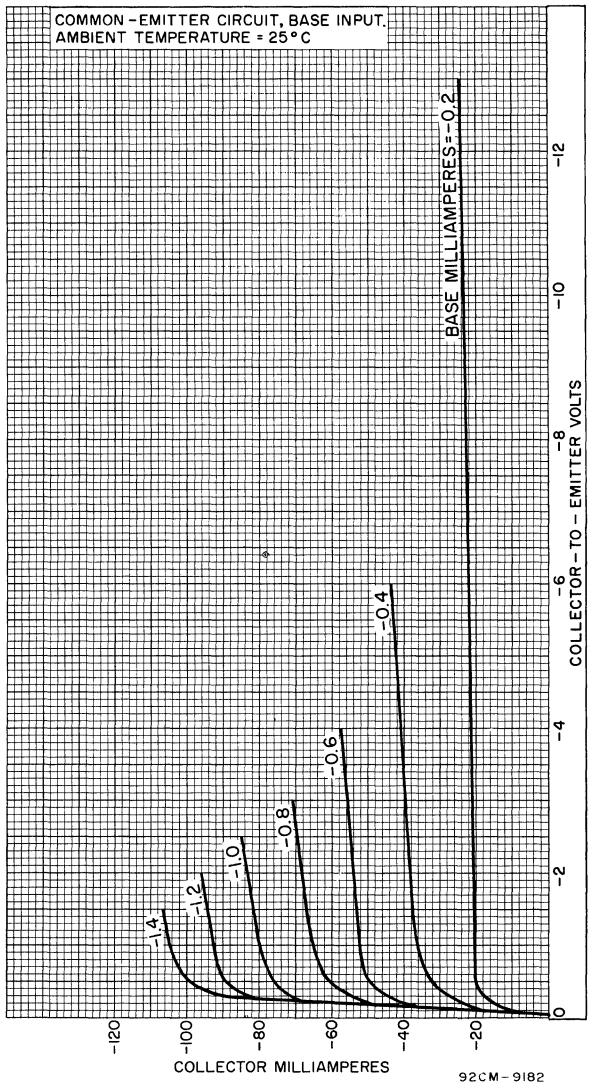


Fig. 4 - Typical Collector Characteristics.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

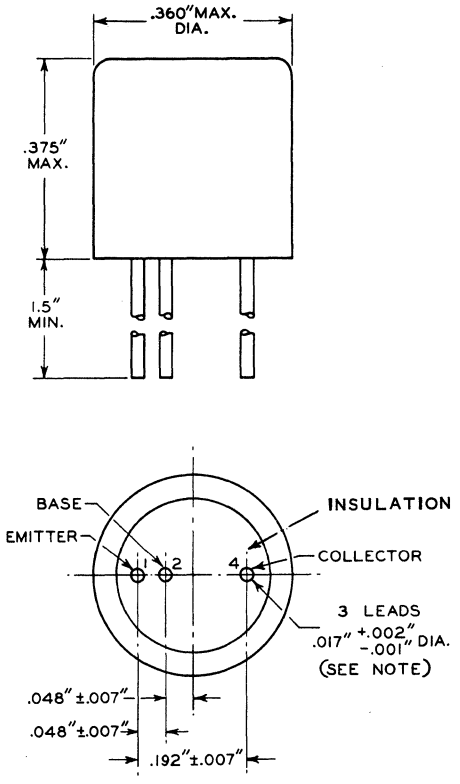
The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variations, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

The 2N270 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connections to the base, emitter, and collector leads of the device may be soldered directly to the leads provided such connections are made at least 1/16 inch from the seating surface of the transistor, and provided care is taken to conduct excessive heat away from the lead seals during soldering. Failure to observe these precautions will result in cracking of the lead seals and permanent damage to the transistor.

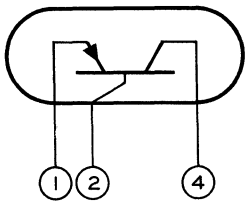
DIMENSIONAL OUTLINE



92CS-9176R4

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50" A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 4 – COLLECTOR

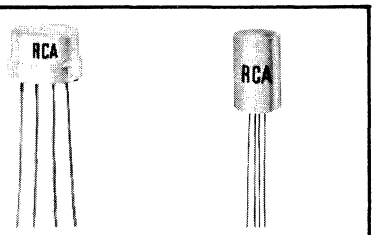
GERMANIUM P-N-P DRIFT TRANSISTORS

2N274 SERIES

File No. 2

RCA-2N274 Series are "drift" transistors of the germanium p–n–p type. They are intended especially for rf service because of their exceptional stability. They are useful in applications such as rf and if amplifiers, oscillators, mixers and converters, and low-level video amplifiers.

For RF Service



JEDEC TO-33 JEDEC TO-44

The design of these transistors features RCA's alloy junction technique and a carefully controlled base region for impurity distribution to produce a built-in accelerating (drift) field. The drift field propels the charge carriers from emitter to collector. Base resistance and collector-transition capacitance are reduced and performance at higher frequency is improved by the impurity distribution.

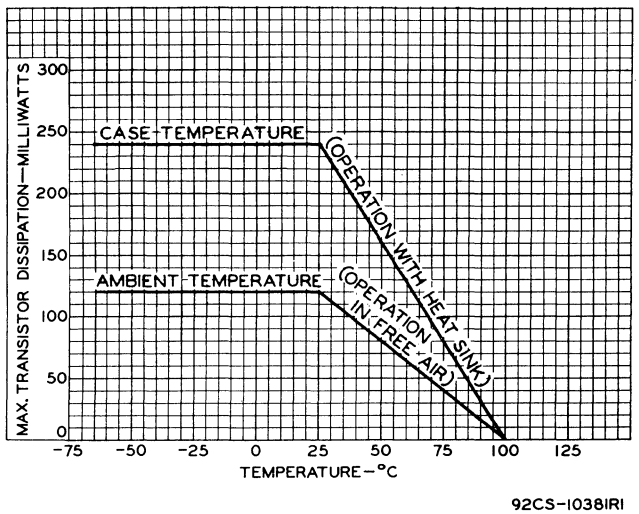
RCA TYPE NO.	Typical h_{fe}	Typical $f_{\alpha b}$ (MHz)	Minimum Power Gain (dB)	JEDEC Package
2N274	60	30	17 @ 12.5 MHz	TO–44
2N384	60	100	15 @ 50 MHz	TO–44
2N1023	60	120	18 @ 50 MHz	TO–44
2N1066	60	120	18 @ 50 MHz	TO–33
2N1224	60	30	17 @ 12.5 MHz	TO–33
2N1225	60	100	15 @ 50 MHz	TO–33
2N1226	60	30	17 @ 12.5 MHz	TO–33
2N1395	90	30	17 @ 12.5 MHz	TO–33
2N1396	90	100	15 @ 50 MHz	TO–33
2N1397	90	120	18 @ 50 MHz	TO–33

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

		All Types Except 2N1226	2N1226	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−40	−60	V
COLLECTOR-TO-EMITTER VOLTAGE With V_{BE} = 0.5 volt	V_{CEV}	−40	−60	V
COLLECTOR CURRENT	I_C	−10	−10	mA
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−0.5	−0.5	V
EMITTER CURRENT		10	10	mA
TRANSISTOR DISSIPATION (See Rating Chart Fig.1):	P_T			
At Ambient Temperature of 25° C for operation in free air		120	120	mW
At Case Temperature of 25° C for operation with heat sink		240	240	mW
AMBIENT TEMPERATURE RANGE Storage & Operating (Junction)		−65 to +100		°C

DISSIPATION DERATING CURVE (All Types)



92CS-10381RI

Fig. 1

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N274 Series 5/66
Reprinted from 1CE-203 3/60

ELECTRICAL CHARACTERISTICS

Ambient Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS				LIMITS						Units
		DC Collector Volts		DC Emitter mA	Signal Frequency MHz	Types 2N274 and 2N1224			Type 2N1226			
		V_{CB}	V_{CE}	I_E		Min.	Typical	Max.	Min.	Typical	Max.	
Collector Breakdown Voltage For I_C = –50 μA	BV_{CBO}			0		–40	–80		–60	–100		V
Punch-Through Voltage For V_{EB} = –0.5 volt and emitter open	V_p					–40	–80		–60	–100		V
Collector-Cutoff Current	I_{CBO}	–12		0			–4	–12		–4	–12	μA
Emitter-Cutoff Current For V_{EB} = –0.5 volt and collector open	I_{EBO}						–1	–12		–1	–12	μA
Collector-to-Base Capacitance	C_{ob}	–12		0			2	3		2	3	pF
Alpha-Cutoff Frequency	$f_{\alpha b}$	–12		1.5			30			30		MHz
Small-Signal Current Transfer Ratio (Beta)	h_{fe}		–12	1.5	1 kHz	20	60	175	20	60	175	
Power Gain[a]	PG	–12		1.5	50							
			–12	1.5	30							
		–12		1.5	12.5	17	22	27	17	22	27	dB
		–12		1.5	1.5	40	45	50	40	45	50	dB
Input Resistance: (AC output-circuit shorted)	R_{in}	–12		1.5	50							
			–12	1.5	30							
		–12		1.5	12.5		150			150		Ω
		–12		1.5	1.5		1350			1350		Ω
Output Resistance: (AC input-circuit shorted)	R_{out}	–12		1.5	50							
			–12	1.5	30							
		–12		1.5	12.5		4000			4000		Ω
		–12		1.5	1.5		70000			70000		Ω
Thermal Resistance: Between junction and case	θ_{J-C}							0.31			0.31	°C/mW
Between junction and free air	θ_{J-A}							0.62			0.62	°C/mW

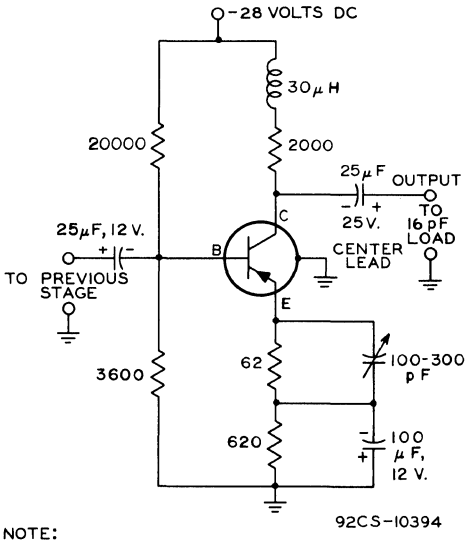
[a]Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer insertion losses not included).

Typical Operation of the 2N274 Series in the Video Amplifier Circuit of Fig. 2:

Ambient Temperature Range −65 to +55° C

	2N274, 2N1224 2N1226, 2N1395	2N384 2N1225 2N1396	2N1023 2N1066 2N1397	
DC Collector-to-Emitter Voltage	−12	−12	−12	volts
DC Emitter Current	5.8	5.8	5.8	mA
Source Impedance	150	150	150	ohms
Capacitive Load	16	16	16	pF
Frequency Response	20 Hz to 9 MHz	20 Hz to 10 MHz	20 Hz to 11 MHz	
Pulse Rise Time	0.039	0.035	0.032	
Voltage Gain	26	26	26	dB
Maximum Peak-to-Peak Output Voltage	20	20	20	volts

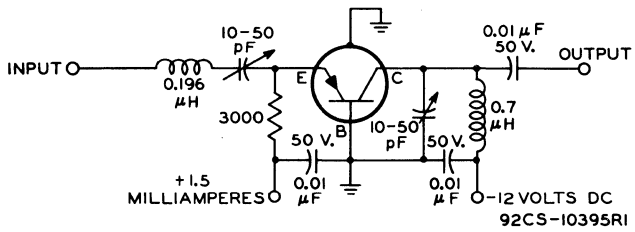
VIDEO AMPLIFIER CIRCUIT (All Types)



NOTE:
ALL RESISTANCE VALUES ARE IN OHMS.
ALL RESISTORS ARE 1/4 WATT.

Fig. 2

50-MHz RF AMPLIFIER CIRCUIT (Types 2N384, 2N1023, 2N1066, 2N1225, 2N1396, and 2N1397.)



NOTE:
ALL RESISTANCE VALUES ARE IN OHMS.
ALL RESISTORS ARE 1/4 WATT.

Fig. 3

PERFORMANCE CHARACTERISTICS (Types 2N1023, 2N1066, and 2N1397.)

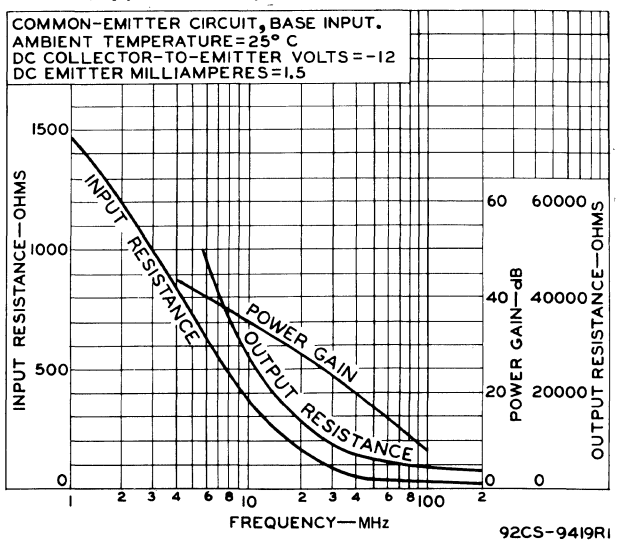


Fig. 4

PERFORMANCE CHARACTERISTICS (Types 2N384, 2N1225, and 2N1396.)

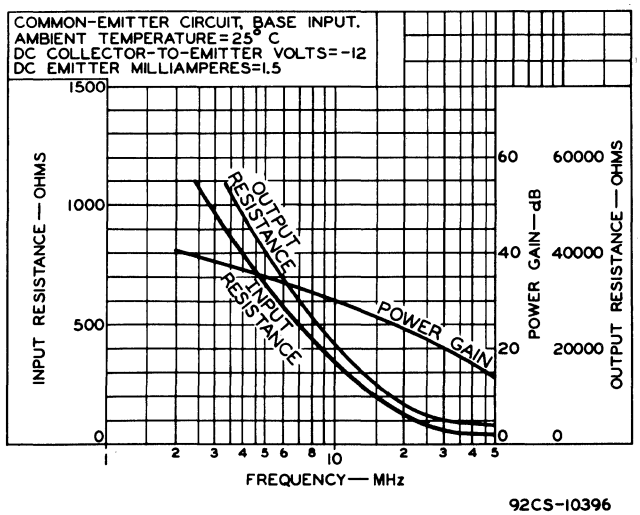


Fig. 5

PERFORMANCE CHARACTERISTICS
(Types 2N274, 2N1224, 2N1226, and 2N1395.)

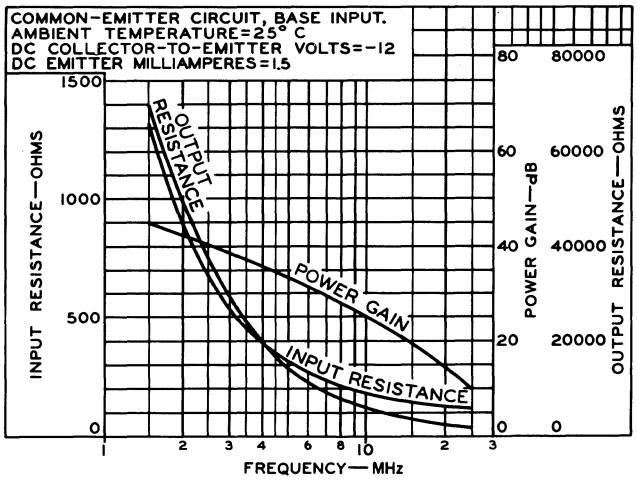


Fig. 6

TYPICAL COLLECTOR CHARACTERISTICS
(Types 2N274, 2N384, 2N1023, 2N1066, 2N1224, 2N1225, and 2N1226.)

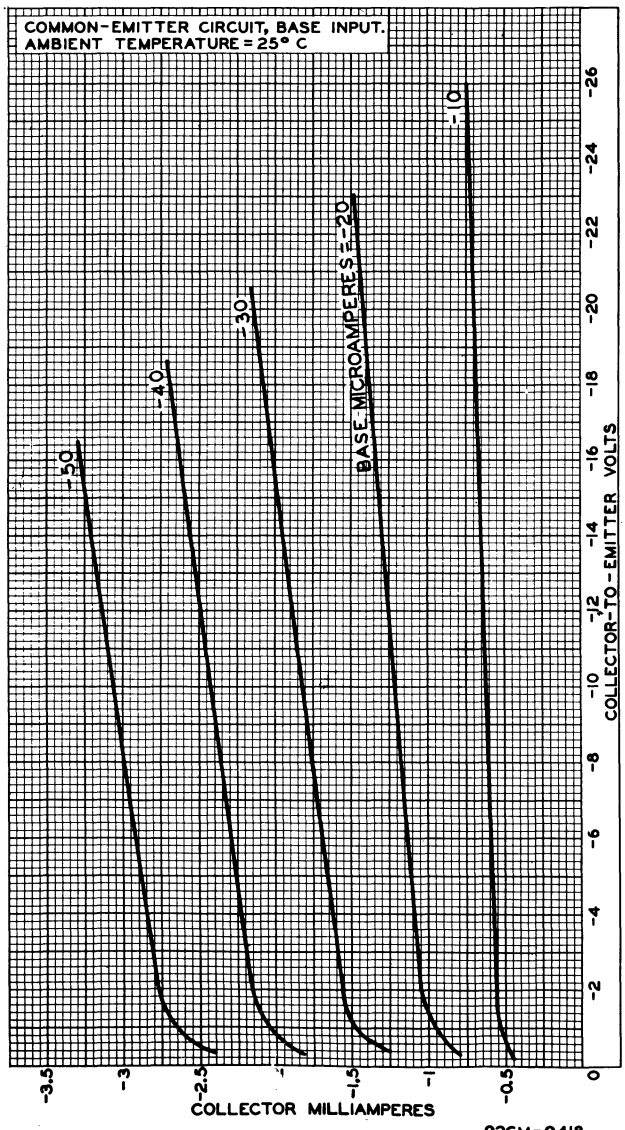


Fig. 7

TYPICAL COLLECTOR CHARACTERISTICS
(Types 2N1395, 2N1396, and 2N1397.)

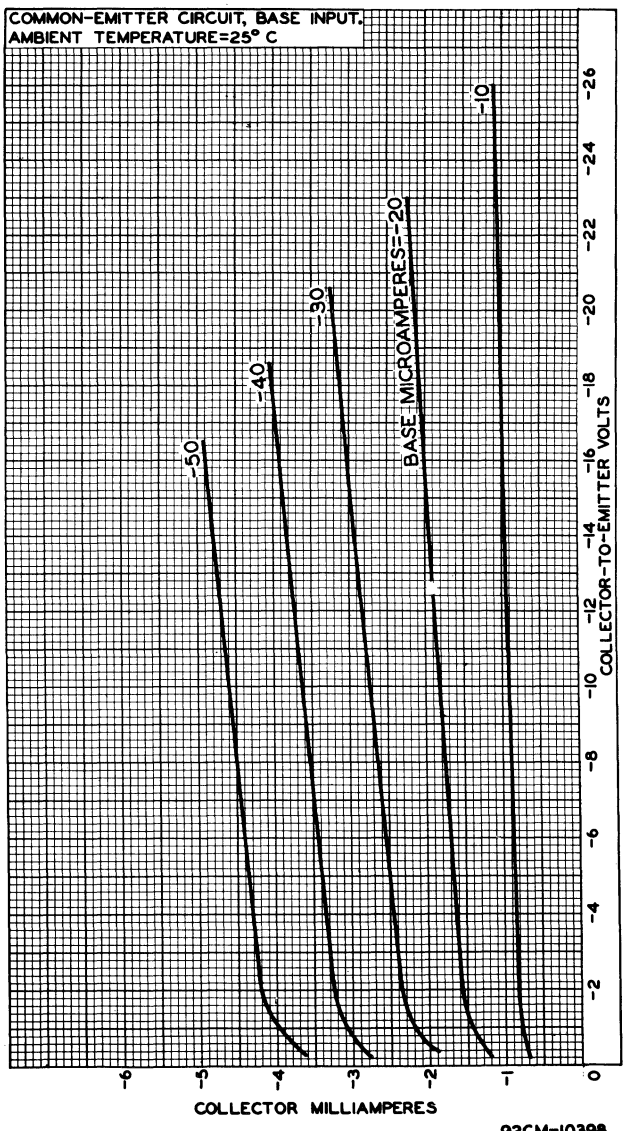


Fig. 8

Symbol	LIMITS															Units
	Type 2N1395			Types 2N384 and 2N1225			Type 2N1396			Types 2N1023 and 2N1066			Type 2N1397			
	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	Min.	Typical	Max.	
BV_{CBO}	−40	−80		−40	−80		−40	−80		−40	−80		−40	−80		V
V_p	−40	−80		−40	−80		−40	−80		−40	−80		−40	−80		V
I_{CBO}		−4	−12		−4	−12		−4	−12		−4	−12		−4	−12	μA
I_{EBO}		−1	−12		−1	−12		−1	−12		−1	−12		−1	−12	μA
C_{ob}		2	3		2	3		2	3		2	3		2	3	pF
$f_{\alpha b}$		30			100			100			120			120		MHz
h_{fe}	50	90	175	20	60	175	50	90	175	20	60	175	50	90	175	
PG	 17 40	 22 45	 27 50	15 16 24	18 20 28	21 24 32	15 16 24	18 20 28	21 24 32	18 20	21 23	24 26	18 20	21 23	24 26	dB dB dB dB
R_{in}		 150 1350			30 50 250			30 50 250			25 100			25 100		Ω Ω Ω Ω
R_{out}		 4000 70000			5000 5000 16000			5000 5000 16000			8000 8000			8000 8000		Ω Ω Ω Ω
R_T			0.31 0.62			0.31 0.62			0.31 0.62			0.31 0.62			0.31 0.62	°C/mW °C/mW

OPERATING CONSIDERATIONS

The flexible leads of these transistors are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage these transistors.

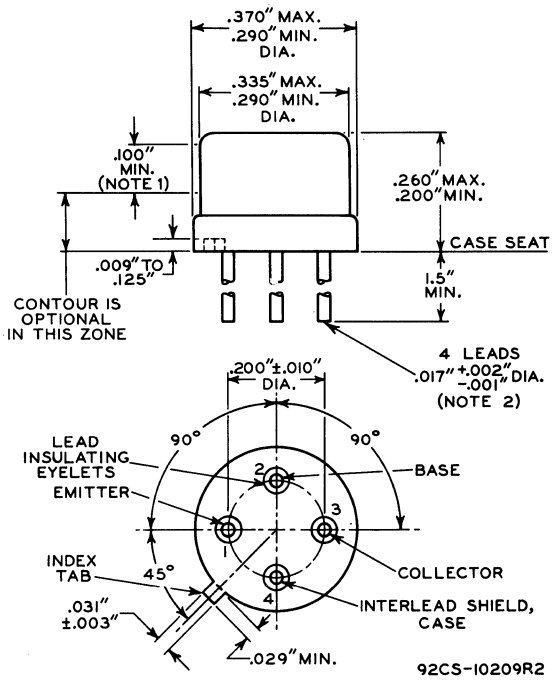
It is recommended that these transistors not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to these transistors.

These transistors utilize shielding to minimize interlead capacitance and to minimize coupling to adjacent circuit components. This shielding is provided by a fourth lead which is internally connected to the metal case. For optimum performance, it is recommended that this lead be connected to the chassis ground.

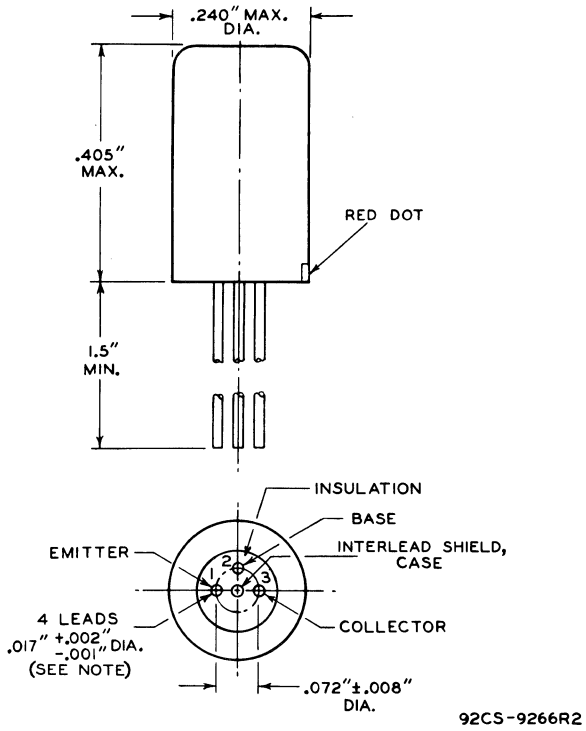
The 2N1224, 2N1225, 2N1226, 2N1066, 2N1395, 2N1396, and 2N1397 are intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If these transistors are used in double-side printed circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

When dip soldering is employed in the assembly of printed-circuitry using these transistors, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.

DIMENSIONAL OUTLINE for Types 2N1066, 2N1224, 2N1225 2N1226, 2N1395, 2N1396 and 2N1397 JEDEC No. TO-33



DIMENSIONAL OUTLINE for Types 2N274, 2N384, and 2N1023 JEDEC No. TO-44



NOTE 1: The diameter in this zone is controlled for automatic handling. The total variation in actual diameter from the true diameter, due to taper and out of round within this zone will not exceed 0.010".

NOTE 2: The specified lead diameter applies in the zone between 0.05" and 0.25" from the base seat. Between 0.25" and 1.5" a maximum diameter of 0.021" is held. Outside of these zones the lead diameter is not controlled.

NOTE: The specified lead diameter applies in the zone between 0.050" and 0.250" from the plane of the actual bottom of the base. Between 0.250" and 1.50" a maximum of 0.021" diameter is held. Outside of these zones, the lead diameter is not controlled.

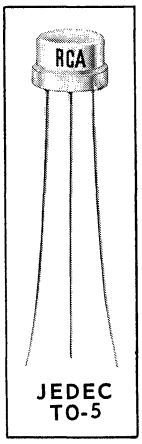
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RCA COMPUTER TRANSISTORS

2N388
2N388A

GERMANIUM N-P-N MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



JEDEC TO-5

- high minimum beta
- high power-dissipation capability
- high collector-current rating
- high temperature rating
- high alpha-cutoff frequency — 14 Mc typical
- tested in strict accordance with military specification MIL-S-19500B
- rugged four-poster, double-weld construction for reliable performance

RCA-2N388 and 2N388A are germanium n-p-n alloy-junction transistors specifically designed for medium-speed switching applications in data-processing equipment.

Maximum Ratings, *Absolute-Maximum Values:*

	2N388	2N388A	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER}: With 10000-ohm resistor between base and emitter	20	20 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEV}: With V_{BE} = -0.5 v.	-	40 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	15	15 max.	volts
COLLECTOR CURRENT, I_C	200	200 max.	ma
TRANSISTOR DISSIPATION: At free-air temperatures up to 25°C	150	150 max.	mw
above 25°C		See *Fig. 1*	
TEMPERATURE RANGE: Storage	-65 to +100	-65 to +100	°C
Operating (Junction)			°C
LEAD TEMPERATURE: 1/16" ± 1/32" from seating surface for 10 seconds max.	235	235 max.	°C

ELECTRICAL CHARACTERISTICS, *Ambient Temperature = 25°C*

Characteristics	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N388		Type 2N388A		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	40			0			-	-	-	40	μa
		25			0			-	10	-	10	μa
		1			0			-	5	-	5	μa
Emitter-Cutoff Current	I_{EBO}			15			0	-	10	-	10	μa
				1			0	-	5	-	5	μa
Collector Current: With base-to-emitter resistance (R_{BE}) = 10000 ohms	I_{CER}		20					-	50	-	50	μa
Collector Current: With base reversed biased (V_{BE} = -0.5 volt)	I_{CEV}		40					-	-	-	50	μa
DC Forward-Current Transfer Ratio	h_{FE}		0.75				200	30	-	30	-	
			0.50				30	60	180	60	180	
Base-to-Emitter Voltage	V_{BE}					10	200	-	1.5	-	1.5	volts
						4	100	-	0.8	-	0.8	volt
Alpha-Cutoff Frequency	$f_{\alpha b}$	6					1	5	-	5	-	Mc
Collector-to-Base Capacitance	C_{ob}	6					1	-	20	-	20	pf
Turn-On Time (Delay time plus rise time): V_{CC} = 20 volts I_{B_1} = 10 ma, R_C = 100 ohms I_{B_2} = -10 ma	$t_d + t_r$						200	-	1.0	-	1.0	μsec
Storage Time: V_{CC} = 20 volts I_{B_1} = 10 ma, R_C = 100 ohms I_{B_2} = -10 ma	t_s						200	-	0.7	-	0.7	μsec
Fall Time: V_{CC} = 20 volts I_{B_1} = 10 ma, R_C = 100 ohms I_{B_2} = -10 ma	t_f						200	-	0.7	-	0.7	μsec

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2N388, 2N388A 6-66
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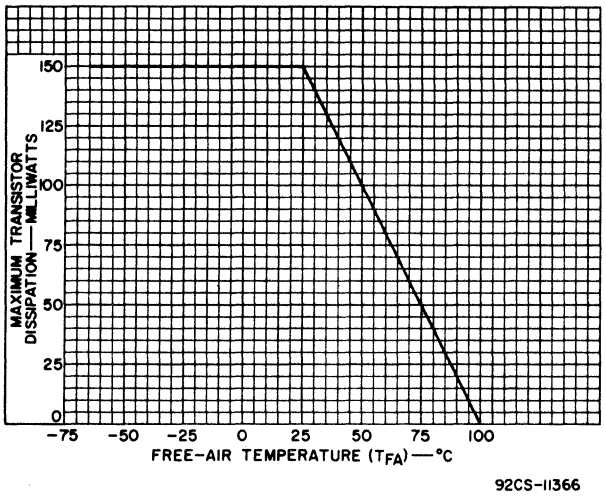
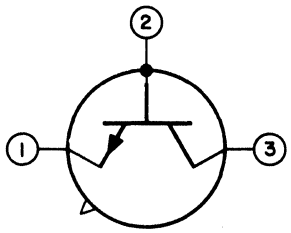


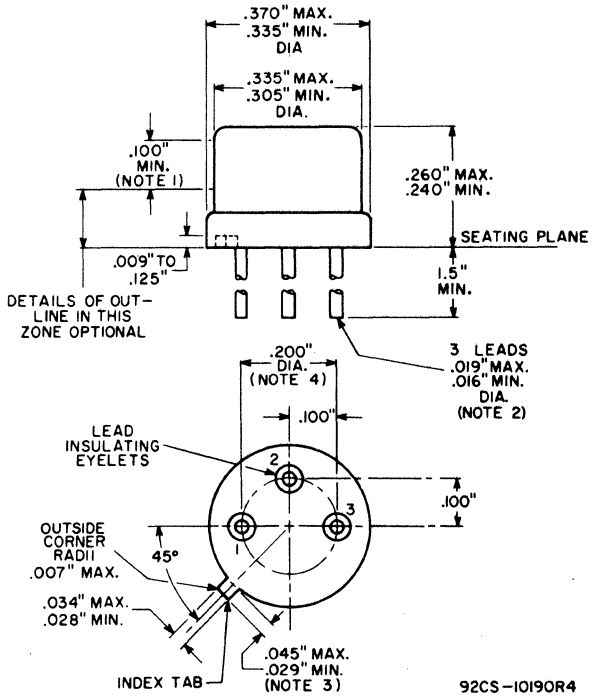
Fig. 1 - Rating Chart for Types 2N388 and 2N388A.

TERMINAL DIAGRAM
(Bottom View)



Lead 1 - Emitter
Lead 2 - Base, Case
Lead 3 - Collector

DIMENSIONAL OUTLINE
(JEDEC No. TO-5)



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

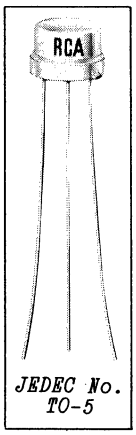
NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" − 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

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GERMANIUM P-N-P MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



JEDEC No. TO-5

RCA-2N395, 2N396, 2N397 and 40403 are germanium p-n-p alloy-junction transistors specifically designed for medium-speed switching applications in military and industrial data-processing equipment.

The 2N395, 2N396, 2N397 and 40403 utilize a hermetically sealed metal JEDEC TO-5 package. The 2N395, 2N396 and 2N397 have the base electrode internally connected to the case. The 40403 has all leads insulated from the case.

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N395	2N396	2N397	40403		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-30	-30	-30	-30	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER}:						
With 10000-ohm resistor between base and emitter	-15	-20	-15	-	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-	-	-	-20	max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-20	-20	-20	-20	max.	volts
COLLECTOR CURRENT, I_C	-200	-200	-200	-200	max.	ma
TRANSISTOR DISSIPATION, P_T:						
At free-air temperatures up to 25° C	150	150	150	200	max.	mw
At free-air temperatures above 25° C	*See Figs. 1 and 2.*					
TEMPERATURE RANGE:						
Storage	-65 to +100					°C
Operating	-65 to +85					°C
LEAD TEMPERATURE:						
≥ 1/16" from seating surface for 10 seconds max.	230	230	230	230	max.	°C

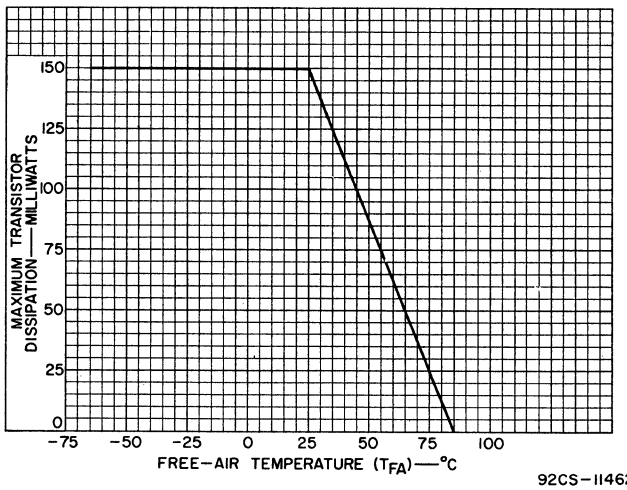


Fig. 1 - Rating chart for types 2N395, 2N396, and 2N397.

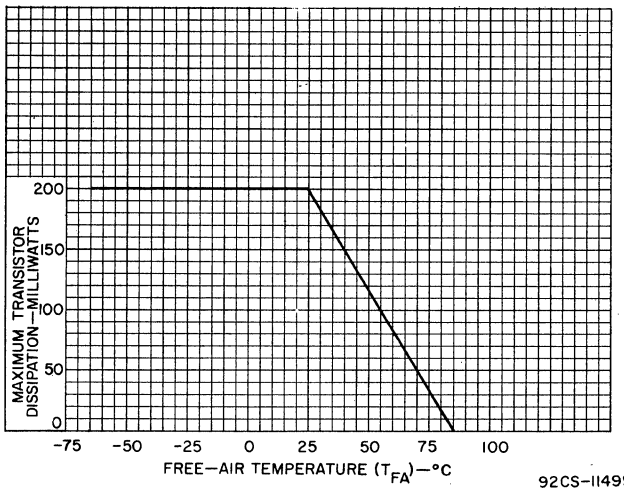


Fig. 2 - Rating chart for type 40403.

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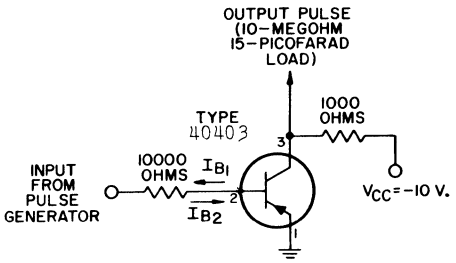
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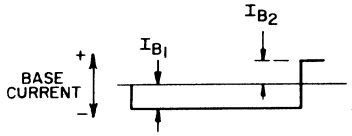
Printed in U.S.A.
2N395, 2N396, 2N397, 40403 9-66
Supersedes ICE-263 Dated 2-62

ELECTRICAL CHARACTERISTICS, *Free-Air Temperature = 25° C Unless Otherwise Specified*

Characteristics	Symbol	TEST CONDITIONS						LIMITS								Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N395		Type 2N396		Type 2N397		Type 40403		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open, and a free-air temperature of: 25° C	I_{CBO}	-15			0			-	-6			-	-6			μa
25° C		-20			0					-	-6			-	-6	μa
71° C		-20			0									-	-120	μa
Emitter-Cutoff Current	I_{EBO}			-10			0	-	-6	-	-6	-	-6	-	-6	μa
Collector Current: With base reversed biased, V_{BB} = 2 volts, and R_b = 10000 ohms	I_{CEX}		-20											-	-6	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		-0.1	-30	-	-30	-	-30	-	-30	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.1		0	-20	-	-20	-	-20	-	-20	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	-0.6	-	-	-	-	-	-	-20	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					-2.5	-50					-	-0.2			volt
						-3.3	-50			-	-0.2			-	-0.2	volt
						-5	-50	-	-0.2							volt
DC Collector-to-Emitter Reach-Through Voltage*	V_{RT}							-15	-	-20	-	-15	-	-20	-	volts
Static Forward-Current Transfer Ratio: For free-air temperature of: 25° C	h_{FE}		-1				-10	20	150	30	150	40	150	30	150	
25° C			-0.35				-200	10	-	15	-	20	-	15	-	
-55° C			-1				-10							20	-	
Small-Signal, Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}	-5			1			3	-	5	-	10	-	5	-	Mc
Collector-to-Base Capacitance	C_{ob}	-5			1			-	20	-	20	-	20	-	20	pf
Delay Time (See *Fig.3*)) $I_{B2} = -I_{B1}$ = 1.0 ma	t_d						-10							0.10	0.20	μsec
Rise Time (See *Fig.3.*) $I_{B2} = -I_{B1}$ = 1.0 ma	t_r						-10							0.20	0.65	μsec
Storage Time (See *Fig.3.*) $I_{B2} = -I_{B1}$ = 1.0 ma	t_s						-10							0.25	0.80	μsec
Fall Time (See *Fig.3.*) $I_{B2} = -I_{B1}$ = 1.0 ma	t_f						-10							0.20	0.40	μsec

* The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.



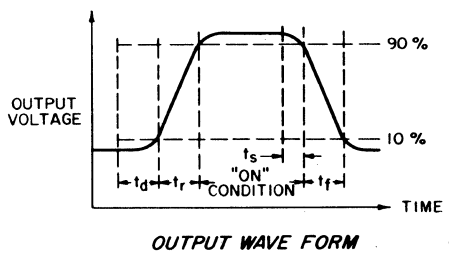


INPUT WAVE FORM

THE RISE AND FALL TIMES OF THE INPUT WAVE FORM SHOULD BE LESS THAN 10 NANOSECONDS.

NOTE: ALL RESISTANCE VALUES HAVE ± 1% TOLERANCE.

t_d = Delay Time
t_r = Rise Time
t_s = Storage Time
t_f = Fall Time

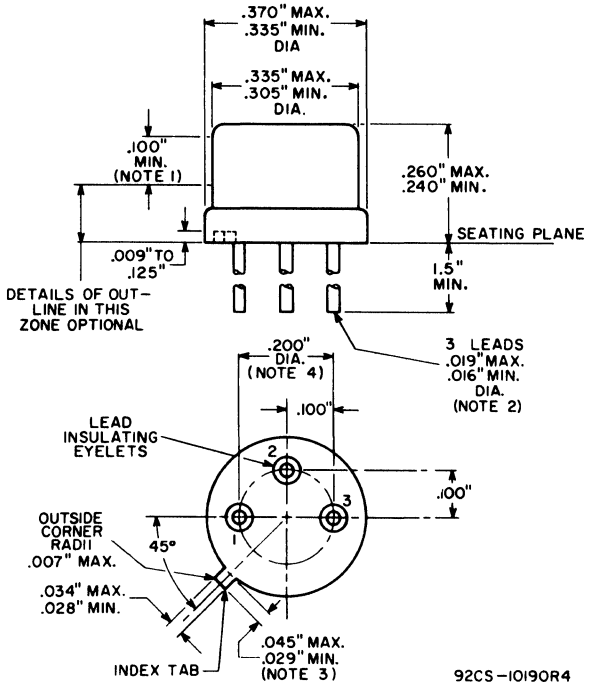


OUTPUT WAVE FORM

92CS-11501

Fig.3 - Circuit Used to Measure Switching Time for Type 40403.

DIMENSIONAL OUTLINE
(JEDEC No.TO-5)



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

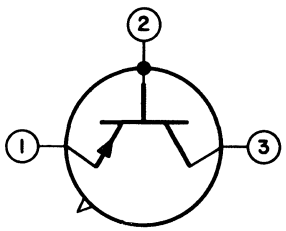
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

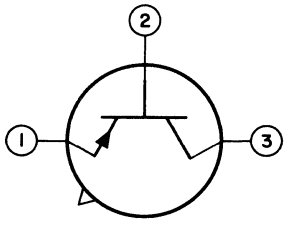
TERMINAL DIAGRAMS
(Bottom View)

2N395, 2N396, 2N397



Lead 1 - Emitter
Lead 2 - Base, Case
Lead 3 - Collector

40403

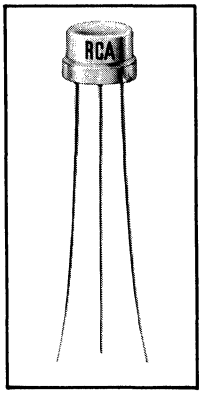


Lead 1 - Emitter
Lead 2 - Base, Case
Lead 3 - Collector


RCA

GERMANIUM P-N-P HIGH-VOLTAGE TRANSISTORS

For "On-Off" Control Applications



JEDEC TO-5

- 105-volt collector-to-emitter reach-through voltage (V_{RT})
- 105-volt collector-to-emitter voltage (V_{CES})
- wide storage and operating temperature ranges
- high collector-current ratings — to 200 ma

RCA-2N398B, 2N398A, and 2N398 are high-voltage germanium alloy-junction transistors of the p-n-p type. These transistors are intended for direct "on-off" control of high-voltage, low-power devices such as neon indicators, relays, incandescent-lamp indicators, indicator counters of electronic computers, and similar applications in critical industrial and military equipment.

The 2N398B, 2N398A, and 2N398 feature a minimum collector-to-base breakdown voltage and collector-to-emitter reach-through voltage of -105 volts. This value permits the design of neon indicator circuits in which one of these transistors can switch the full firing voltage of the indicator lamp. Because these transistors have a minimum dc forward-current transfer ratio of 20, neon indicating circuits can be designed to perform the functions of a logic circuit without the use of a separate logic stage.

The 2N398B is a direct replacement for the 2N398A and 2N398. It is manufactured under stringent quality controls and is tested in strict accordance with rigid procedures conforming to the mechanical, environmental, and life requirements of MIL-S-19500B. Furthermore, sample lots of each production run of the 2N398B are tested to special ratings and each transistor in the sample lot must pass rigorous controlled life-performance tests.

The 2N398B, in addition to having a higher dissipation rating and a lower value of thermal resistance than the 2N398A and 2N398, has lower collector-cutoff current and tightly controlled values of I_{CBO}, I_{CER}, and I_{CES}.

In addition, the 2N398B, because of its exceptionally low I_{CBO}, controlled small-signal beta (h_{fe}), and controlled cutoff frequency (f_{hfb}), is particularly well suited for the design of amplifiers for industrial service.

RCA-2N398B Features:

- conservative ratings — to permit reliable operation without danger of thermal runaway
- exceptionally high dissipation rating — 250 mw at T_{FA} = 25° C (at least 66% higher than dissipation rating of 2N398A)
- exceptionally low thermal resistance — 0.3 °C/mw (at least 40% lower than thermal resistance of 2N398A)
- controlled I_{CBO} of -300 μa max. at 71° C and V_{CB} = -105 volts
- controlled I_{CES} of -300 μa max.
- controlled I_{CER} of -300 μa max.
- controlled operating and storage life-performance tests
- Special Ratings and Performance Data:
  temperature cycling, thermal shock, vibration fatigue, variable-frequency vibration, constant acceleration, impact shock, moisture resistance, salt atmosphere

Maximum Ratings, *Absolute-Maximum Values:*

SWITCHING SERVICE

	2N398	*2N398A*	*2N398B*		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-105	-105	-105	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CES}:					
With R_{BE} = 0	-105	-105	-105	max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-50	-50	-75	max.	volts
COLLECTOR CURRENT, I_C	-100	-200	-200	max.	ma
EMITTER CURRENT, I_E	100	200	200	max.	ma
TRANSISTOR DISSIPATION:					
At free-air temperatures up to 25° C	50	150	250	max.	mw
At free-air temperatures above 25° C	-	Derate linearly at 2 mw/°C	Derate linearly at 3.33 mw/°C		
At free-air temperature of 55° C	10	-	-	max.	mw
TEMPERATURE RANGE:					
Storage	-65 to +85	-65 to +100	-65 to +100		°C
Operating	-65 to +55	-65 to +100	-65 to +100		°C
LEAD TEMPERATURE:					
1/16" ± 1/32" from seating surface for:					
10 seconds max.	230	-	250	max.	°C
3 seconds max.	-	250	-	max.	°C

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Printed in U.S.A.
2N398B, 2N398A, 2N398 7-66
Supersedes issue dated 10-62

Electrical Characteristics (Free-air temperature = 25° C unless otherwise specified)	Symbol	TEST CONDITIONS						LIMITS						Units
		DC Collector Volts		DC Emitter Volts	DC Current (Ma)			Type 2N398		Type 2N398A		Type 2N398B		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: For free-air temperature of: 25° C	I_{CBO}	-2.5			0			-	-14	-	-14	-	-6	μa
25° C		-105			0			-	-50	-	-50	-	-25	μa
71° C		-105			0			-	-	-	-	-	-300	μa
Emitter-Cutoff Current	I_{EBO}			-2.5			0	-	-	-	-	-	-6	μa
				-50			0	-	-50	-	-50	-	-	μa
				-75			0	-	-	-	-	-	-50	μa
Collector Current: With base-to-emitter resistance (R_{BE}) = 0	I_{CES}		-105	0				-	600	-	600	-	-300	μa
Collector Current: With base-to-emitter resistance (R_{BE}) = 10000 ohms	I_{CER}		-55									-	-300	μa
DC Collector-to-Emitter Reach-Through Voltage[a]	V_{RT}							-105	-	-105	-	-105	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					-0.25	-5	-	-0.35	-	-0.35	-	-0.25	volt
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$					-0.25	-5	-	-0.40	-	-0.40	-	-0.30	volt
DC Forward-Current Transfer-Ratio	h_{FE}		-0.25				-5					20	-	
			-0.35				-5	20	-	20	-			
Small-Signal, Forward-Current Transfer Ratio: At a frequency of 1 Kc	h_{fe}		-6				-1					40	-	
			-6				-1			20	-			
Small-Signal, Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}	-6			1							1	-	Mc
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		-0.025					-105	-	volts
					0		-0.050	-105	-	-105	-			volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.050		0	-50		-50		-75		volts
Thermal Resistance: Junction-to-free air	θ_{J-FA}									-	0.5	-	0.3	°C/mw

[a] The dc collector-to-emitter reach-through voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base, and by measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt.

SPECIAL RATINGS AND PERFORMANCE TESTS FOR TYPE 2N398B

Shock:

Impact Acceleration . . . . . 1500 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted with suitable protection for the leads. An impact of 1500 g maximum is applied to the transistors by means of an impact testing machine. During this test, the transistors are subjected to five blows each with an acceleration of 1500 g and a duration of approximately 0.5 msec, in each of the orientations X_1, Y_1, Y_2, and Z_1. At the end of the test, the transistors in the sample lot are required to meet the limits for V_{CBO}, V_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Thermal Shock:

Temperature Extremes. . . . . +100 to 0 °C

This test is performed on a sample lot of transistors from each production run. The transistors are completely immersed in water at a high temperature (100 ± 3 °C) for not less than 15 seconds and then are immediately plunged into water at a low temperature (0 ± 3 °C). At the end of the test, the transistors in the sample lot are required to meet the limits for I_{CBO} and h_{FE} as shown under *Characteristics Endpoint Values*.

Vibration Fatigue:

Vibrational Acceleration . . . . . 20 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are supplied with the required test voltages while rigidly mounted on a vibration platform. The transistors are then subjected to a simple harmonic motion at any single frequency between 40 and 100 cps with a constant peak acceleration of 20 g. The vibration is applied for 32 hours minimum in each of the orientations X_1, Y_1, and Z_1 (for a total time of 96 hours minimum). At the end of the test, the transistors are required to meet the limits for I_{CBO} and h_{FE} as shown under *Characteristics Endpoint Values*.

Constant Acceleration:

Centrifugal Acceleration . . . . . 10000 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted with suitable protection for the leads. A centrifugal acceleration of 10000 g is applied to the transistors for one minute in each of the orientations X_1, Y_1, and Z_1. The acceleration is increased to 10000 g in not less than 20 seconds and then decreased gradually to zero in not less than 20 seconds. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CBO}, BV_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Temperature Cycling:

Cycles of Intermittent Operation. . . 10 min. cycles

This test is performed on a sample lot of transistors from each production run. The transistors undergo 10 temperature cycles from -65 ± 3 °C to +100 ± 3 °C. At the end of the test, the transistors

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in the sample lot are required to meet the established limits for I_{CBO} and h_{FE} as shown under *Characteristics Endpoint Values*.

Variable-Frequency Vibration Performance:

100 to 2000 cps at a Constant Peak Acceleration of 20 g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted on a vibration platform and subjected to vibration in each of the orientations X_1, Y_1, and Z_1 over a frequency range of 100 to 2000 cps with approximately logarithmic variation of frequency and a constant peak acceleration of 20 g. The entire frequency range from 100 to 2000 cps is covered in not less than four minutes. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CBO}, BV_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Moisture Resistance:

This test is performed on a sample lot of transistors from each production run. The transistors are subjected to temperature cycling during this moisture-resistance test to provide alternate periods of condensation and drying. Increased effectiveness is also obtained by the use of a high temperature which intensifies the effects of humidity. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CBO}, BV_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Solderability:

This test is performed on a sample lot of transistors from each production run. The transistor leads are immersed in a flux composed of 25% (by weight) water-white resin and 75% isopropyl alcohol (90%) for a minimum of 5 seconds and then are dipped into molten solder (60% tin, and 40% lead, at 230 ± 5 °C) for 5 ± 1/2 seconds. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CBO}, BV_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Lead Fatigue:

Two leads of each transistor in the sample lot are subjected to a pull of 16 ± 1 ounces for three 90° arcs of the case (movement of the case, without torsion, to a position perpendicular to the pull axis and return to normal). All arcs on a single lead are in the same direction and in the same plane. The lead under test is restricted so that the bend starts 3/32 ± 1/32 inch from the case. Breakage of one or more of the leads under these test conditions constitutes failure.

Salt Atmosphere:

This test is performed on a sample lot of transistors from each production run. The transistors are placed in a test chamber through which a salt atmosphere fog (at a temperature of 35° C) is passed for 24 $^{+2}_{-0}$ hours. The fog concentration and velocity are adjusted so that the rate of salt deposition in the test area is 10000 – 50000 mg/meter^2/day. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CBO}, BV_{EBO}, and h_{FE} as shown under *Characteristics Endpoint Values*.

Storage Life Performance (High Temperature):

This test is performed on a sample lot of transistors from each production run. The transistors are placed in a chamber at a temperature of 100 ± 3° C for a period of 1000 hours. At the end of 1000 hours, the transistors in the sample lot are required to meet the limits for I_{CBO}, h_{FE}, BV_{CBO}, and BV_{EBO} as shown under *Characteristics Endpoint Values*.

Operating Life Performance:

This test is performed on a sample lot of transistors from each production run. The transistors are operated at a transistor dissipation of 150 mw (with V_{CC} = -100 v) in the circuit shown in Fig. 1, and at a free-air temperature of 25 ± 3° C. At the end of 1000 hours, the transistors in the sample lot are required to meet the limits for I_{CBO}, h_{FE}, BV_{CBO}, and BV_{EBO} as shown under *Characteristics Endpoint Values*.

CHARACTERISTICS ENDPOINT VALUES

Characteristic	Test Conditions	LIMITS Min.	Max.	Units
I_{CBO}	V_{CB} = -2.5 volts I_E = 0	-	-10	μa
h_{FE}	V_{CE} = -0.25 volt I_C = -5 ma	15.5	-	
BV_{CBO}	I_C = -25 μa I_E = 0	-90	-	volts
BV_{EBO}	I_E = -50 μa I_C = 0	-60	-	volts

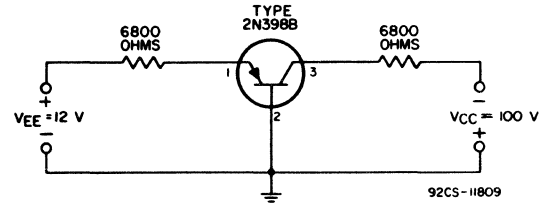
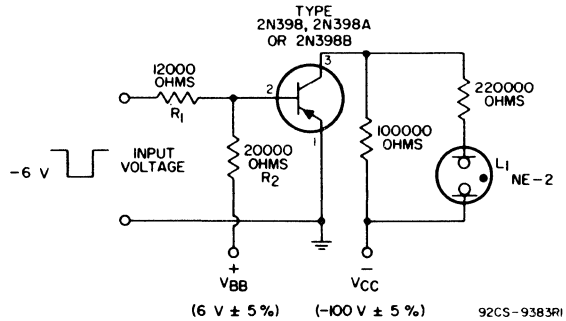


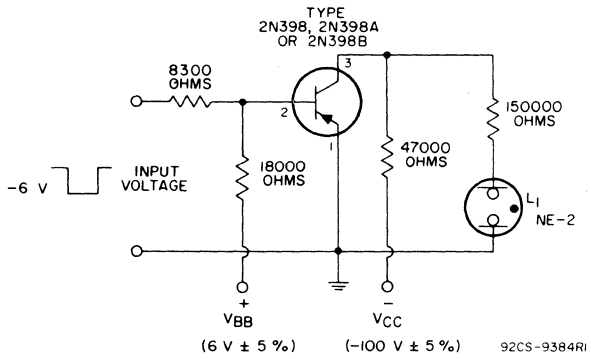
Fig. 1 - Circuit Used for Operating Life Test for Type 2N398B.



Note 1: All resistance values have ± 5% tolerance and a rating of 1/2 watt.

Note 2: With an input voltage of zero, the transistor is cut off by the base-bias circuit consisting of V_{BB}, R_2, and R_1. Under these conditions, the transistor is equivalent to an open switch due to its high collector-to-emitter resistance. Because L_1 is connected in series with the transistor, the voltage across L_1 is far below the approximately 70-volt firing-voltage required for its ignition. The input signal of -6 volts overcomes the cutoff bias of the transistor and causes it to conduct heavily (saturate), thereby grounding L_1 through the low collector-to-emitter resistance; the voltage across L_1 is sufficient to cause it to ignite.

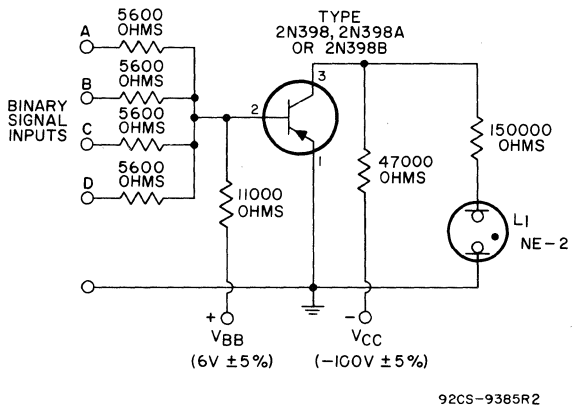
Fig. 2 - A typical neon indicator circuit designed to ignite an indicator lamp (L_1) with an input voltage of -6 volts and extinguish it with an input voltage of zero.



Note 1: All resistance values have ± 5% tolerance and a rating of 1/2 watt.

Note 2: With an input voltage of zero, the transistor is cut off as in Fig.2, but in this circuit L_1 is connected across the transistor which is equivalent to an open switch in parallel with L_1. Under this condition, L_1 will ignite. An input voltage of -6 volts causes the transistor to conduct heavily (saturate), thereby causing L_1 to extinguish by shorting it to ground through the transistor.

Fig. 3 - A typical neon indicator circuit designed to ignite an indicator lamp (L_1) with an input voltage of zero and extinguish it with an input voltage of -6 volts.

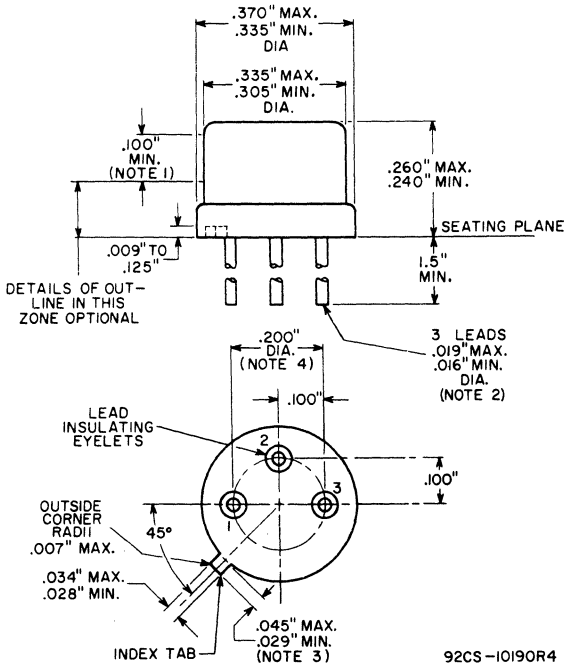


Note 1: All resistance values have ± 5% tolerance and a rating of 1/2 watt.

Note 2: The indicator lamp circuit is similar to Fig.3; however, the input is capable of handling four separate binary signals. The circuit will actuate L1 according to the binary logic, $(A \cdot B \cdot C \cdot D)$ where, binary "1" = zero-signal volts and binary "0" = -6 volts. All four inputs must be at zero-signal volts for the transistor to be in the non-conducting state and the indicator lamp L_1 to be "ON". If a binary "0" signal of -6 volts is applied at any input, the transistor conducts heavily (saturates), equivalent to a closed switch across L_1, thereby causing L_1 to extinguish. When all four inputs are at binary "1" (zero-signal volts), L_1 will ignite indicating the logic $A \cdot B \cdot C \cdot D = 1$.

Fig. 4 - A typical four-input "AND" -type binary-digital circuit designed to operate an indicator lamp (L_1).

DIMENSIONAL OUTLINE (JEDEC No. TO-5)



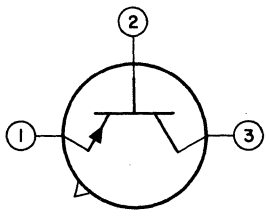
NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

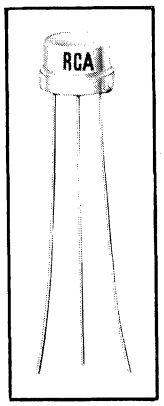
TERMINAL DIAGRAM
(Bottom View)



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector

GERMANIUM P-N-P MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



JEDEC TO-5

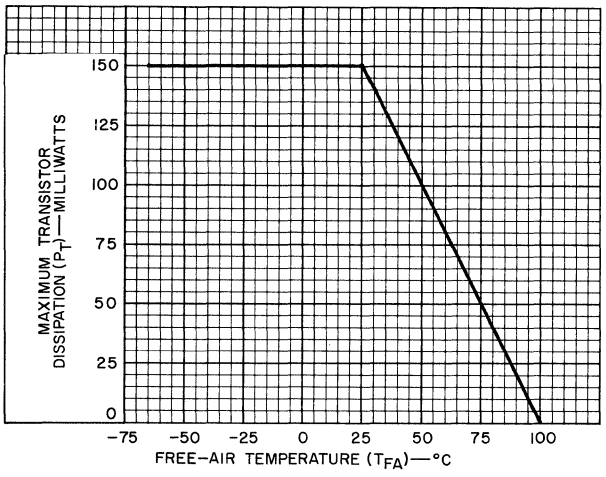
RCA-2N404, 2N404A, 2N581 and 2N582 are germanium p-n-p alloy-junction transistors specifically designed for medium-speed switching applications in industrial and military data-processing equipment.

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N404	2N404A	2N581	2N582	
Collector-to-Base Voltage, V_{CBO}	-25	-40	-18	-25 max.	V
Collector-to-Emitter Voltage V_{CEV} (V_{EB} = -1 V)	-24	-35	-15	-14 max.	V
Emitter-to-Base Voltage, V_{EBO}	-12	-25	-10	-12 max.	V
Collector-Current, I_C	-100	-150	-100	-100 max.	mA
Emitter-Current, I_E	100	150	100	100 max.	mA
Transistor Dissipation, P_T ♦:					
For Ambient Temperatures					
Up to T_A = 25°C	150	150	150	150 max.	mW
Above T_A = 25°C derate at	2.5	2	2.5	2.5 max.	mW/°C
Temperature Range:					
Operating	-65 to +85	-65 to +100	-65 to +85	-65 to +85	°C
Storage	← -65 to +100 →				°C
Lead Temperature (During Soldering:					
At distances ≥ 1/16" from seating surface for 10 seconds max.	255	255	255	255 max.	°C

♦ For higher dissipation values in switching applications, see RCA Application Note AN-181.

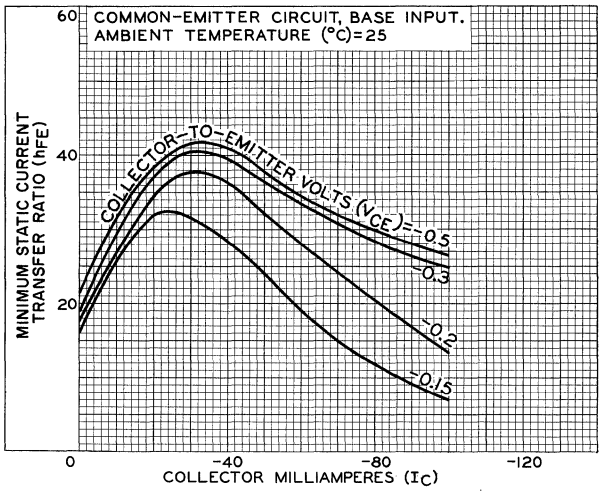


92CS-10907R3

Fig.1 - Rating Chart for Types 2N404, 2N404A, 2N581, and 2N582.

FEATURES:

- tested in strict accordance with military specification MIL-T-19500A
- exceptional reliability
- high-power-dissipation capability
- high typical betas
- fast switching speeds



92CS-1089IR2

Fig.2 - Minimum Static-Current-Transfer Ratio Characteristics for Type 2N404 and 2N404A.

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ELECTRICAL CHARACTERISTICS At T_A = 25°C unless otherwise specified.

Characteristics	Symbols	TEST CONDITIONS					LIMITS												Units
		Collector-to-Base Voltage V_{CB}	Collector-to-Emitter Voltage V_{CE}	Collector Current I_C	Emitter Current I_E	Base Current I_B	2N404			2N404A			2N581			2N582			
		V	V	mA	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			-0.02	0		-25	-	-	-40	-	-	-18	-	-	-25	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	-0.02		-12	-	-	-25	-	-	-10	-	-	-12	-	-	V
Collector Cutoff Current	I_{CBO}	-12 -12	T_A = 25°C T_A = 80°C		0 0		- -	-2 -45	-5 -90	- -	- -	-5 -90	- -	-3 -	-10 -	- -	-2 -45	-5 -90	μA μA
Emitter Cutoff Current	I_{EBO}		V_{EB} = -2.5	0			-	-1	-	-	-	-	-	-1	-	-	-1	-	μA
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			-12 -20 -24 -24 -100		-0.4 -1 -0.6 -1 -5	- - - - -	-0.1 - - -0.12 -	-0.15 - - -0.2 -	- - - - -	- - - - -	-0.15 - - -0.2 -	- -0.2 - - -	- -0.3 - - -	- - - - -	- - - - -	- - -0.12 - -0.2	- - -0.2 - -0.3	V V V V V
Base-to-Emitter Saturation Voltage	V_{BE}(sat)			-12 -20 -24 -24 -100		-0.4 -1 -0.6 -1 -5	- - - - -	-0.25 - - -0.32 -	-0.35 - - -0.4 -	- - - - -	- - - - -	-0.35 - - -0.4 -	- - - - -	- -0.35 - - -	- -0.5 - - -	- - - - -	- - -0.3 - -0.6	- - -0.4 - -0.8	V V V V V
Small-Signal Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}	-6		-1			4	13	-	4	-	-	4	8	-	14	18	-	MHz
Static Forward-Current Transfer Ratio	h_{FE}		-0.15 -0.2 -0.3 -0.3	-12 -24 -20 -100			30 24 - -	50 40 - -	- - - -	30 24 - -	- - - -	- - - -	- - 20 -	- - 30 -	- - - -	- 40 - 20	- 60 - 25	- - - -	
Stored Base Charge	Q_s			-10 -20 -24		-1 -2 -1.2	- - -	800 - -	1400* - -	- - -	- - -	1400* - -	- - -	- 1700 -	- 2400 -	- - -	- - 800	- - 1200	pC pC pC
Collector Output Capacitance	C_{ob}	-6 -6		0	1		- -	12 -	20 -	- -	- -	- 20‡	12 -	20 -	- -	- -	12 -	20 -	pF pF

*See Fig.13 for Test Circuit. ‡measured at f = 2 MHz.

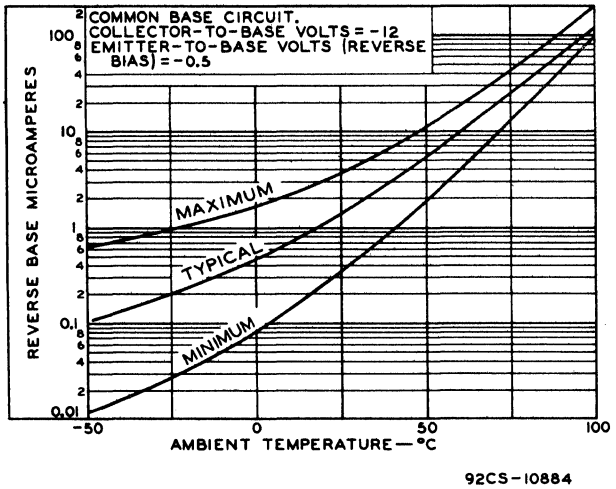


Fig.10 - Reverse Characteristics for Type 2N404.

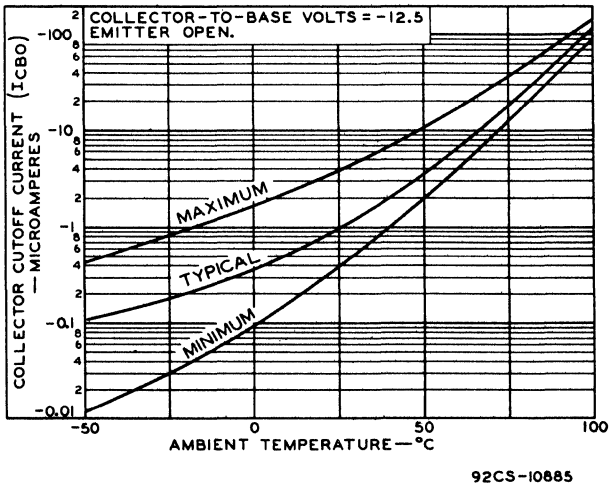


Fig.11 - Operation Characteristics for Type 2N404.

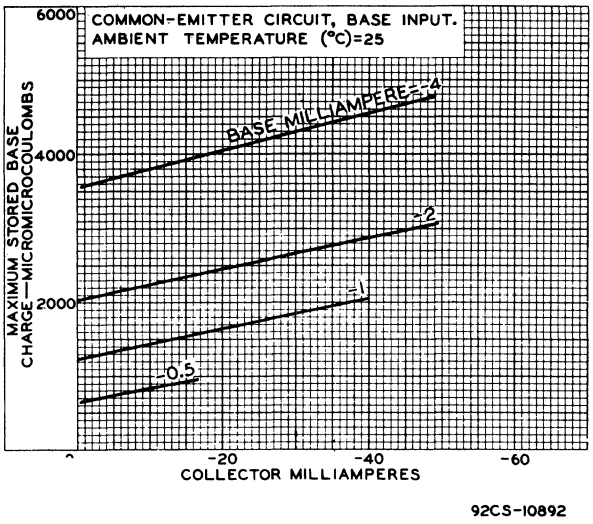


Fig.12 - Maximum Stored-Base-Charge Characteristics for Type 2N404.

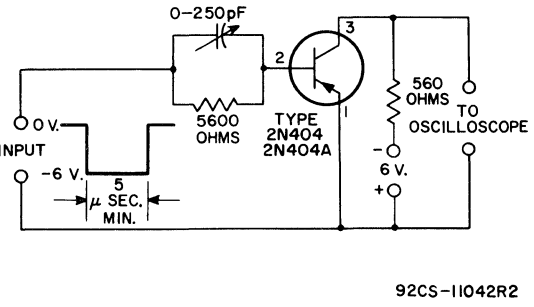


Fig.13 - Stored-Base-Charge Test Circuit for Types 2N404, and 2N404A.

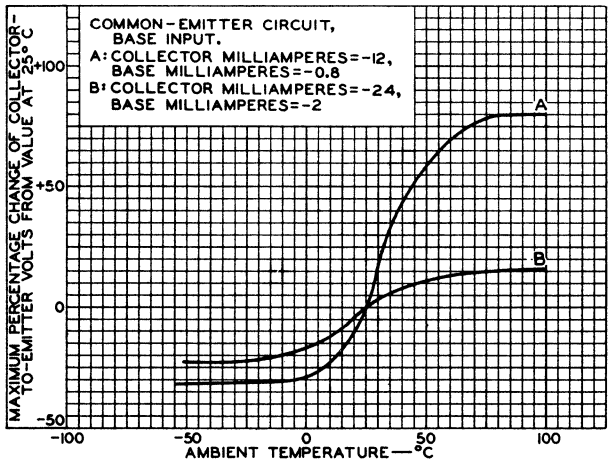


Fig.5 - Maximum Characteristics for Type 2N404.

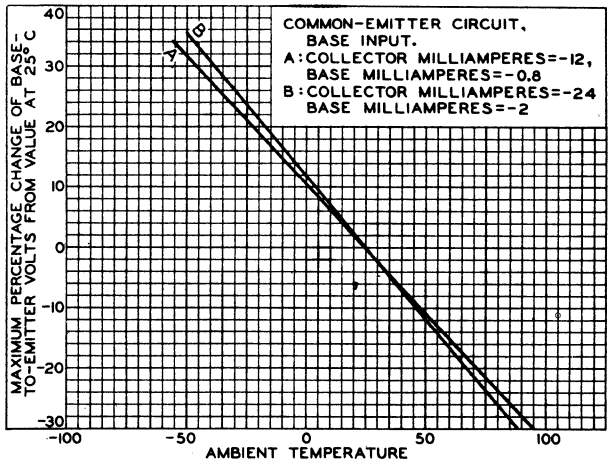


Fig.6 - Maximum Characteristics for Type 2N404.

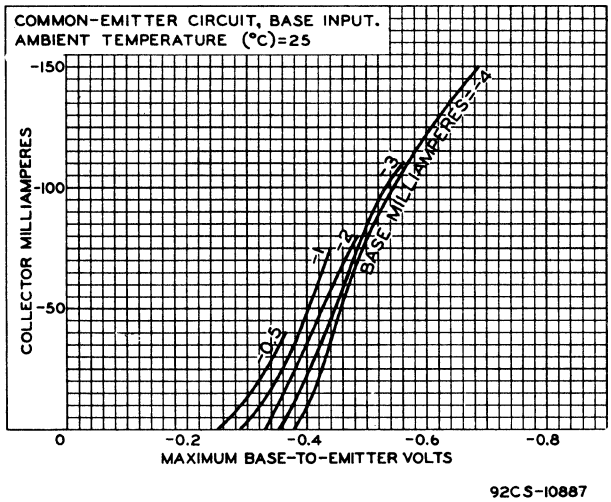


Fig.7 - Maximum Characteristics for Types 2N404 and 2N404A.

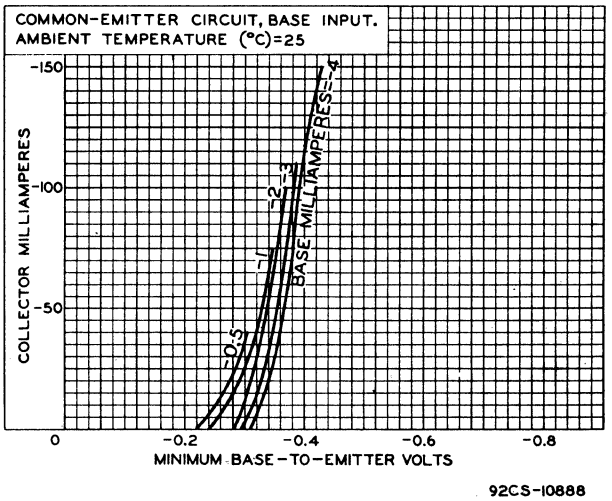


Fig.8 - Minimum Characteristics for Types 2N404 and 2N404A.

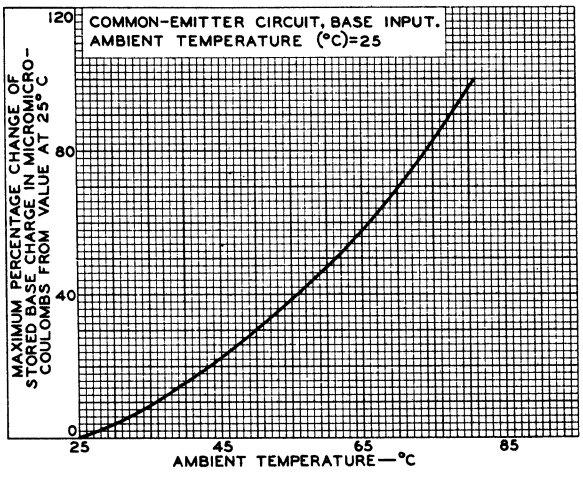


Fig.9 - Maximum Characteristic for Type 2N404.

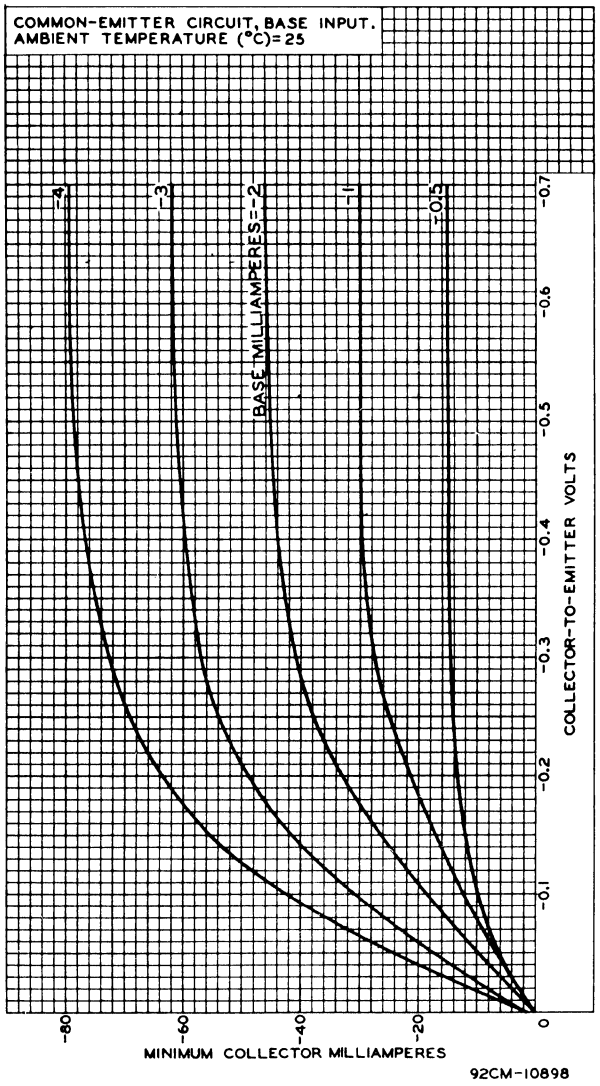


Fig.3 - Minimum Collector Characteristics for Type 2N404.

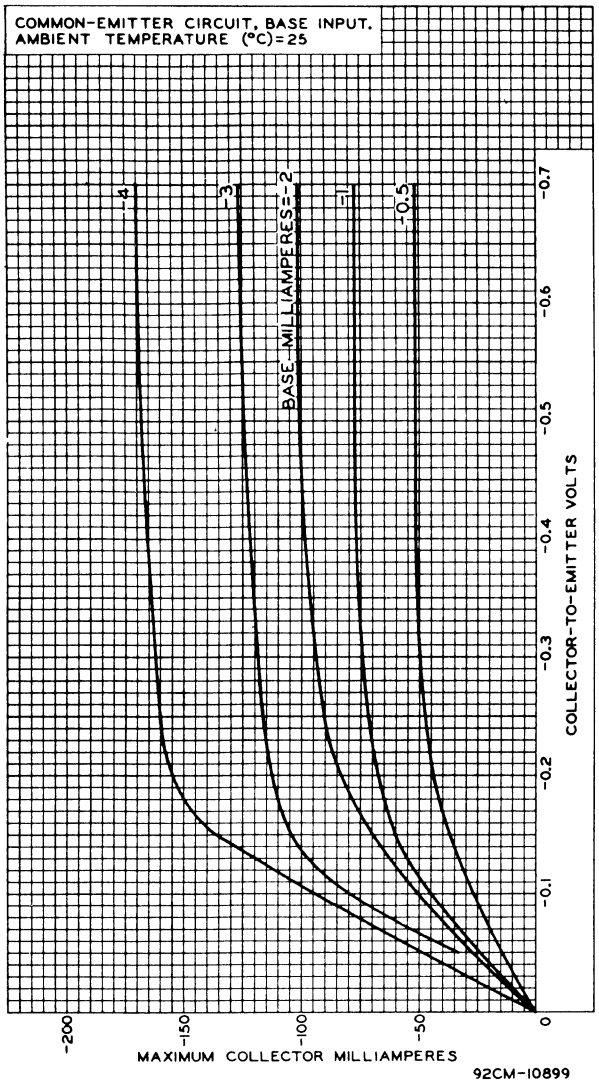
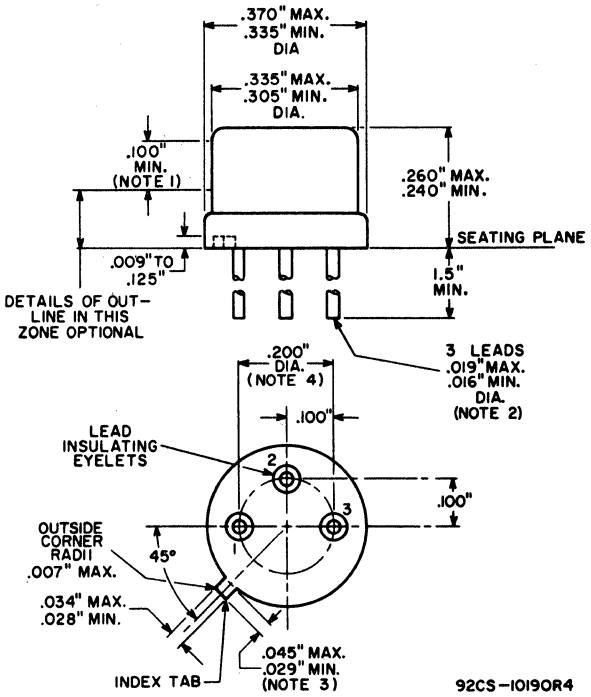


Fig.4 - Maximum Collector Characteristics for Type 2N404.

DIMENSIONAL OUTLINE (JEDEC No.TO-5)



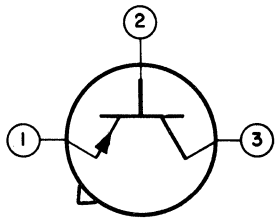
NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

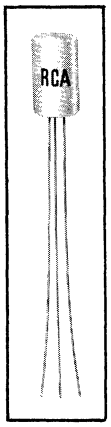
TERMINAL DIAGRAM (Bottom View)



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector

GERMANIUM PNP TRANSISTORS

For AF-Amplifier Applications in Consumer-Product Equipment



JEDEC TO-1

RCA-2N406 and 2N408 are alloy-junction transistors of the germanium pnp type intended for use in audio-frequency applications in battery-operated portable radio receivers and audio amplifiers.

RCA-2N406 is intended particularly for use as a low-power class A audio-frequency driver amplifier, and features a typical static beta of 60 and a matched impedance power gain of 43 dB.

RCA-2N408 is intended particularly for use in large-signal class A and B af-amplifiers, and features high power sensitivity, low distortion, and low battery drain.

These characteristics, in addition to excellent stability throughout life, make the 2N406 and 2N408 transistors especially useful in low-power audio amplifier applications.

RCA-2N406 and 2N408 utilize hermetically sealed JEDEC TO-1 metal packages.

FEATURES

- good linearity of static beta over entire collector-current range
- high minimum static beta, h_{FE}:
  2N406 = 40 at I_C = -50 mA
  2N408 = 55 at I_C = -50 mA
- high peak collector current capability:
  i_C = -150 max. mA
- hermetically sealed JEDEC TO-1 package

Maximum Ratings, *Absolute-Maximum Values:*

	2N406	*2N408*	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-20	-20 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-18	-18 max.	V
COLLECTOR CURRENT, I_C	-35	-70 max.	mA
PEAK COLLECTOR CURRENT, i_C	-150	-150 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures up to 25°C	150	150 max.	mW
At ambient temperatures above 25°C	Derate at 2.5 mW/°C		
TEMPERATURE RANGE:			
Operating	71	71 max.	°C
Storage	-65 to +85		°C
LEAD TEMPERATURE (During Soldering):			
At distances not closer than 1/16" to seating surface for 10 seconds maximum	230	230	°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N406, 2N408 12-66
Supersedes issue dated 11-57

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS					LIMITS						Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	2N406			2N408			
		V	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-12			0		-	-	-14	-	-	-14	μA
Emitter-Cutoff Current	I_{EBO}			-2.5		0	-	-	-14	-	-	-14	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	-0.05	-20	-	-	-20	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			-2		-0.05	-18	-	-	-18	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.014	0	-2.5	-	-	-2.5	-	-	V
Base-to-Emitter Voltage	V_{BE}		-10			-2	-	-0.13	-	-	-0.13	-	V
Static Forward-Current-Transfer Ratio	h_{FE}		-1			-50	40	60	120	55	90	140	
Gain-Bandwidth Product	f_T		-6			-2	-	1	-	-	1	-	MHz
Thermal Resistance (Junction to Ambient)	θ_{JA}						-	-	400	-	-	400	°C/W

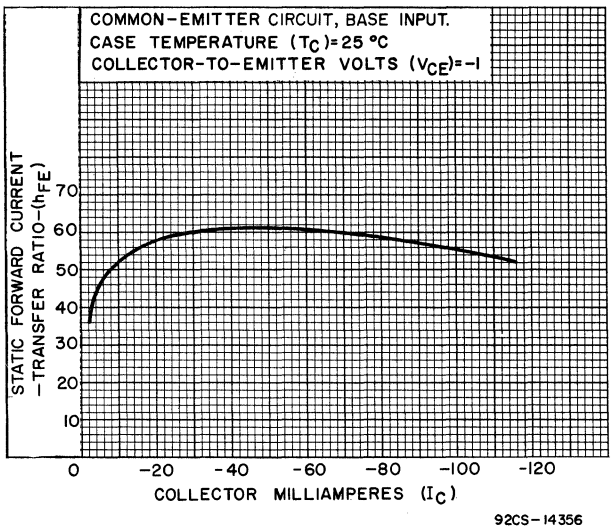


Fig.1 - Typical Static Beta Characteristic for Type 2N406

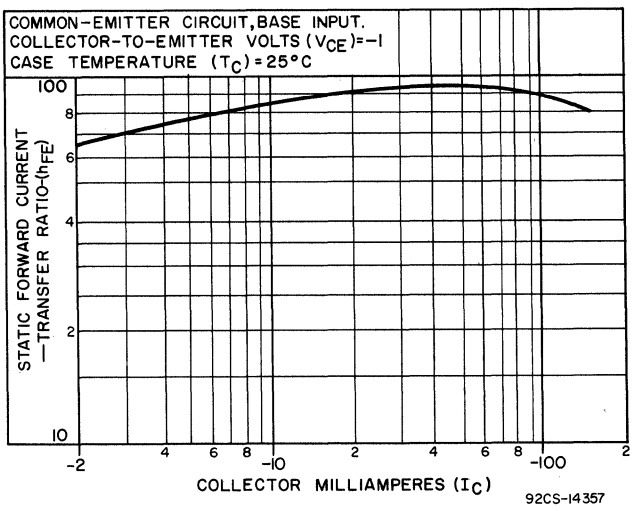


Fig.2 - Typical Static Beta Characteristic for Type 2N408

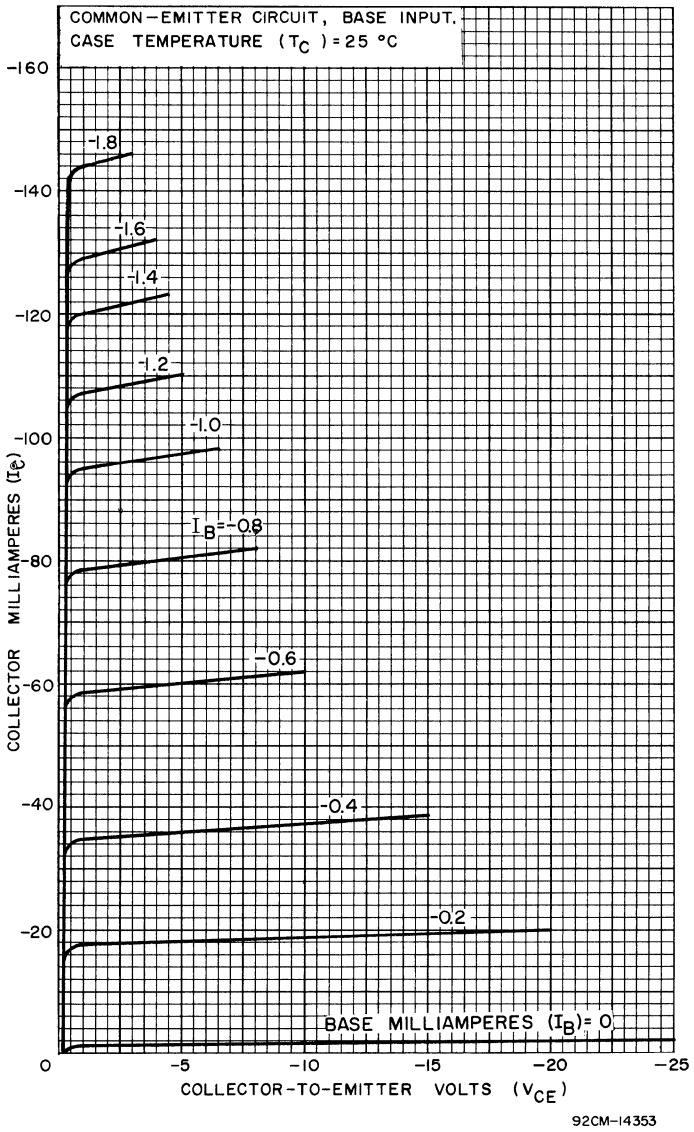


Fig.3 - Typical Collector Characteristics for Type 2N408.

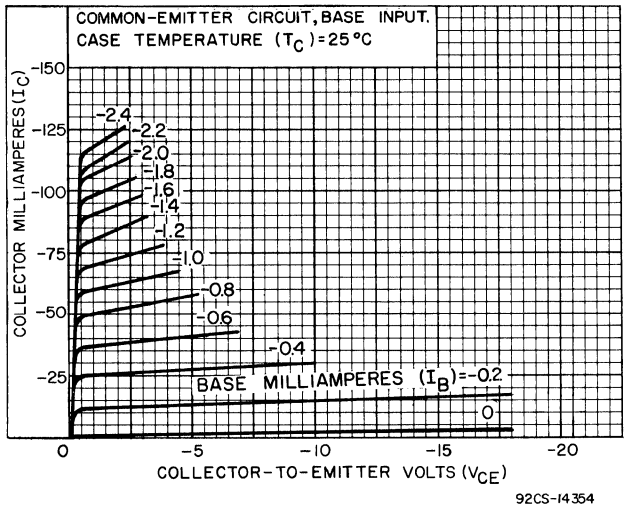


Fig.4 - Typical Collector Characteristics for Type 2N406.

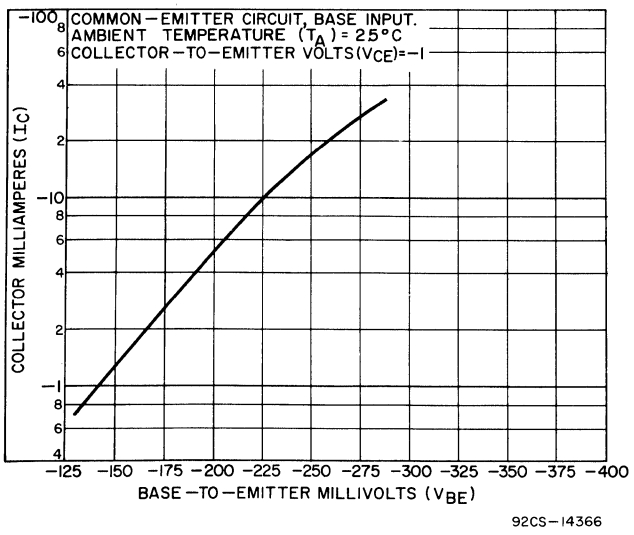


Fig.5 - Typical Transfer Characteristic for Type 2N406.

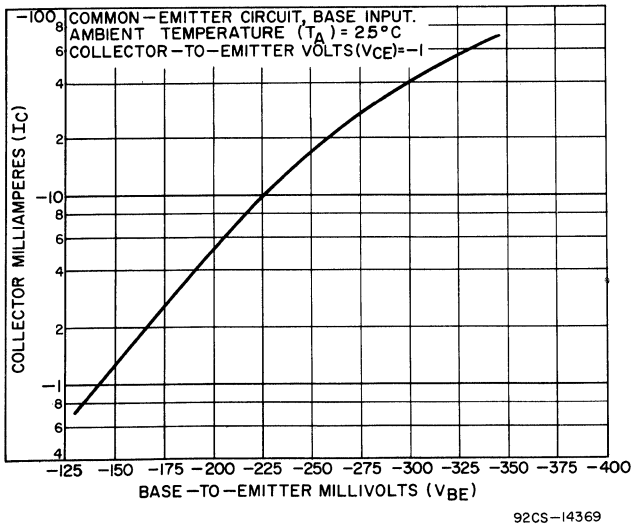


Fig.6 - Typical Transfer Characteristic for Type 2N408.

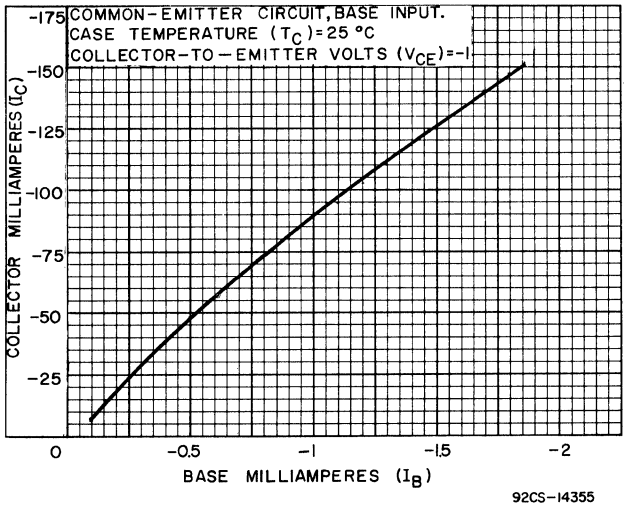
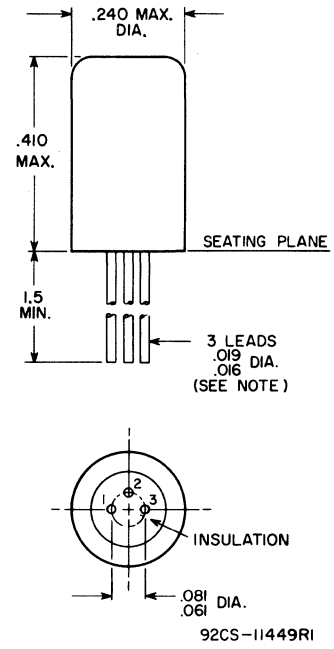


Fig.7 - Typical Current Transfer Characteristic for Type 2N408.

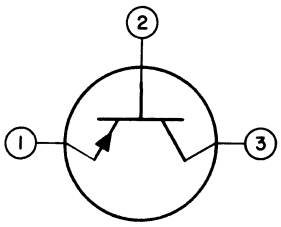
DIMENSIONAL OUTLINE
JEDEC No.TO-1



Dimensions in Inches

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM



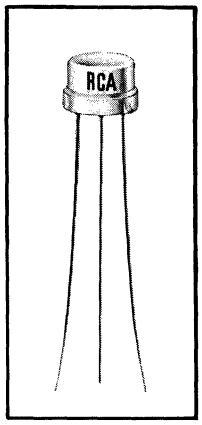
Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector

2N414

RCA-2N414 is a germanium p-n-p alloy-junction transistor specifically designed for medium-speed switching applications in commercial and military data-processing equipment.

GERMANIUM P-N-P MEDIUM-SPEED TRANSISTOR

FOR SWITCHING SERVICE IN ELECTRONIC DATA-PROCESSING SYSTEMS



JEDEC NO. TO-5

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	-30 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With base open	-15 max.	volts
With base-to-emitter volts = +1.	-20 max.	volts
EMITTER-TO-BASE VOLTAGE	-20 max.	volts
PEAK COLLECTOR CURRENT	-400 max.	ma
DC COLLECTOR CURRENT	-200 max.	ma
TRANSISTOR DISSIPATION:		
(See *Rating Chart Fig.1*)		
At an ambient temperature of 25° C	150 max.	mw
At an ambient temperature of 55° C	75 max.	mw
JUNCTION TEMPERATURE:		
Operating and storage	-65 to +85	°C
LEAD TEMPERATURE:		
For immersion in molten solder for 10 seconds max.	240	°C

FEATURES:

- typical alpha-cutoff frequency.... 8 Mc
- high typical beta (at collector-to-emitter volts = -6)..... 80
- high collector-current rating (peak value)..... 400 ma

ELECTRICAL CHARACTERISTICS, *at ambient temperature of 25° C*	Symbol	Circuit	TEST CONDITIONS						2N414			Units
			DC Voltage (volts)			DC Current (ma)		Frequency Mc	Min.	Typ.	Max.	
			V_{CB}	V_{CE}	V_{EB}	I_E	I_C					
Collector Cutoff Current	I_{CBO}		-12			0				-2	-5	μa
Emitter Cutoff Current	I_{EBO}				-12		0			-2	-5	μa
Alpha-Cutoff Frequency	$f_{\alpha b}$	B	-6			1				8		Mc
Collector Capacitance	C_{ob}	B	-6			1				11		μμf
Small-Signal Current Transfer Ratio	h_{fe}	E		-6		1		1 Kc		80		
Small-Signal Short-Circuit Input Impedance	h_{ib}	B	-6			1		1 Kc		30		ohms
Small-Signal-Open-Circuit Reverse-Voltage Transfer Ratio	h_{rb}	B	-6			1		1 Kc		0.5 x 10-3		
Extrinsic Base Resistance	$r_{bb'}$	E		-6		1		6		120		ohms
Noise Factor	NF	E		-6		1		1.5		6		db
Power Gain	PG	E		-6		1		1.5		16		db

B = Common-Base Circuit.

E = Common-Emitter Circuit, Base Input.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N414 7-66
Reprinted from issue dated 10-60

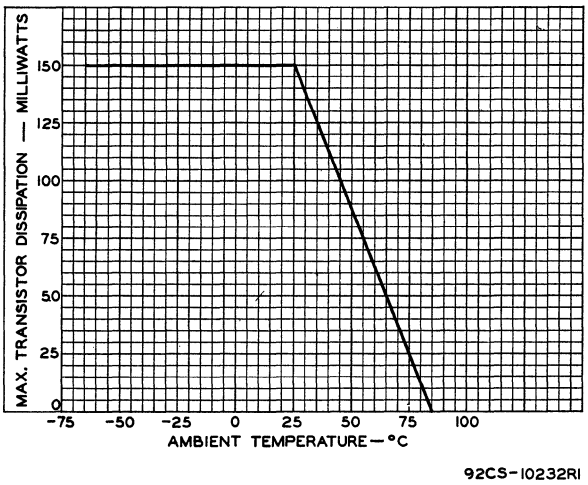
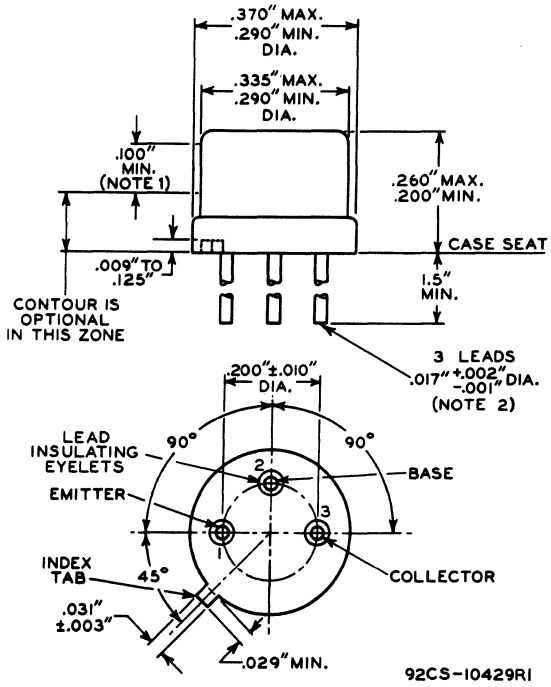


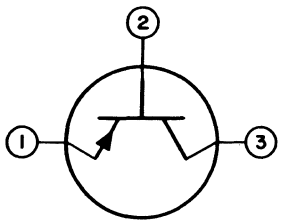
Fig. 1 - Rating Chart for Type 2N414.

DIMENSIONAL OUTLINE

JEDEC No. TO-5



TERMINAL DIAGRAM



Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector

NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE WILL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE BASE SEAT. BETWEEN 0.25" AND 1.5" A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

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RCA COMPUTER TRANSISTORS

2N585
2N1090
2N1091

RCA-2N585, 2N1090, and 2N1091 are germanium alloy-junction transistors of the n-p-n type.

These devices are designed for use in medium-speed, medium-current switching applications in military and industrial data-processing equipment.

All three devices are hermetically sealed in metal JEDEC TO-5 packages, and have all active elements insulated from the case.

Types 2N585, 2N1090, and 2N1091 are useful in logic gate counter, and line-driver applications at repetition frequencies up to 250 KHz.

SWITCHING SERVICE

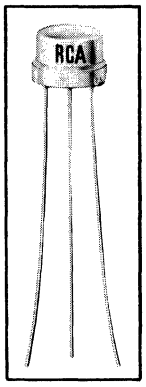
Absolute-Maximum Ratings:

	2N585	2N1090	2N1091	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25	25	25	max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15	15	12	max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEV} (V_{BE}=-1V)	24	18	15	max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	20	20	20	max. V
COLLECTOR CURRENT, I_C	200	400	400	max. mA
EMITTER CURRENT, I_E	-200	-400	-400	max. mA
TRANSISTOR DISSIPATION, P_T:				
For ambient temperatures up to 25°C	120	120	120	max. mW
For ambient temperatures above 25°C	——	See Fig.1	——	
TEMPERATURE:				
Operating (Ambient)	71	85	85	max. °C
Storage Range	——	-65 to +85	——	°C
LEAD TEMPERATURE (During Soldering):				
At distances not closer than 1/32" to seating surface for 10 seconds max.	255	255	255	max. °C

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GERMANIUM N-P-N MEDIUM-SPEED TRANSISTORS

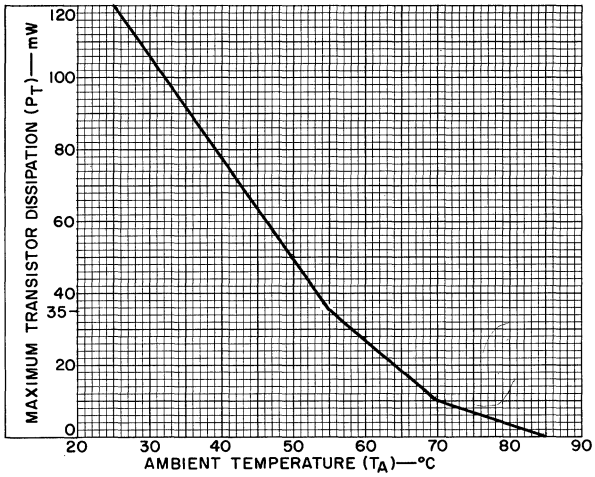
For Switching Applications



JEDEC TO-5

Features:

- low collector saturation voltages [$V_{CE(sat)}$]:
  - 2N585 – 0.1 V typ at I_C = 20 mA, I_B = 1 mA
  - 2N1090 – 0.22 V typ at I_C = 200 mA, I_B = 10 mA
  - 2N1091 – 0.2 V typ at I_C = 200 mA, I_B = 6.7 mA
- high DC beta at high I_C (h_{FE}):
  - 2N1090 – 35 typ
  - 2N1091 – 55 typ
  - } at I_C = 0.2 A
- hermetically sealed JEDEC TO-5 package



.92CS-14079

Fig.1 - Rating Chart for Types 2N585, 2N1090 and 2N1091.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N585, 2N1090, 2N1091 8-66
Supersedes 2N1090,2N1091 dated 3-59; 2N585, 6-59

ELECTRICAL CHARACTERISTICS AT T_A = 25°C:

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS									UNITS
		Collector-to-Emitter Voltage V_{CE}	Collector-to-Base Voltage V_{CB}	Collector Current I_C	Emitter Current I_E	Base Current I_B	2N585			2N1090			2N1091			
		V	V	mA	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			0.025	0		25	-	-	25	-	-	25	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			0.6		0	15	-	-	15	-	-	12	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	-0.025		20	-	-	20	-	-	20	-	-	V
Collector-Cutoff Current	I_{CBO}		0.25 12		0 0		- -	3 4	6 8	- -	- 4	- 8	- -	- 4	- 8	μA μA
Emitter-Cutoff Current	I_{EBO}		V_{BE}=5	0			-	1.5	5	-	1.5	5	-	1.5	5	μA
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			20 20 20 200 200		1 0.67 0.5 6.7 10	- - - - -	0.1 - - - -	0.2 - - - -	- - - - -	- - - - 0.22	- 0.2 - - 0.3	- - - - -	- - - - -	- - 0.2 0.3 -	V V V V V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$			20 20 20 200 200		1 0.67 0.5 10 6.7	- - - - -	0.35 - - - -	0.45 - - - -	- - - - -	- 0.28 - 0.85 -	- 0.4 - 1.5 -	- - - - -	- - 0.27 - 0.66	- - 0.35 - 1.1	V V V V V
Static Forward Current-Transfer Ratio	h_{FE}	0.2 0.3		20 200			20 -	40 -	- -	30 20	50 35	- -	40 30	70 55	- -	
Open-Circuit Common-Base Output Capacitance	C_{ob}		6		0		-	17	25	-	17	25	-	17	25	pF
Small-Signal Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}	6			-1		3	5	-	5	7	-	10	13	-	MHz
Stored Base Charge	Q_S			20 20 20		2 1.33 1	- - -	1800 - -	3000 - -	- - -	- 1000 -	- 1600 -	- - -	- - 750	- - 1000	pC pC pC
Delay Time	t_d	V_{CC}=10		20		I_{B1}= 2 I_{B2}=-2	-	0.05	-	-	-	-	-	-	-	μs
				200		I_{B1}= 20 I_{B2}=-20	-	-	-	-	0.05	-	-	-	-	μs
				200		I_{B1}= 13.3 I_{B2}=-13.3	-	-	-	-	-	-	-	0.05	-	μs
Rise Time	t_r	V_{CC}=10		20		I_{B1}= 2 I_{B2}=-2	-	0.35	-	-	-	-	-	-	-	μs
				200		I_{B1}= 20 I_{B2}=-20	-	-	-	-	0.25	-	-	-	-	μs
				200		I_{B1}= 13.3 I_{B2}=-13.3	-	-	-	-	-	-	-	0.2	-	μs
Storage Time	t_s	V_{CC}=10		20		I_{B1}= 2 I_{B2}=-2	-	0.25	-	-	-	-	-	-	-	μs
				200		I_{B1}= 20 I_{B2}=-20	-	-	-	-	0.2	-	-	-	-	μs
				200		I_{B1}= 13.3 I_{B2}=-13.3	-	-	-	-	-	-	-	0.17	-	μs
Fall Time	t_f	V_{CC}=10		20		I_{B1}= 2 I_{B2}=-2	-	0.2	-	-	-	-	-	-	-	μs
				200		I_{B1}= 20 I_{B2}=-20	-	-	-	-	0.15	-	-	-	-	μs
				200		I_{B1}= 13.3 I_{B2}=-13.3	-	-	-	-	-	-	-	0.13	-	μs

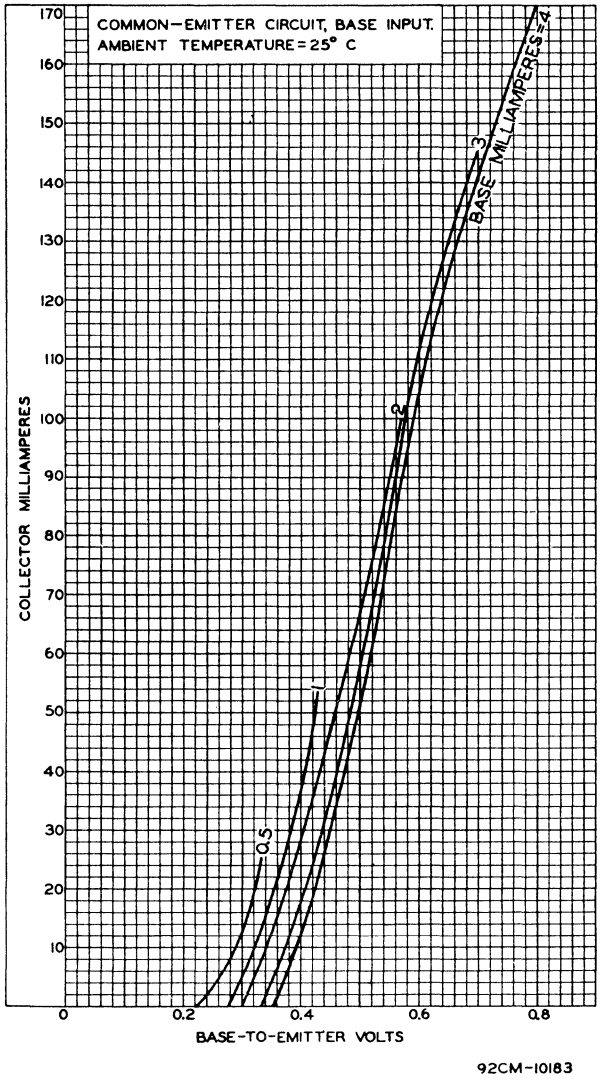


Fig.2 - Typical Transfer Characteristics for Type 2N585.

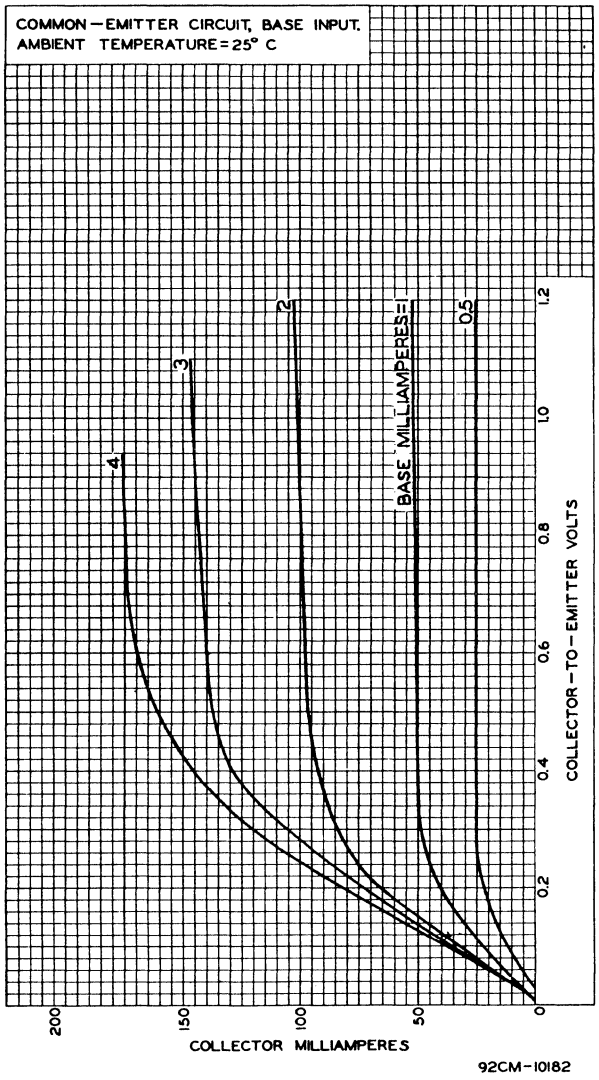


Fig.3 - Typical Collector Characteristics for Type 2N585.

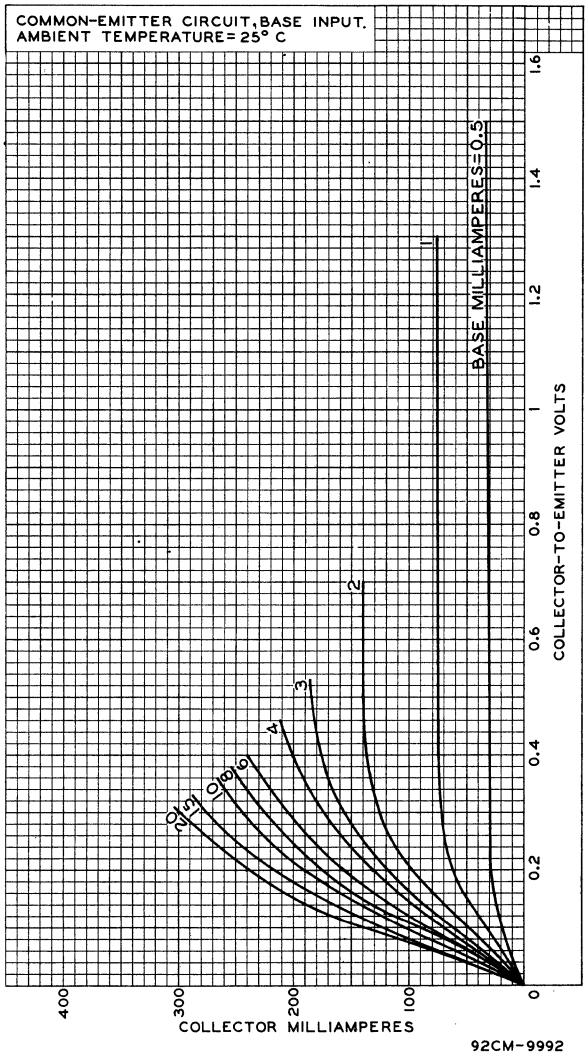


Fig.4 - Typical Collector Characteristics for Type 2N1090.

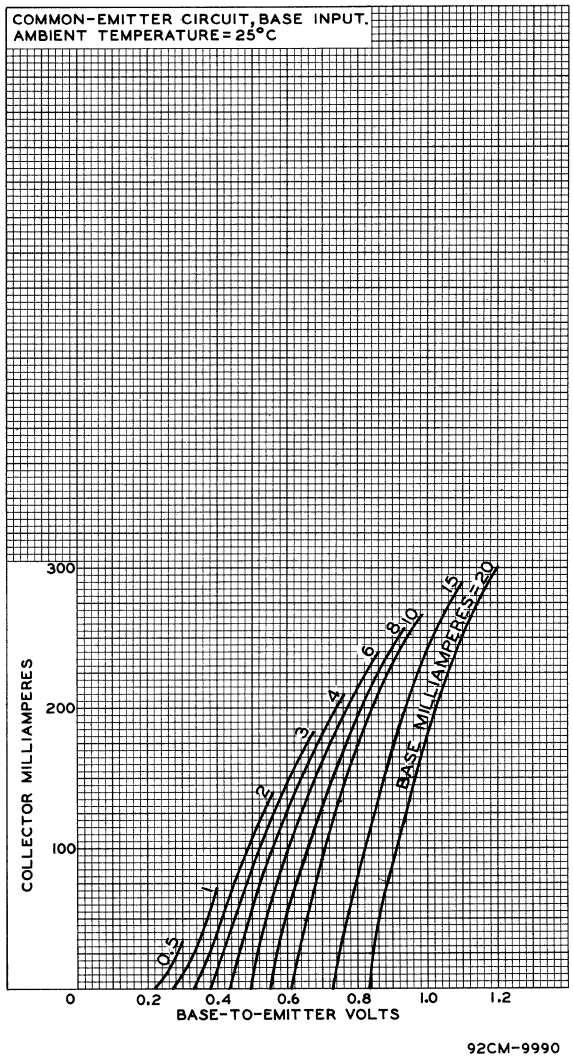


Fig.5 - Typical Transfer Characteristics for Type 2N1090.

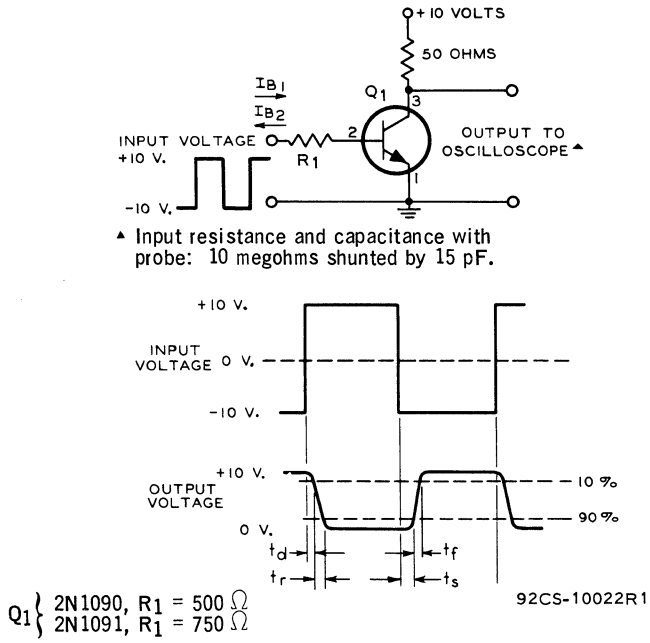


Fig.6 - Inverter Circuit Utilizing Types 2N1090 and 2N1091.

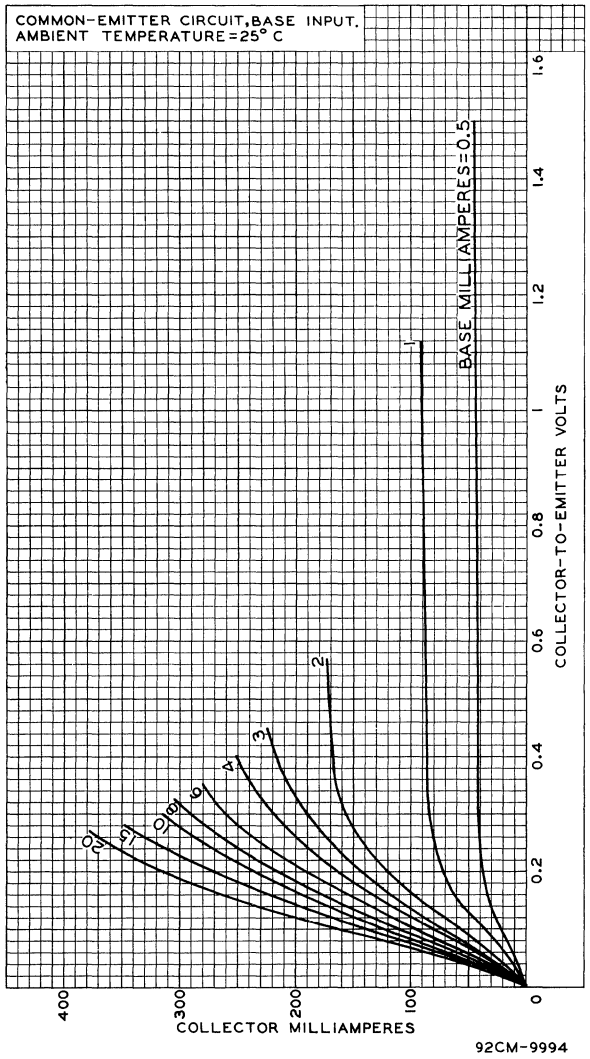


Fig.7 - Typical Collector Characteristics for Type 2N1091.

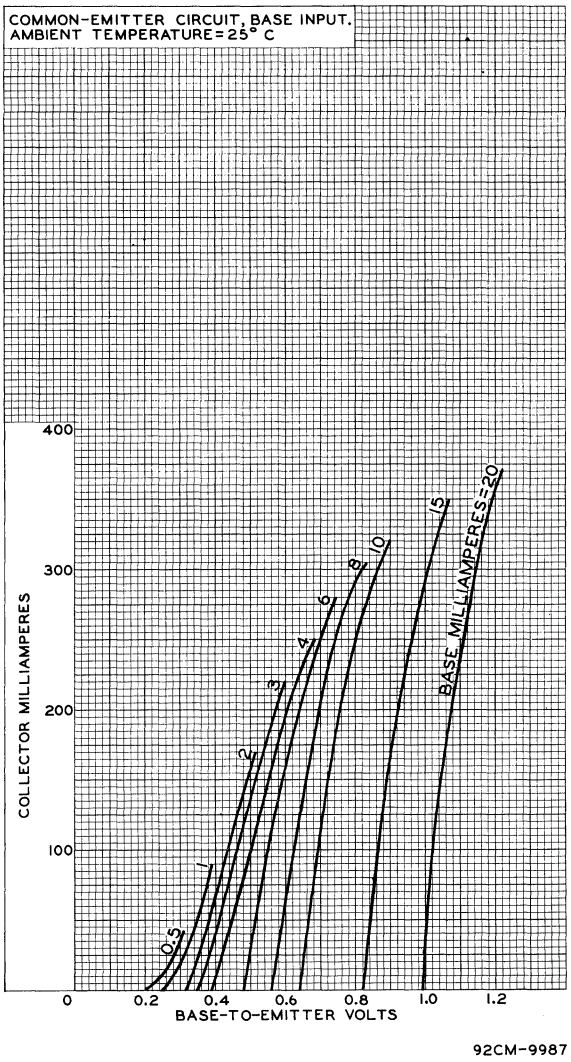
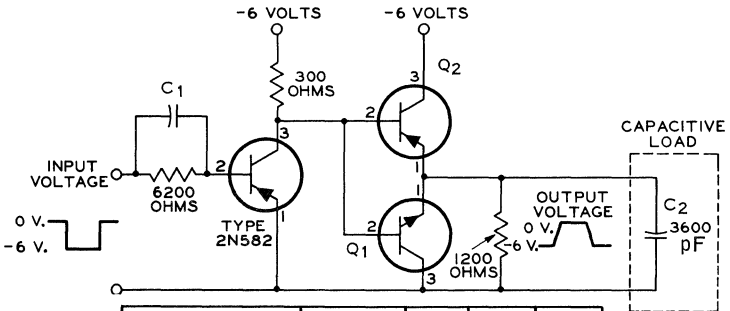


Fig.8 - Typical Transfer Characteristics for Type 2N1091.



Q1 (TRANSISTOR UNDER TEST)	Q2	C1	ton	toff
		pF	μs	μs
2N1090	2N579	450	0.21	0.34
2N1091	2N1307*	200	0.81	0.28

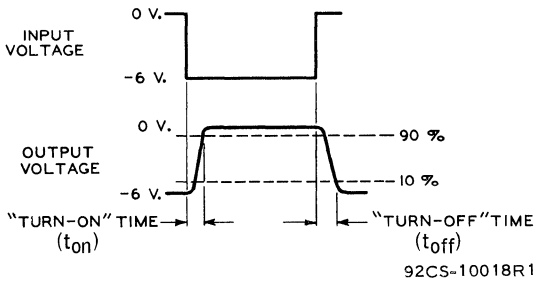
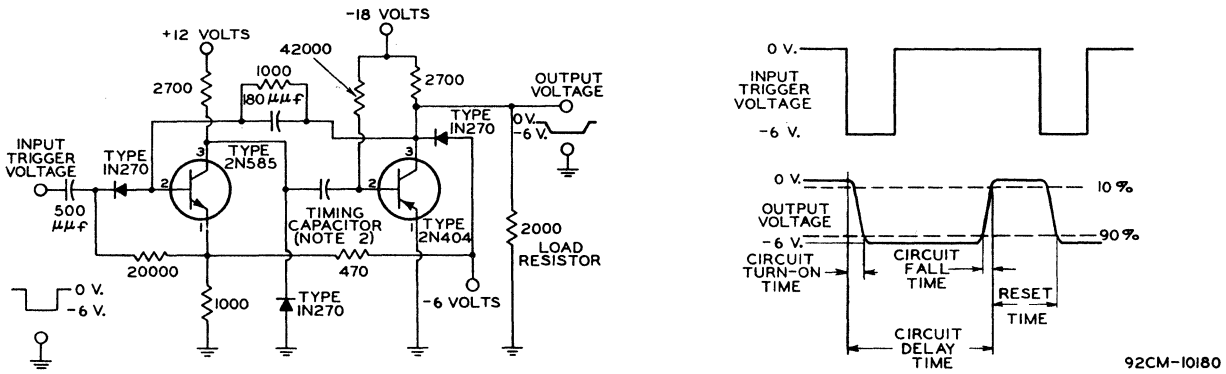


Fig.9 - Typical Switching Circuit Utilizing Types 2N1090 and 2N1091 in a Complementary-Symmetry Emitter-Follower Stage.

Fig.9 is a typical switching circuit utilizing Types 2N1090, 2N1091, 2N579 and 2N1307* in a complementary-symmetry, emitter-follower output stage designed to drive large capacitive loads encountered in computer applications such as in multistage shift-register circuits. The circuit can be turned on and off while driving a capacitive load of 3600 picofarads. In addition to rapid switching, the circuit operates at low dc currents, permitting low dissipation in the complementary-symmetry, emitter-follower stage. With the input voltage at 0 volts, the 2N582 inverter stage and Q_1 are cut off and C_2 charges through Q_2 to -6 volts. When the input is switched to -6 volts, the 2N582 conducts (saturates), Q_2 is cut off, and C_2 discharges rapidly through Q_1. When the input is switched to 0 volts, the initial conditions are restored and C_2 charges through Q_2.

* base internally connected to case.



TIMING CAPACITOR pF	TYPICAL SWITCHING TIMES — μs					
	INPUT TRIGGER VOLTAGE		OUTPUT VOLTAGE			
	Pulse Width	Pulse Rise Time	Circuit "Turn-On" Time	Circuit Fall Time	Circuit Delay Time	Minimum Reset Time
350	1	0.01	0.45	0.8	9	2.7
3400	1	0.01	0.45	2.5	82.5	8.5
7900	1	0.01	0.45	4.2	204	18

NOTE 1: ALL CAPACITORS ARE MICA AND HAVE A WORKING VOLTAGE RATING OF 50 VOLTS. RESISTANCE VALUES ARE IN OHMS AND HAVE ±5% TOLERANCE. RESISTORS RATED AT 0.5 WATT.

NOTE 2: THIS CIRCUIT IS DESIGNED FOR FREQUENCY-DIVIDER, SYNC-GENERATOR, PULSE-SHAPER, ETC., SERVICE IN COMPUTER AND INDUSTRIAL SWITCHING APPLICATIONS. THE TIMING CAPACITOR HAS A HIGH CHARGE-TO-DISCHARGE RATIO PROVIDED BY A COMPLEMENTARY-SYMMETRY CIRCUIT CONFIGURATION. THE CIRCUIT DELAY TIME IS A FUNCTION OF THE TIMING CAPACITOR. THE MINIMUM RESET TIME IS THE MINIMUM TIME REQUIRED BETWEEN THE TERMINATION OF ONE TRIGGER PULSE AND THE BEGINNING OF THE NEXT TRIGGER PULSE TO ALLOW THE MULTIVIBRATOR CIRCUIT TO BE RESET.

Fig.10 - Monostable Multivibrator Complementary-Symmetry Circuit Utilizing Type 2N585.

STORED BASE CHARGE

General Description

The stored base charge, Q_S, is a fundamental transistor characteristic which is useful as an indication of the "turn-off" capability of a transistor from a saturated "bottomed" conduction state to a non-conduction state. The stored base charge is defined as the total charge stored in the base region of the transistor for the saturated "on" condition specified by the collector and base current.

Determination of Stored Base Charge

The stored base charge for any value of collector current and base current ($I_C = V_{CC}/R_C$, $I_B = V/R_B$) may be measured in the circuit of Fig.11. The value of capacitor "C" is increased until the transistor turns off cleanly and monotonically as shown in the output voltage waveform of Fig.11. The stored base charge in picocoulombs may be computed from the equation: $Q_S = VC$, where V is in volts and C is in picofarads.

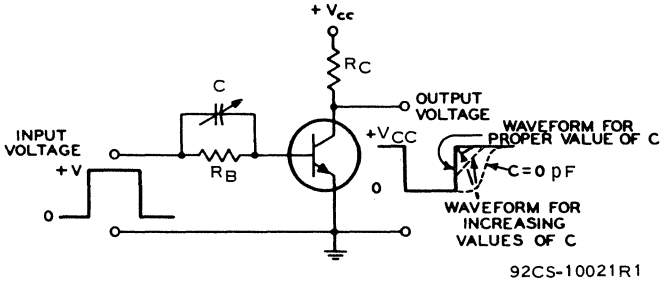


Fig.11 - Circuit for Measuring Value of Stored Base Charge.

Use of Stored Base Charge Q_S to Determine Value of Capacitor "C" in Figure 12

In circuits of the resistance-capacitance logic type (Fig.12), or of the Eccles-Jordan Type (Fig.13), the maximum stored base-charge value may be used directly to determine the required value for capacitor "C". This capacitor, sometimes referred to in such circuits as a "speed-up" capacitor, helps to overdrive the device momentarily in order to compensate for the stored base charge and thus permit proper circuit operation. For example, assuming an input signal voltage V of 10 volts, a collector current of 20 mA, and a base current of 1 mA, the maximum stored base charge for the 2N1091 is 1000 picocoulombs, as specified in the characteristics chart. The required value of "C" is therefore:

$$C = \frac{Q}{V} = \frac{1000\ \text{pC}}{10\ \text{V}} = 100\ \text{pF}$$

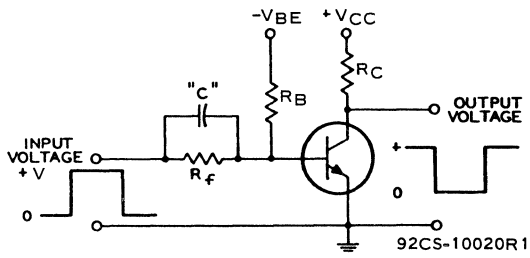
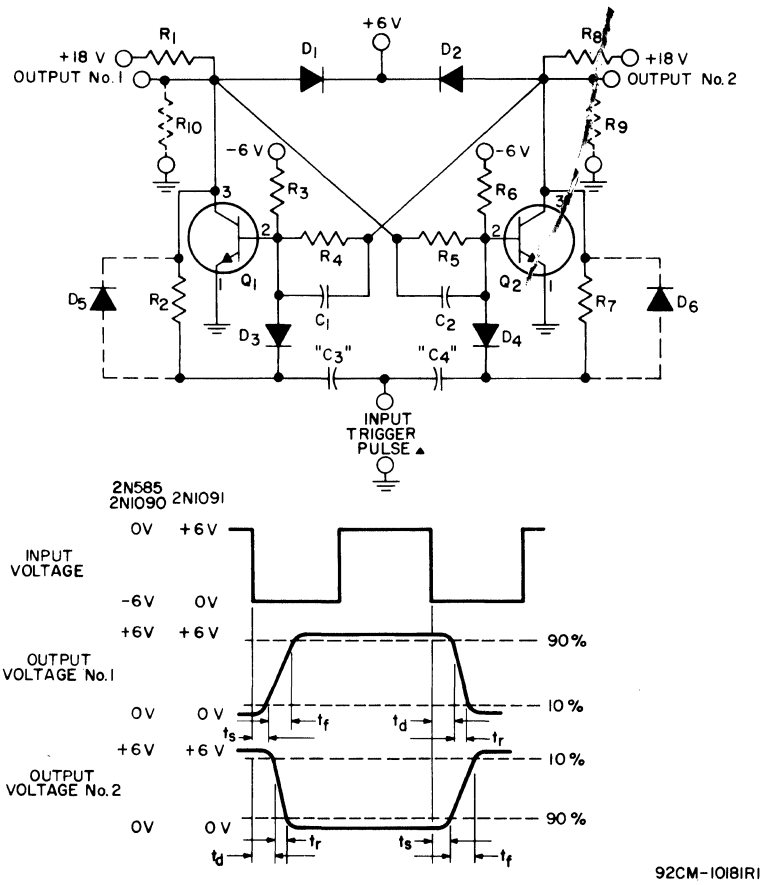


Fig.12 - Typical Logic Circuit Employing Capacitor "C" to Compensate for Transistor Stored Base Charge.



TRANSISTOR TYPE UNDER TEST (Q_1, Q_2)

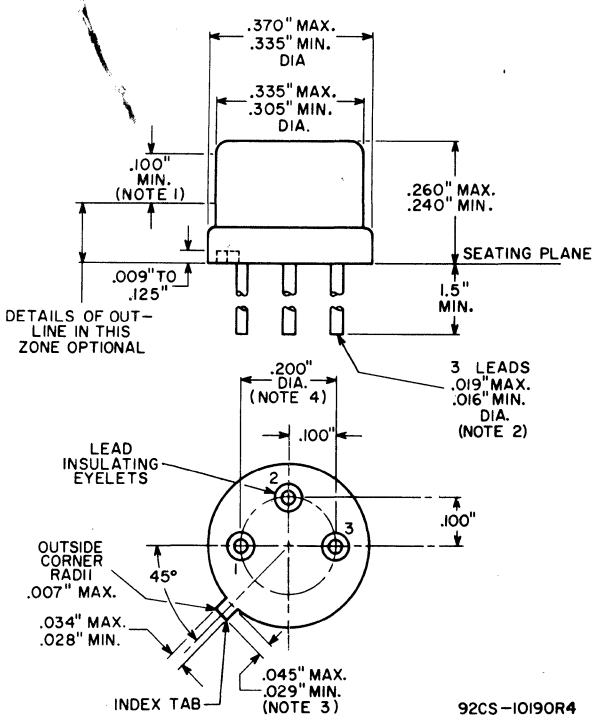
	2N585	2N1090	2N1091
C_1, C_2	270 pF	270 pF	150 pF
"C_3", "C_4"	570 pF	510 pF	330 pF
D_1, D_2, D_3, D_4	1N695	1N695	1N695
D_5, D_6	NOT USED	NOT USED	1N695
R_1, R_8	1 kΩ, 1 W	1 kΩ, 1 W	1 kΩ, 1 W
R_2, R_7	3 kΩ	3 kΩ	3 kΩ
R_3, R_6	13 kΩ	1.5 kΩ	18 kΩ
R_4, R_5	2.8 kΩ	3.3 kΩ	4.7 kΩ
R_9, R_{10}	1.2 kΩ	1.2 kΩ	NOT USED
▲Maximum repetition frequency	200 kHz	250 kHz	1 MHz

NOTE: All Resistance, Capacitance, and Voltage Values have a tolerance of ± 5%.

TYPE	TYPICAL SWITCHING TIMES				UNITS
	DELAY TIME t_d	RISE TIME t_r	STORAGE TIME t_s	FALL TIME t_f	
2N585	0.21	0.1	0.16	0.28	μs
2N1090	0.21	0.1	0.15	0.27	μs
2N1091	0.21	0.1	0.14	0.21	μs

Fig. 13 - Typical Eccles-Jordan Type "Flip-Flop" Counter Switching Circuit Utilizing Types 2N585, 2N1090 and 2N1091.

DIMENSIONAL OUTLINE (JEDEC No.TO-5)



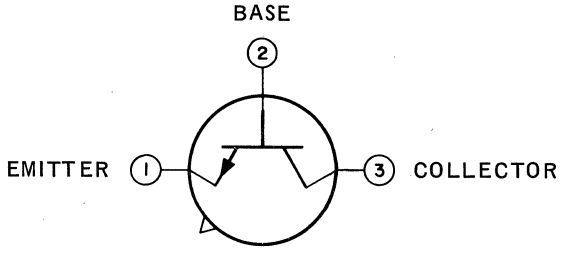
NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

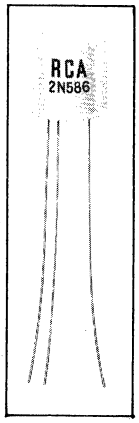
NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

TERMINAL DIAGRAM (Bottom View)



GERMANIUM P-N-P ALLOY-JUNCTION TRANSISTOR

For Low-Speed Switching Applications in Military and Industrial Equipment



RCA-2N586 is a germanium p-n-p alloy-junction transistor designed for use in low-speed switching applications in industrial and military equipment. It is particularly useful as a relay-actuating device and in voltage-regulator, multivibrator, dc-to-dc converter, and power supply circuits. This transistor may also be used in audio-frequency oscillator service and in large-signal class A or class B push-pull audio-frequency amplifier service.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	-45 max.	V
EMITTER-TO-BASE VOLTAGE	-12 max.	V
COLLECTOR CURRENT	250 max.	mA
EMITTER CURRENT	-250 max.	mA
TRANSISTOR DISSIPATION, P_T:		
At ambient temperatures: T_A up to 25°C	250 max.	mW
T_A = 55°C	125 max.	mW
T_A = 71°C	60 max.	mW
TEMPERATURE RANGE:		
Storage and operating (Ambient)	-65 to +85	°C
LEAD TEMPERATURE (During Soldering):		
At distances not less than 1/32" from seating surface for 10 seconds max.	255	°C

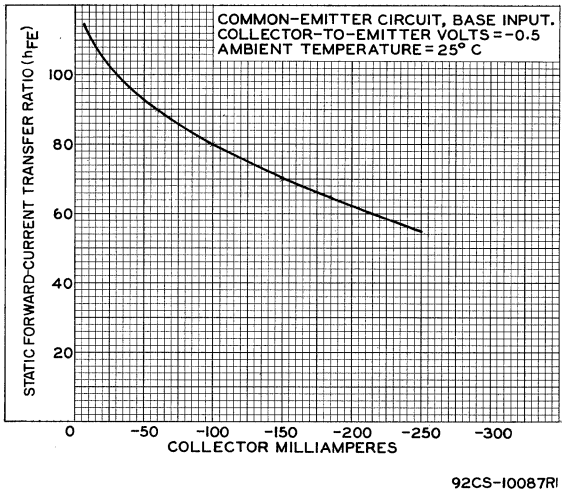


Fig. 1 - Typical Static Beta Characteristic for Type 2N586.

FEATURES

- low saturation voltage— $V_{CE}(sat) = -0.5$ V at $I_C = -0.25$ A
- high typical DC beta— $h_{FE} = 55$ at $I_C = -0.25$ A
- high minimum breakdown voltages— $BV_{CEO} = -25$ V, $BV_{CES} = -45$ V
- hermetically sealed in 3-lead metal package

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Printed in U.S.A.
2N586 9-66
Supersedes issue dated 6-59

ELECTRICAL CHARACTERISTICS, at $T_A = 25^oC$:

CHARACTERISTICS	SYMBOLS	DC Collector-to-Emitter Voltage V_{CE}	DC Base-to-Emitter Voltage V_{BE}	DC Collector-to-Base Voltage V_{CB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	TYPE 2N586			UNITS
		V	V	V	mA	mA	mA	min.	typ.	max.	
Collector-to-Emitter Breakdown Voltage	BV_{CEO}				-1		0	-25	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CES}		0		-0.05			-45	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				-250		-25	-	-	-0.5	V
Base-to-Emitter Voltage	V_{BE}				-250		-7	-	-0.7	-1	V
Punch-Through Voltage	V_P		-1			0		-45	-	-	V
Collector Cutoff Current	I_{CBO}			-45		0		-	-	-16	μA
Emitter Cutoff Current	I_{EBO}		-12		0			-	-	-12	μA
Static Forward Current-Transfer Ratio	h_{FE}	-0.5			-250			35	55	-	

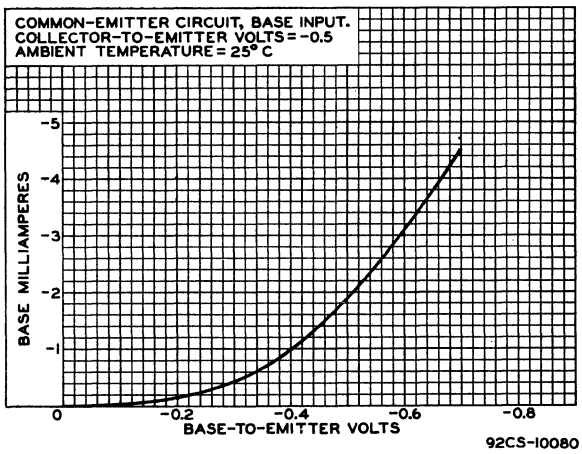


Fig. 2 - Typical Input Characteristic for Type 2N586.

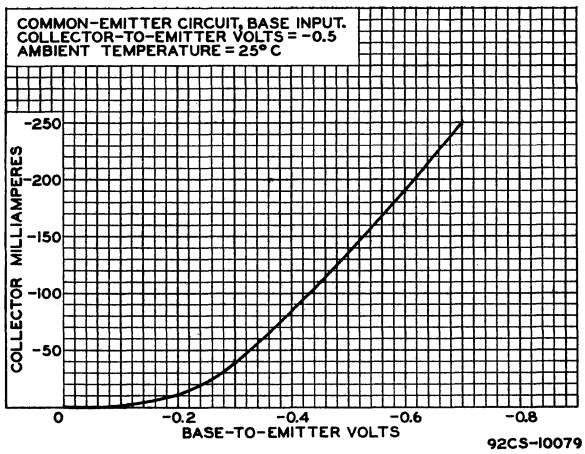


Fig. 3 - Typical Transfer Characteristic for Type 2N586.

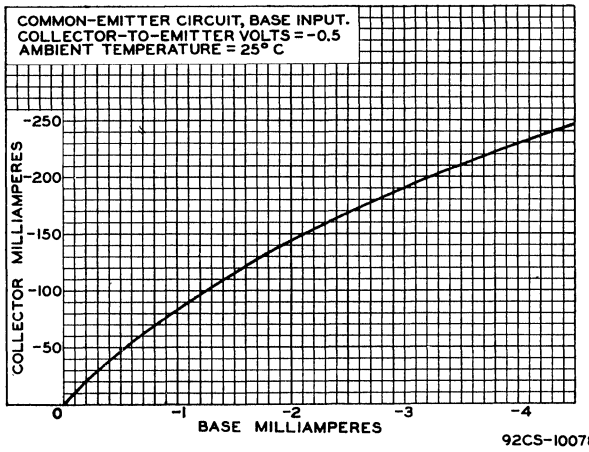


Fig. 4 - Typical Current-Transfer Characteristic for Type 2N586.

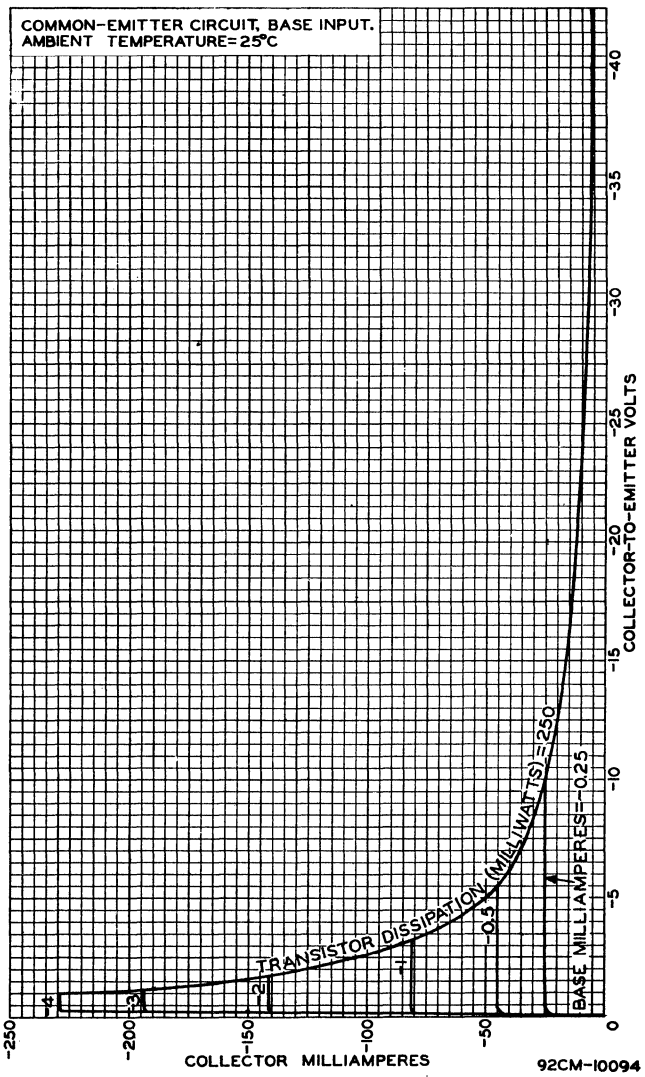


Fig. 5* - Typical Collector Characteristics for Type 2N586.

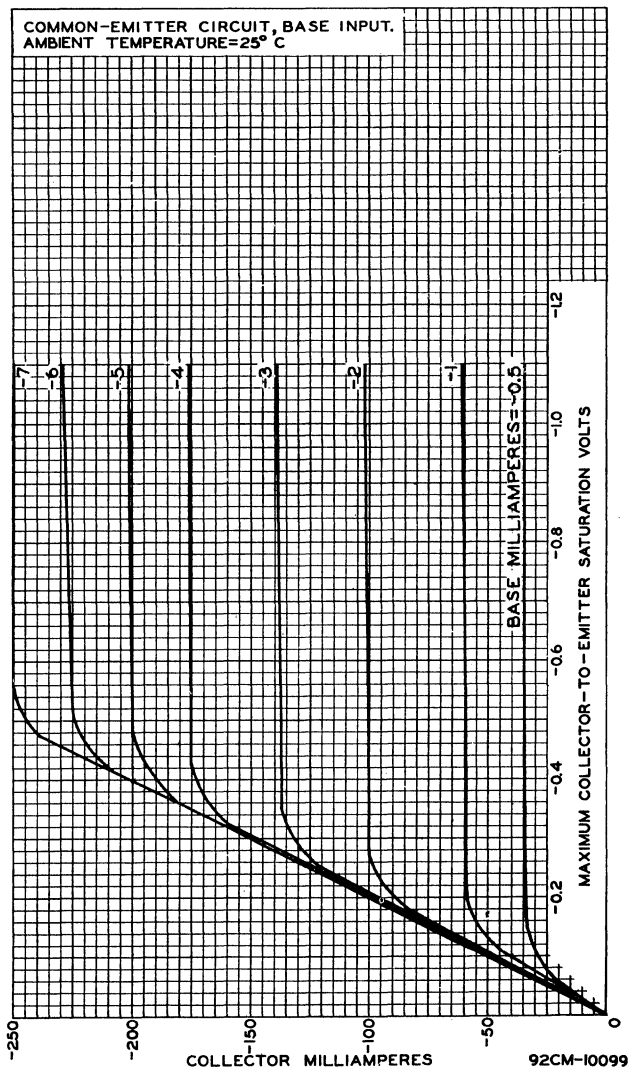
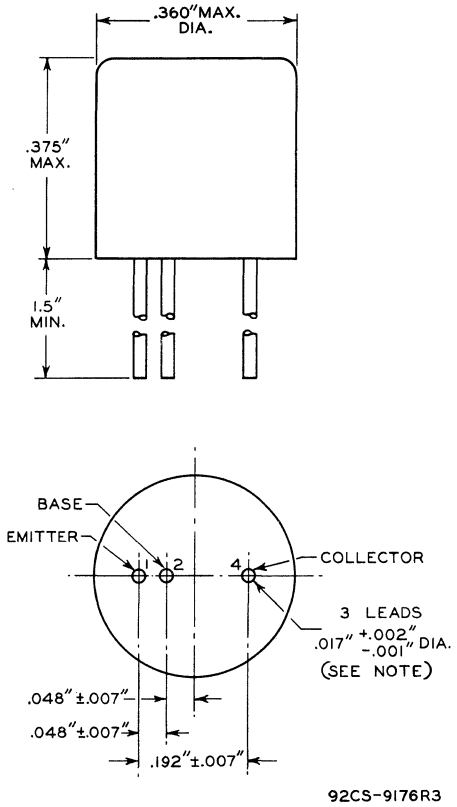


Fig. 6* - Maximum Collector-to-Emitter Saturation Voltage Characteristics for Type 2N586.

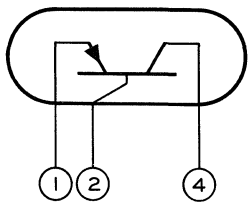
* Fig. 5 and Fig. 6 apply for transistors having the minimum Static Forward-Current Transfer Ratio (h_{FE}) as specified in the characteristics chart.

DIMENSIONAL OUTLINE



NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50" A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

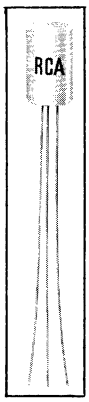
TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 4 – COLLECTOR

GERMANIUM PNP TRANSISTOR

For Class A AF-Amplifier Applications in Consumer-Product Equipment



JEDEC TO-1

RCA-2N591 is an alloy-junction transistor of the germanium pnp type intended primarily for use in large-signal af-amplifier applications in automobile radio receivers. RCA-2N591 features a typical small-signal forward current-transfer ratio of 70 and a matched-impedance power gain of 41 dB.

The 2N591 utilizes a hermetically sealed JEDEC TO-1 metal package.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}. . . -32 max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO} . -32 max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}. . . . -12 max. V
COLLECTOR CURRENT, I_C. . . . . -40 max. mA
TRANSISTOR DISSIPATION, P_T:
At ambient temperatures { up to 55°C . . . . . 85 max. mW; above 55°C . Derate at 2.83 mW/°C
At case temperatures { up to 55°C . . . . . 200 max. mW; above 55°C . Derate at 6.67 mW/°C
TEMPERATURE RANGE:
Operating. . . . . 71 max. °C
Storage. . . . . -65 to +85°C
LEAD TEMPERATURE (During Soldering):
At distances not closer than 1/16" to seating surface, for 10 seconds max. . . . . 255 °C

FEATURES

- high dissipation capability:
  P_T = 0.2 W max. at T_C = 55°C
- low leakage current:
  I_{CBO} = -7 μA max. at V_{CB} = -10 V
- high minimum breakdown voltages:
  BV_{CBO} = -32 V min.
  BV_{EBO} = -12 V min.

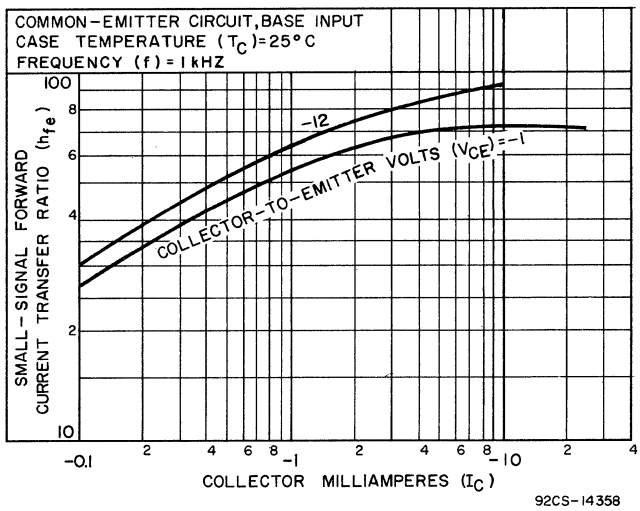


Fig. 1 - Typical Small-Signal-Beta Characteristics.

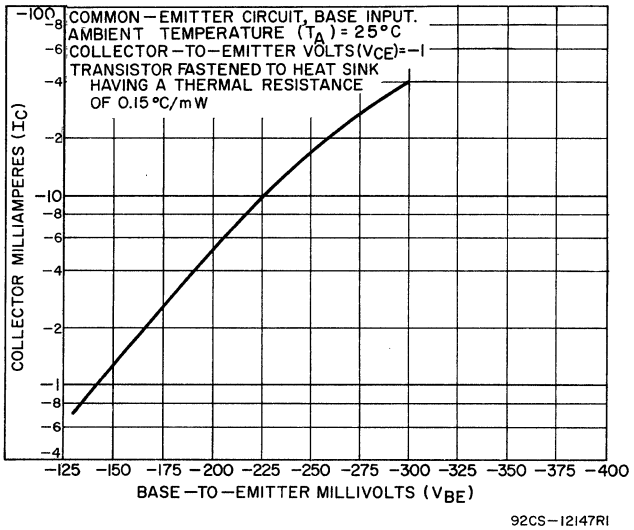


Fig. 2 - Typical Transfer Characteristic.

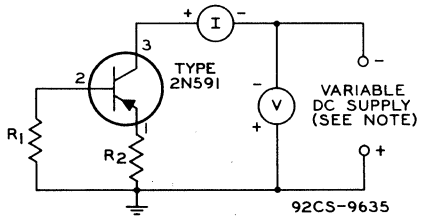
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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N591 12-66
Supersedes issue dated 5-58

ELECTRICAL CHARACTERISTICS AT $T_C = 25^oC$

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS						LIMITS			UNITS
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	TYPE 2N591			
		V	V	V	mA	mA	mA	min.	typ.	max.	
Collector-Cutoff Current	I_{CBO}	-10				0		-	-	-7	μA
Emitter-Cutoff Current	I_{EBO}			-1	0			-	-	-20	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.05	0		-32	-	-	V
Collector-to-Emitter Breakdwon Voltage (See Fig.3)	BV_{CEX}				-0.3		0	-32	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0	0.05		-12	-	-	V
Small-Signal Forward Current-Transfer Ratio (Measured at 1 kHz)	h_{fe}		-12		-2			40	70	120	
Thermal Resistance (Junction-to-Ambient)	θ_{JA}							-	-	353	°C/W
Thermal Resistance (Junction-to-case)	θ_{JC}							-	-	150	°C/W

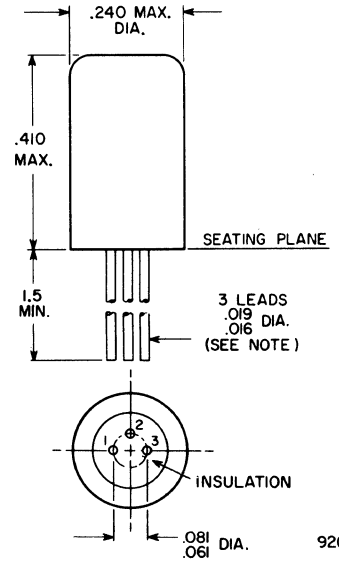


NOTE: Supply voltage adjusted to provide a dc collector current of -0.3 ma.

R_1 = 4700 ohms, 0.5 watt — I = DC Milliammeter
R_2 = 500 ohms, 0.5 watt — V = DC Voltmeter

Fig.3 - Test Circuit for Measuring Collector-to-Emitter Breakdown Voltage.

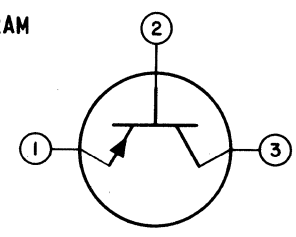
DIMENSIONAL OUTLINE
JEDEC No. TO-1
All Dimensions in Inches



NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM

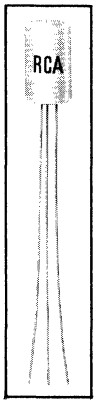
LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR



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GERMANIUM NPN TRANSISTORS

For Class B AF Amplifier Applications in Consumer-Product Equipment



JEDEC TO-1

RCA-2N647 and 2N649 are alloy-junction transistors of the germanium npn type intended for use in audio-frequency applications in battery-operated portable radio receivers, phonographs, and audio amplifiers.

RCA-2N647 and 2N649 are especially useful in conjunction with types 2N217 and 2N408 (pnp types) in complementary-symmetry class B push-pull af power-output stages. Such combinations are capable of providing a power output of approximately 100 milliwatts at a power gain of 54 dB.

Features of the 2N647 and 2N649 which make them desirable for the design of battery-operated radio receivers are excellent uniformity of characteristics, high minimum static beta, high gain-bandwidth product, and low leakage currents.

RCA 2N647 and 2N649 are hermetically sealed devices utilizing the JEDEC TO-1 metal package.

FEATURES

- high minimum static beta:
  h_{FE} = 50 min. at I_C = 50 mA
- high gain-bandwidth product:
  f_T = 2 MHz typ.
- low leakage currents:
  I_{CBO}, I_{EBO} = 14 μA max.
- hermetically sealed JEDEC TO-1 metal package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N647	2N649	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25	20 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	25	18 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	12	2.5 max.	V
COLLECTOR CURRENT, I_C	100	100 max.	mA
EMITTER CURRENT, I_E	-100	-100 max.	mA
TRANSISTOR DISSIPATION, P_T: At ambient temperatures up to 25°C	100	100 max.	mW
above 25°C	Derate at 1.66		mW/°C
TEMPERATURE RANGE: Operating	-65 to +71		°C
Storage	-65 to +85		°C
LEAD TEMPERATURE (During Soldering): At distances not closer than 1/16 inch to seating surface for 10 seconds max.	255	255 max.	°C

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ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS					LIMITS						Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N647			Type 2N649			
		V	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25 12			0 0		- -	- -	14 -	- -	- -	- 14	μA μA
Emitter-Cutoff Current	I_{EBO}			12 2.5		0 0	- -	- -	14 -	- -	- -	- 14	μA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.05	25	-	-	20	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			5 2		0.014 0.05	25 -	- -	- -	- 18	- -	- -	V V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.014	0	12	-	-	2.5	-	-	V
Static Forward-Current Transfer Ratio	h_{FE}		1			50	50	70	150	50	70	150	
Gain-Bandwidth Product	f_T		6			2	-	2	-	-	2	-	MHz
Extrinsic Base-Lead Resistance	$r_{bb'}$		6			2	-	-	350	-	-	350	Ω

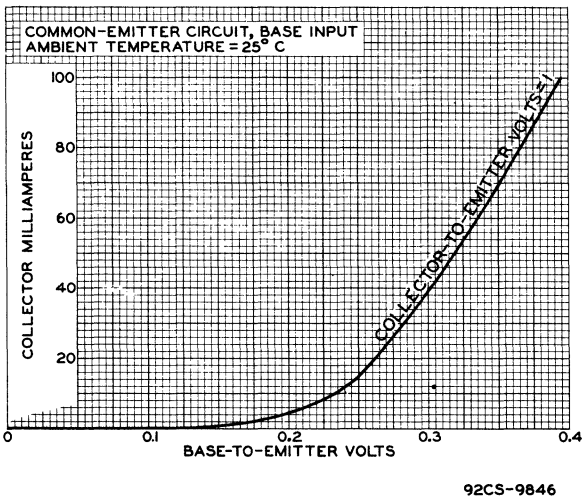


Fig.1 - Typical transfer characteristic for types 2N647 and 2N649.

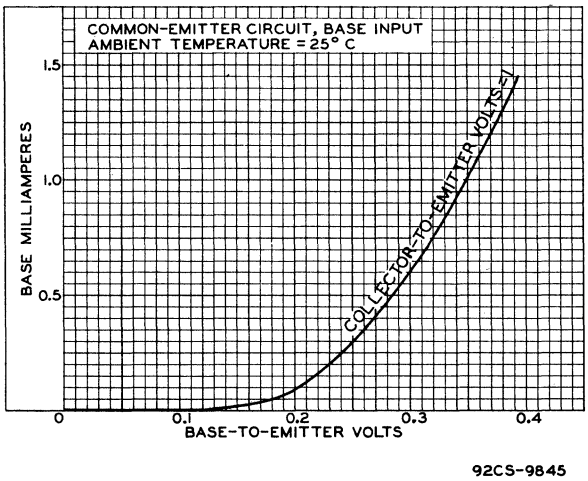


Fig.2 - Typical input characteristic for types 2N647 and 2N649.

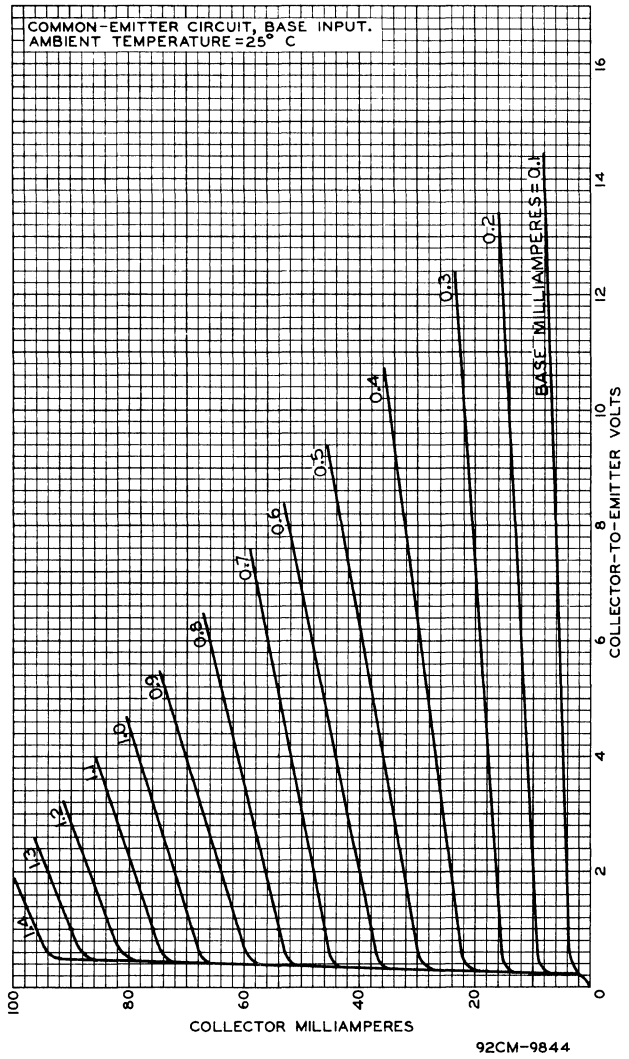


Fig.3 - Typical collector characteristics for types 2N647 and 2N649.

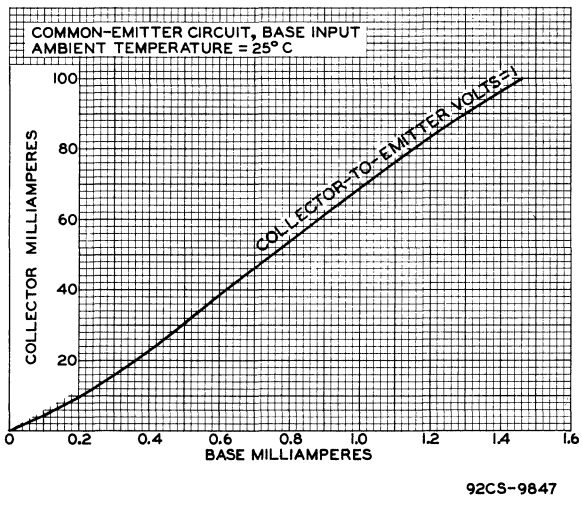
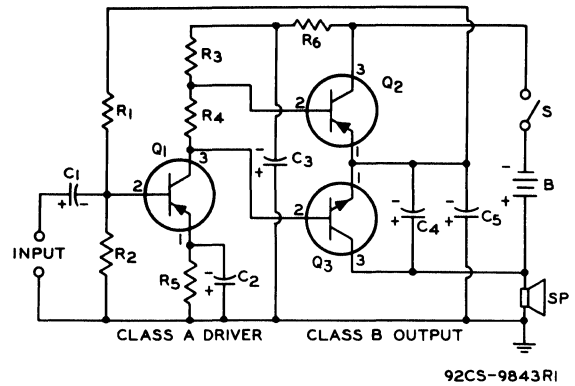


Fig.4 - Typical current transfer characteristic for types 2N647 and 2N649.



B: 6 volt battery
C_1: 5 μF, 6 V, electrolytic type
C_2, C_3: 50 μF, 6 V, electrolytic type
C_4: 0.5 μF, 6 V, electrolytic type
C_5: 50 μF, 6 V, electrolytic type
R_1: 12 KΩ, 0.5 W
R_2: 8.2 KΩ, 0.5 W
R_3: 1.5 KΩ, 0.5 W
R_4: 180 Ω, 0.5 W
R_5: 560 Ω, 0.5 W
R_6: 330 Ω, 0.5 W
Q_1: 2N217 or 2N408
Q_2: 2N217 or 2N408
Q_3: 2N647 or 2N649
S: switch
SP: speaker 45 Ω voice coil

Fig.5 - Audio amplifier circuit utilizing transistor complements 2N217, 2N647 or 2N408, 2N649 in Class B push-pull complementary-symmetry power output stage.

Typical Performance Data for Complementary-Symmetry, Class B Push-Pull AF-Amplifier Circuit Shown in Fig.5.

At an Ambient Temperature of 25°C and Signal Frequency of 1000 Hz

DC Supply Voltage	6 V
DC Collector-to-Emitter Voltage:	
For driver stage	2.3 V
Zero-Signal DC Collector Current:	
For each transistor (Driver and output stage)	1.5 mA
Zero-Signal DC Base-to-Emitter Voltage:	
For output stage	0.14 V
Peak Collector Current:	
For each transistor in output stage	70 mA
Input Resistance	1100 Ω
Load Resistance	45 Ω
Power Gain	54 dB
Power Output:	
With an input of 20 millivolts	100 mW
Total Harmonic Distortion:	
At a power output of 100 milliwatts	10% max.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

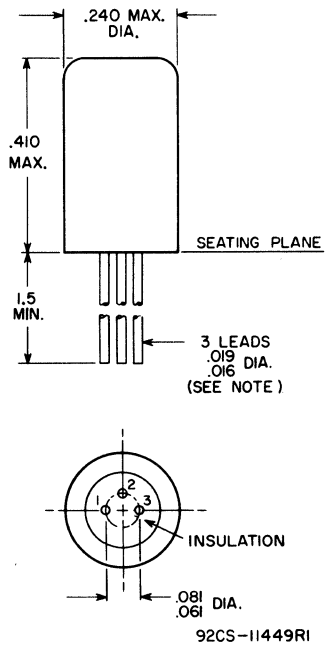
The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variations, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connections to the base, emitter, and collector leads of these devices may be soldered directly to the leads provided such connections are made at least 1/16 inch from the seating surface of the transistor, and provided care is taken to conduct excessive heat away from the lead seals during soldering. Failure to observe these precautions will result in cracking of the lead seals and permanent damage to the transistor.

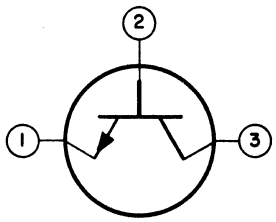
DIMENSIONAL OUTLINE
JEDEC No.TO-1



Dimensions in Inches

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector

SILICON CONTROLLED-RECTIFIERS

2N681–2N690

File No. 96

All-Diffused Types for Power-Control and Power-Switching Applications



JEDEC TO-48

RCA-2N681 through 2N690 controlled-rectifiers are all-diffused, three-junction, silicon devices for use in power-control and power-switching applications requiring blocking-voltage capabilities to 600 volts and forward-current capability of 16 amperes (average value) or 25 amperes (rms value).

FEATURES

- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Multi-diffusion process – permits precise control of individual junction parameters
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Each unit aged at maximum ratings to assure dependable performance
- All-welded construction and hermetic sealing
- Shorted emitter gate-cathode construction
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance
- Exceptionally high stud-torque capability through use of high-strength copper-alloy stud

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 cps, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES										UNITS
	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689	2N690	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM} (non-rep)[a]	35	75	150	225	300	350	400	500	600	720	volts
Peak Reverse Voltage (Repetitive), v_{RM} (rep)[b]	25	50	100	150	200	250	300	400	500	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM} (rep)[c]	←				600					→	volts
Forward Current: For case temperature (T_C) of +65° C, and a conduction angle of 180°, I_{FAV}[d]	←				16					→	amp
RMS value, I_{FRMS}[e]	←				25					→	amp
For other case temperatures and conduction angles	←				See *Fig.2*					→	
Peak Surge Current, i_{FM} (surge)[f]: For one cycle of applied voltage	←				150					→	amp
For more than one cycle of applied voltage	←				See *Fig.3*					→	
Peak Gate Power, P_{GM}[g]	←				5					→	watts
Average Forward Gate Power, P_{GAV}[h]	←				0.5					→	watt
Peak Forward Gate Current, i_{GKM}[i]	←				2					→	amp
Peak Gate Voltage:											
Forward, v_{GKM}[k]	←				10					→	volts
Reverse, v_{KGM}[k]	←				5					→	volts
Temperature:											
Storage, T_{stg}	←				-65 to +150					→	°C
Operating, Case#, T_C	←				-65 to +125					→	°C
Free Air, T_{FA}	←				See *Fig.4*					→	

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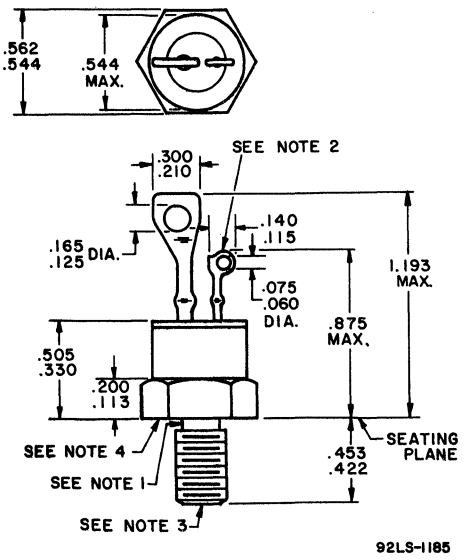
Printed in U.S.A.
2N681–2N690 5/66
Reprinted from 2N681–2N690 10/65

Electrical and Thermal Characteristics at Maximum Electrical Ratings (unless otherwise specified), and at Indicated Case Temperature, T_C.

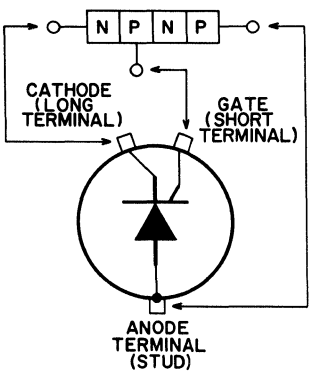
CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES										UNITS
	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689	2N690	
Minimum Forward Breakover Voltage, V_{BOO}[m]:											
At T_C = +125° C	25	50	100	150	200	250	300	400	500	600	volts
Maximum Average (DC) Forward Blocking Current, I_{FBOAV}[n]:											
At T_C = +125° C	6.5	6.5	6.5	6.5	6	5.5	5	4	3	2.5	ma
Maximum Average (DC) Reverse Blocking Current, I_{RBOAV}[p]:											
At T_C = +125° C	6.5	6.5	6.5	6.5	6	5.5	5	4	3	2.5	ma
Maximum Average Forward Voltage Drop, V_{FAV}[q]:											
At a Forward Current of 25 amperes and a T_C = +65° C	0.86										volt
Maximum DC Gate-Trigger Current, I_{GT}[r]:											
At T_C = +125° C	25										ma
DC Gate-Trigger Voltage, V_{GT}[s]:											
Maximum at T_C = -65° to +125° C	3										volts
Minimum at T_C = +125° C	0.25										volt
Holding Current, i_{HOO}[t]:											
Typical at T_C = +125° C	15										ma
Maximum Thermal Resistance, Junction-to-Case, θ_{J-C}[u]	2										°C/watt

Measured at the center of any of the six major faces on the perimeter of the hexagonal flange.

DIMENSIONAL OUTLINE
JEDEC TO-48



TERMINAL DIAGRAM



TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER

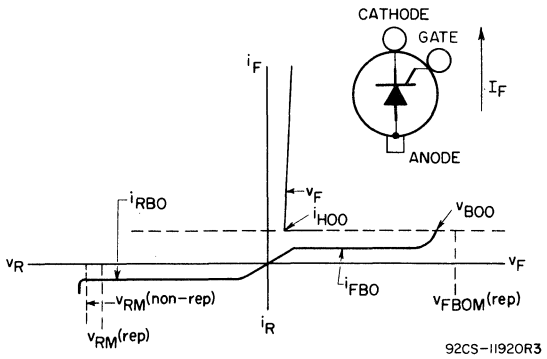
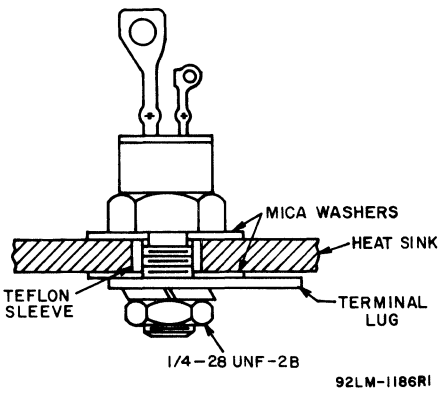


Fig. 1



Suggested Mounting Arrangement for Insulating Types 2N681 - 2N690 from Heat Sink. Components Shown (Except Heat Sink) are Furnished with Each Device.

Note 1: Complete threads to extend to within 2-1/2 threads of head. Dia. of unthreaded portion 0.249" maximum, 0.220" minimum.

Note 2: Angular orientation of these terminals is undefined. Square or radius on end of terminal is optional.

Note 3: 1/4-28 UNF-2A. Maximum pitch dia. of plated threads shall be basic pitch dia. 0.2268", minimum pitch dia. 0.2225". Ref. (Screw Thread Standards for Federal Services 1957) Handbook H28 1957 P1.

Note 4: A chamfer (or undercut) on one or both ends of hexagonal portion is optional.

RATING CHART

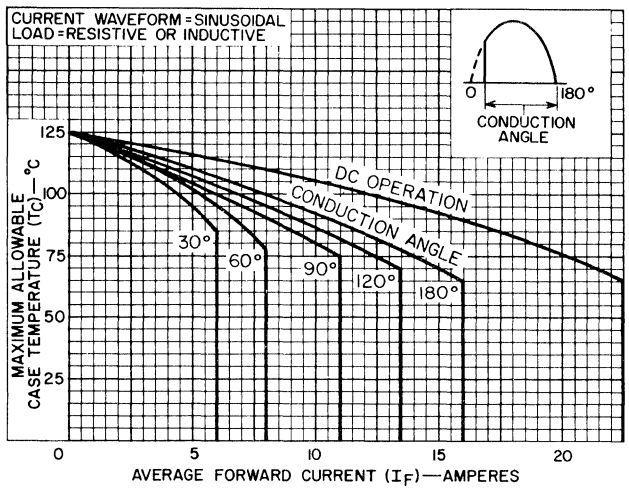
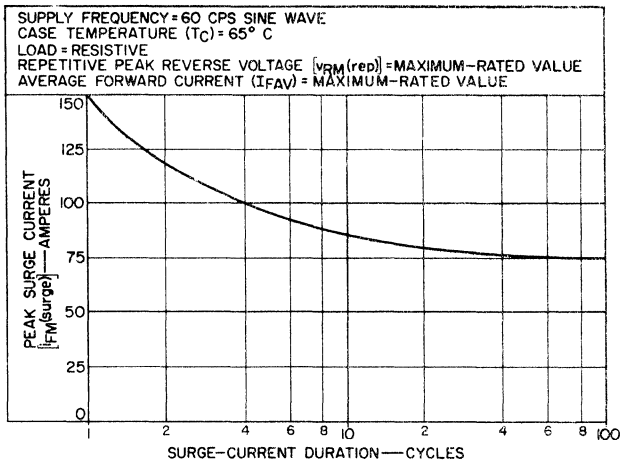


Fig.2 92CS-11928R3

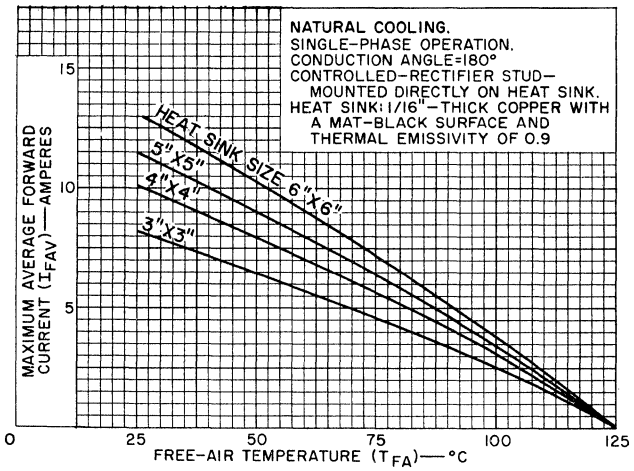
SURGE CURRENT RATING CHART



92CS-11918R1

Fig.3

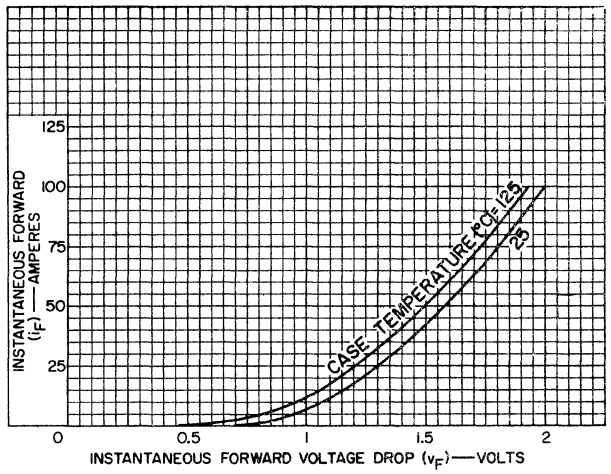
OPERATION GUIDANCE CHART



92CS-11916R1

Fig.4

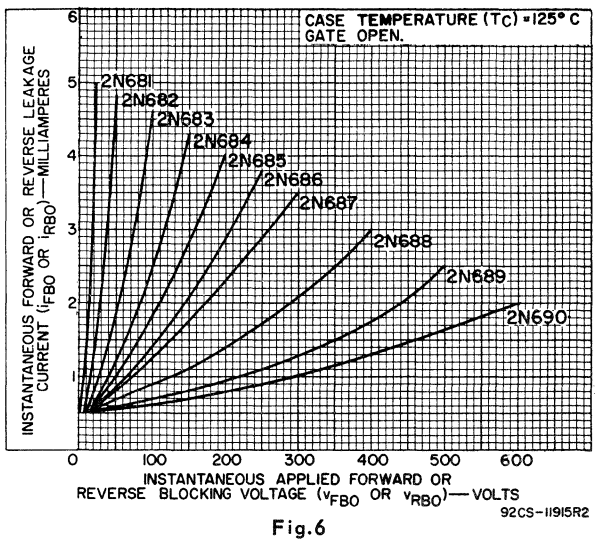
FORWARD CHARACTERISTICS



92CS-11917

Fig.5

FORWARD AND REVERSE LEAKAGE CHARACTERISTICS



92CS-11915R2

Fig.6

CONTROLLED-RECTIFIER TERMS, SYMBOLS, AND DEFINITIONS

(as used in this bulletin)

a **Transient Peak Reverse Voltage (Non-repetitive)** - v_{RM}(non-rep) - The maximum value of negative (reverse-blocking) voltage which may be applied between the anode and cathode for not more than 5 milliseconds when the gate is open (gate voltage is zero or negative with respect to cathode).

b **Peak Reverse Voltage (Repetitive)** - v_{RM}(rep) - The maximum instantaneous value of negative (reverse-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

c **Peak Forward Blocking Voltage** - v_{FBOM}(rep) - The maximum instantaneous value of positive (forward-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

d **Forward Current** - I_{FAV} - The average (dc) value of the current flowing from anode to cathode in the device.

e **RMS Forward Current** - I_{FRMS} - The RMS value of the current flowing from anode to cathode in the device.

f **Peak Surge Current** - i_{FM}(surge) - The maximum total instantaneous value of forward current which may be imposed during one forward half-cycle with the device operating within its specified maximum voltage, average-forward-current, gate-power, and temperature ratings in a single-phase circuit with 60-cps supply and resistive load. The peak surge current may be repeated after sufficient time has elapsed for the device to return to pre-surge thermal equilibrium conditions.

g **Peak Gate Power** - P_{GM} - The maximum instantaneous power dissipated between gate and cathode.

h **Average Forward Gate Power** - P_{GAV} - The average power dissipated between gate and cathode.

i **Peak Forward Gate Current** - i_{GKM} - The maximum instantaneous value of the current which may flow between gate and cathode.

k **Peak Gate Voltage** - v_{GKM} or v_{KGM} - The maximum instantaneous value of voltage, either forward or reverse, which may be applied between gate and cathode.

m **Forward Breakover Voltage** - v_{BOO} - The value of positive anode voltage at which a controlled rectifier switches into the conducting state when the gate is open.

n **Maximum Average Forward Blocking Current** - I_{FBOAV} - The maximum full-cycle average value of forward blocking current through a controlled rectifier when the gate is open.

p **Maximum Average Reverse Blocking Current** - I_{RBOAV} - The maximum full-cycle average value of reverse blocking current through a controlled rectifier when the gate is open.

q **Maximum Average Forward Voltage Drop** - V_{FAV} - The average value over one complete cycle of the forward voltage drop across a controlled rectifier operating at its maximum-average-forward-current rating in a single-phase circuit with 60-cps supply and resistive load.

r **Gate-Trigger Current** - I_{GT} - The gate current required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

s **Gate-Trigger Voltage** - V_{GT} - The gate-to-cathode voltage required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

t **Holding Current** - i_{HOO} - The instantaneous value of forward current i_F below which a controlled rectifier with its gate open returns to its forward blocking state.

u **Thermal Resistance, Junction-to-Case** - θ_{J-C} - The thermal resistance in °C per watt, between the junction and any of the six major surfaces on the perimeter of the hexagonal flange.

OPERATING CONSIDERATIONS

Because these controlled rectifiers may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent personnel from coming in contact with the rectifier.

The recommended torque is 26 to 36 inch-pounds applied to 1/4-28 UNF-2B hex nut assembled on thread.

The applied torque during installation should not exceed 50 inch-pounds.

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SILICON N-P-N TRANSISTOR

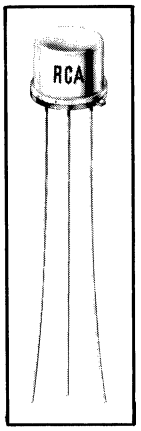
2N697

File No. 16

RCA-2N697 is a double-diffused-junction transistor of the silicon n-p-n type designed for use in high-speed-switching applications in military and industrial data-processing equipment.

This transistor is especially designed and processed to assure stability of characteristics and reliable performance under conditions of severe thermal and mechanical stress, and other environmental hazards.

For High-Speed Switching Service In Electronic Data-Processing Systems



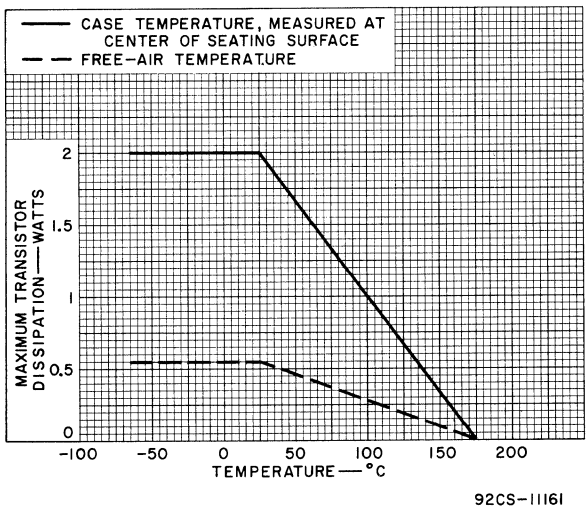
JEDEC TO-5

- tested in accordance with military specification MIL-S-19500B
- exceptional reliability
- exceptional stability of characteristics–stabilized by prolonged baking at 300°C
- typical pulse beta = 75
- low saturation voltages:
  $V_{CE}(sat)$ = 1.5 volts max. at I_C = 150 ma
  $V_{BE}(sat)$ = 1.3 volts max. at I_C = 150 ma

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE With emitter open	60 max.	volts
EMITTER-TO-BASE VOLTAGE With collector open	5 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE With external $R_{BE} \leq 10$ ohms .	40 max.	volts
COLLECTOR CURRENT	500 max.	ma
TRANSISTOR DISSIPATION:		
At case temperatures: up to 25° C. .	2 max.	watts
At case temperatures: above 25° C. .	See *Rating Chart*	
At free-air temperatures: up to 25° C. .	0.6 max.	watt
At free-air temperatures: above 25° C. .	See *Rating Chart*	
OPERATING TEMPERATURE RANGE: (Case or free-air).	-65 to +175	°C
LEAD TEMPERATURE: 1/16" ± 1/32" from case, for immersion for 10 seconds max.	255 max.	°C

R_{BE} = Base-to-emitter resistance.



Rating Chart for Type 2N697.

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Printed in U.S.A.
2N697 6/66
Reprinted from 2N697 6/61

ELECTRICAL CHARACTERISTICS

At a free-air temperature of 25° C unless otherwise indicated

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS			UNITS
		DC COLLECTOR-TO-BASE VOLTAGE V_{CB}	DC COLLECTOR-TO-EMITTER VOLTAGE V_{CE}	DC COLLECTOR CURRENT I_C	DC EMITTER CURRENT I_E	DC BASE CURRENT I_B				
		volts	volts	ma	ma	ma	min.	typ.	max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			0.1	0		60	75	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	0.1		5	7.5	-	volts
Collector-to-Emitter Voltage (R_{BE} = 10 ohms)	V_{CER}			100[a]			40	50	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			150		15	-	0.8	1.5	volts
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			150		15	-	1	1.3	volts
Collector-Cutoff Current:	I_{CBO}									
At T_{FA} = 25° C		30			0		-	0.01	1	μa
At T_{FA} = 150° C		30			0		-	1	100	μa
DC-Pulse Forward-Current Transfer Ratio[b]	h_{FE}		10	150			40	75	120	
Small-Signal Forward-Current Transfer Ratio	h_{fe} at 20 Mc		10	50			2.5	5	-	
Output Capacitance	C_{ob}	10			0		-	20	35	μμf
Gain-Bandwidth Product[c]	f_T						-	100	-	Mc

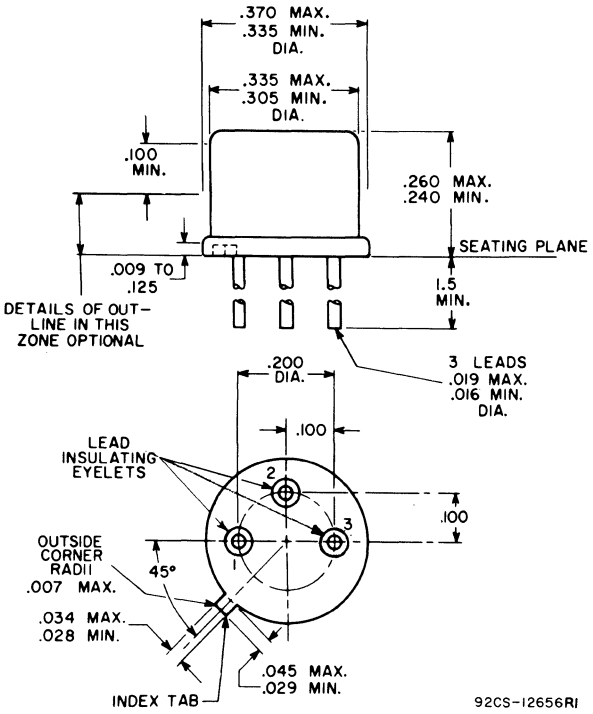
[a] Pulsed to prevent excessive heating of collector junction.

[b] Pulse width ≦ 12 msec, duty cycle ≦ 2%. R_{BE} = External base-to-emitter resistance.

[c] Frequency at which h_{fe} = 1. T_{FA} = Free-air temperature.

DIMENSIONAL OUTLINE FOR TYPE 2N697

JEDEC TO-5



TERMINAL CONNECTIONS

Lead No.1 - Emitter

Lead No.2 - Base

Lead No.3 - Collector

SILICON N-P-N PLANAR TRANSISTOR

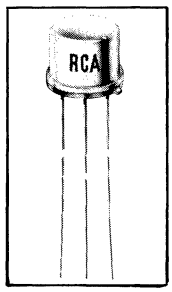
2N699

File No. 22

RCA-2N699 is a triple-diffused-junction planar transistor of the silicon n-p-n type intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. The 2N699 features a minimum gain-bandwidth product of 50 Mc making it well suited for vhf and video applications.

The triple-diffused-junction design of the 2N699 makes possible higher breakdown voltage ratings, lower saturation voltages, higher sustaining voltages, and lower output capacitance.

For Small-Signal and Medium-Power Applications



JEDEC TO-5

- minimum gain-bandwidth product = 50 Mc
- planar construction — insures low noise and low leakage characteristics
- low output capacitance
- high breakdown voltage (BV_{CBO}) = 120 volts minimum at I_C = 0.1 ma
- low saturation voltage

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE:		
With emitter open	120 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With external $R_{BE} \leq 10$ ohms	80 max.	volts
EMITTER-TO-BASE VOLTAGE:		
With collector open	5 max.	volts
TRANSISTOR DISSIPATION:		
At case temperatures: up to 25° C	2 max.	watts
above 25° C	See *Rating Chart*	
At free-air temperatures: up to 25° C	0.6 max.	watt
above 25° C	See *Rating Chart*	
TEMPERATURE RANGE:		
Storage	-65 to +300	°C
Operating (Junction)	175	°C

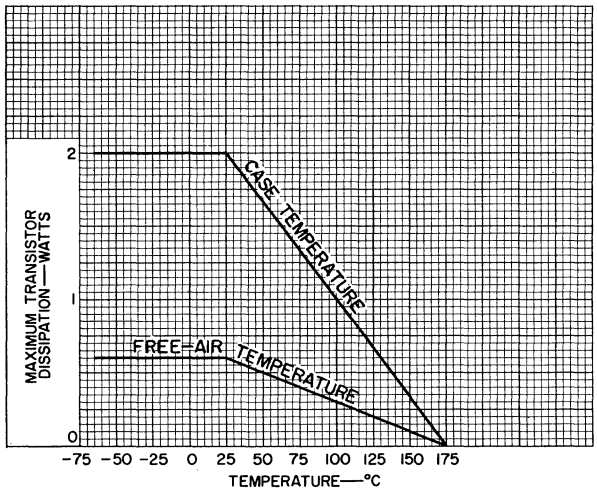


Fig. 1 — Rating Chart for Type 2N699.

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N699 6/66
Reprinted from 2N699 2/62

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	TEST CONDITIONS								LIMITS		Units
		Case Temperature °C	Frequency Kc	DC Collector-to-Base Voltage (volts)	DC Collector-to-Emitter Voltage (volts)	DC Emitter-to-Base Voltage (volts)	DC Collector Current (ma)	DC Emitter Current (ma)	DC Base Current (ma)			
				V_{CB}	V_{CE}	V_{EB}	I_C	I_E	I_B	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	25		60				0		-	2	μa
Emitter-Cutoff Current	I_{EBO}	25				2	0			-	100	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0.1	0		120	-	volts
DC-Pulse Forward-Current Transfer Ratio *	h_{FE}	25			10		150			40	120	
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance = 10 ohms*	$V_{CER(sus)}$	25					100			80	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25					150		15	-	5	volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25					150		15	-	1.3	volts
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25 25 25	1 1 20 Mc		5 10 10		1 5 50			35 45 2.5	100 - -	
Output Capacitance	C_{ob}	25		10				0		-	20	pf
Input Resistance	h_{ib}	25 25	1 1		5 10		1 5			20 -	30 10	ohms ohms
Voltage-Feedback Ratio	h_{rb}	25 25	1 1		5 10		1 5			- -	2.5×10^{-4} 3×10^{-4}	
Output Conductance	h_{ob}	25 25	1 1		5 10		1 5			0.1 -	0.5 1	μmho μmho
Thermal Resistance: Junction-to-case Junction-to-free air	 θ_{J-C} θ_{J-FA}	 - -								 - -	 75 250	 °C/watt °C/watt

* Pulse width ≤ 300 μsec, duty factor ≤ 2%.

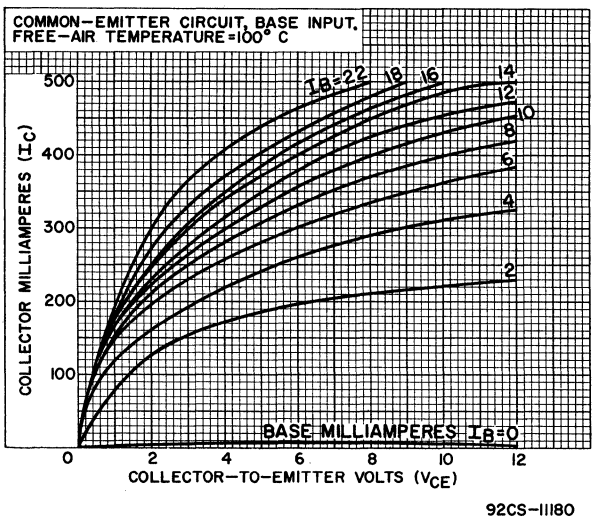


Fig.2 – Typical Collector Characteristics at 100° C for Type 2N699.

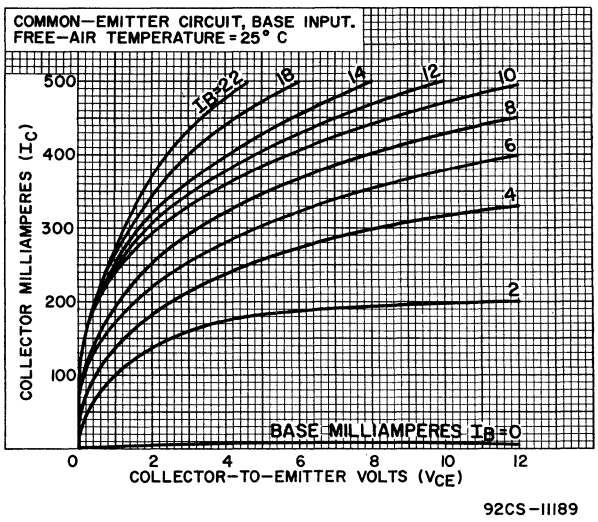


Fig.3 – Typical Collector Characteristics at 25° C for Type 2N699.

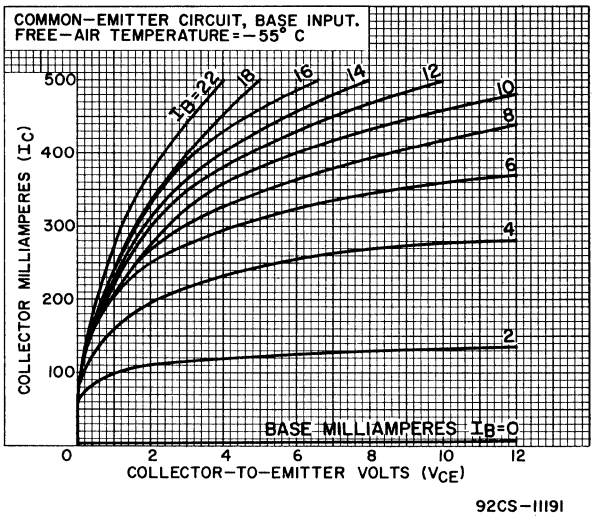


Fig.4 – Typical Collector Characteristics at -55° C for Type 2N699.

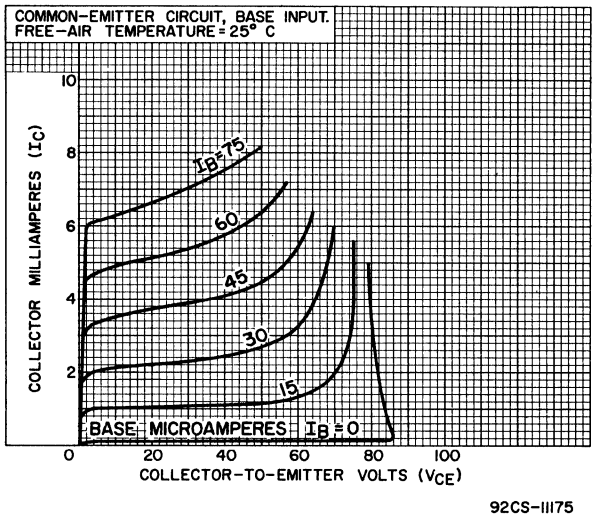


Fig.5 – Typical Collector Characteristics at 25° C for Type 2N699.

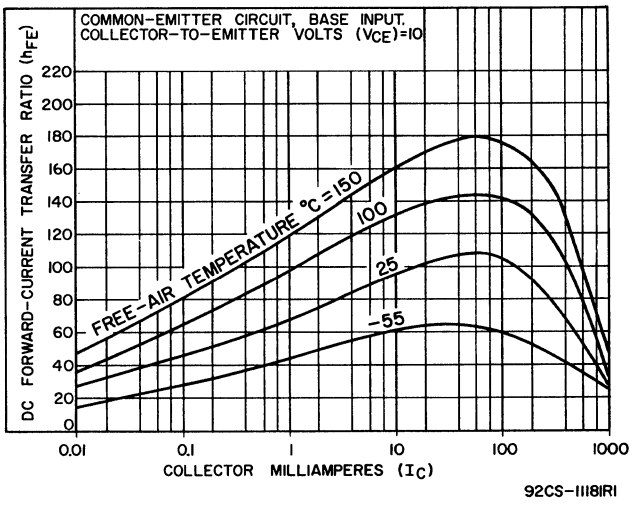


Fig.6 – Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N699.

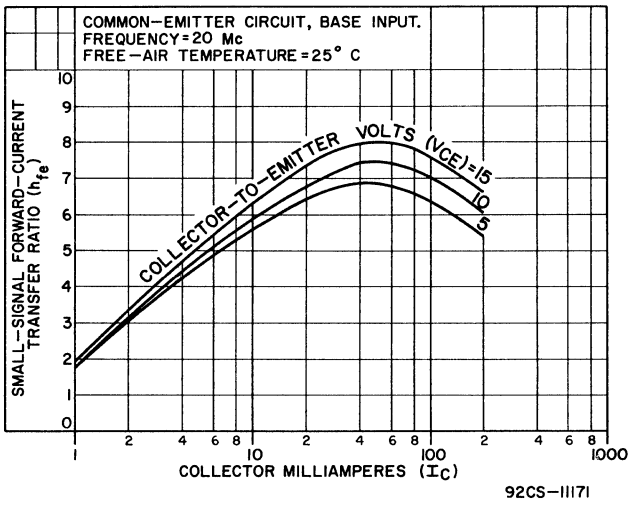


Fig.7 – Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Type 2N699.

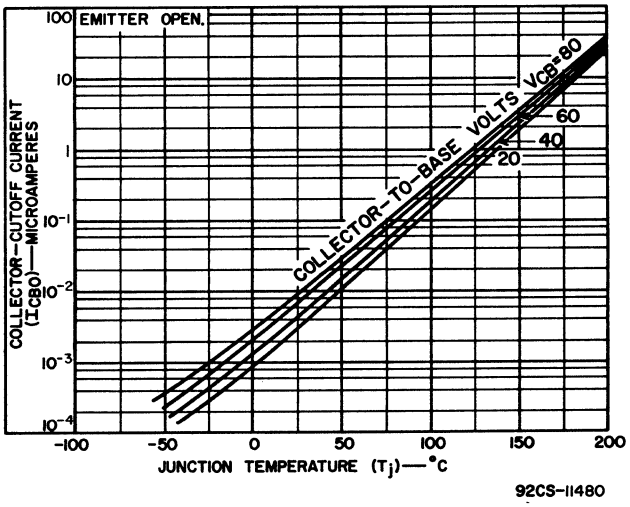
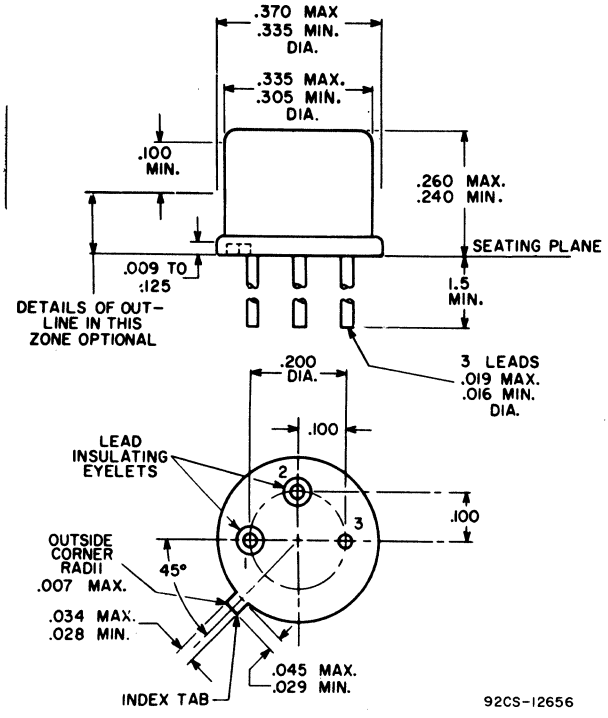


Fig.8 – Typical Collector-Cutoff-Current Characteristics for Type 2N699.

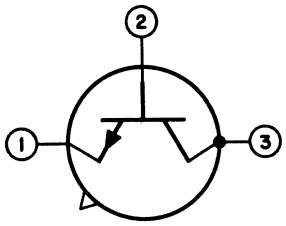
DIMENSIONAL OUTLINE
for Type
2N699
JEDEC No. TO-5



TERMINAL DIAGRAM

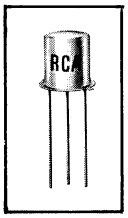
LEAD 1 – EMITTER

LEAD 2 – BASE



LEAD 3 – COLLECTOR, CASE

SILICON MESA N-P-N DIFFUSED-JUNCTION TRANSISTORS



JEDEC
TO-18

For Switching Applications in Commercial and Military Data Processing Equipment

RCA-2N706 and 2N706A are silicon mesa diffused-junction transistors designed for high-speed switching applications in commercial and military data-processing equipment.

These devices utilize a hermetically sealed three-lead JEDEC TO-18 package.

Maximum Ratings, *Absolute-Maximum Values:*

	2N706	2N706A	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25	25 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER} (R_{BE} = 10 Ω)	20	20 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	5 max.	V
COLLECTOR CURRENT, I_C	-	50 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures: up to 25°C	0.3	0.3 max.	W
At ambient temperatures: above 25°C	See Fig. 1		
At case temperatures: up to 25°C	1	1 max.	W
At case temperatures: above 25°C	See Fig. 1		
TEMPERATURE RANGE:			
Junction temperature	175	175	°C
Storage temperature	-65 to +175		°C
LEAD TEMPERATURE (During Soldering): At distances not closer than 1/32" to seating surface, for 10 seconds max.		255 max.	°C

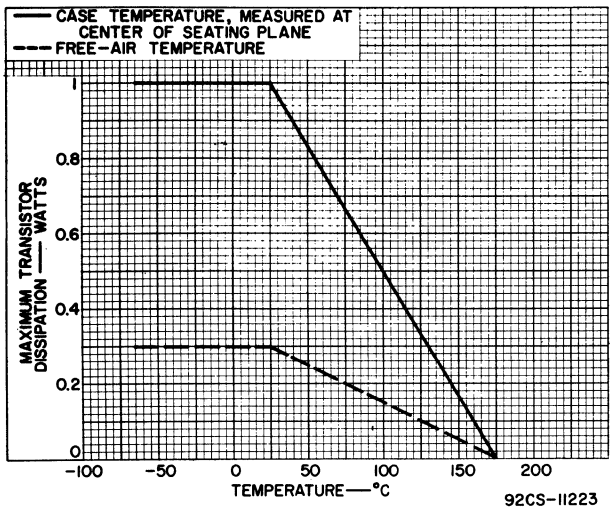


Fig. 1 - Rating Chart for Types 2N706 and 2N706A.

- high dissipation rating at T_C = 25°C, P_T = 1 W
- minimum gain-bandwidth product, f_T = 200 MHz

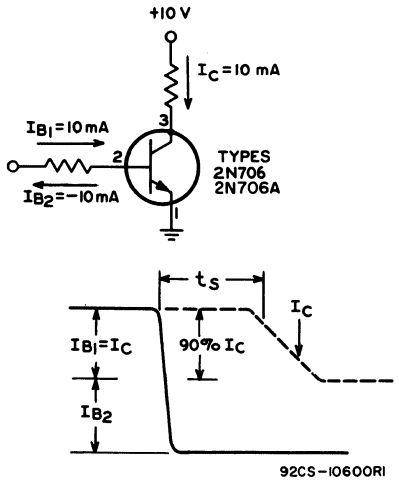


Fig. 2 - Circuit Used to Measure Storage Time (t_s) for Types 2N706 and 2N706A.

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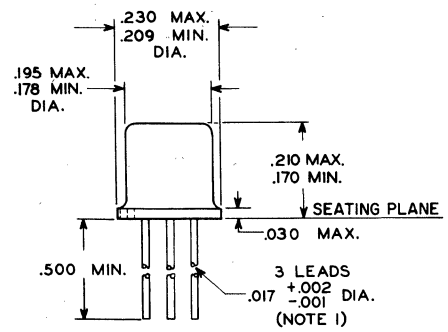
ELECTRICAL CHARACTERISTICS, at $T_A = 25^oC$:

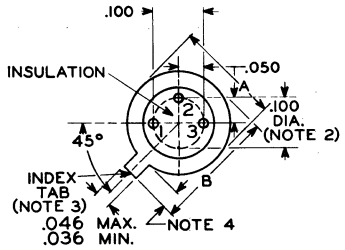
CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS						UNITS
		Collector-to-Emitter Voltage V_{CE}	Collector-to-Base Voltage V_{CB}	Collector Current I_C	Emitter Current I_E	Base Current I_B	2N706			2N706A			
		V	V	mA	mA	mA	min.	typ.	max.	min.	typ.	max.	
Collector-Cutoff Current $T_A = 25^oC$ $T_A = 150^oC$	I_{CBO}		15 15		0 0		- -	0.005 3.5	0.5 30	- -	- -	0.5 30	μA μA
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			10		1	-	0.3	0.6	-	-	0.6	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			10		1	-	0.75	0.9	0.7	-	0.9	V
Static Forward Current-Transfer Ratio	h_{FE}	1		10			20*	-	-	20	-	60	
Small-Signal Current Transfer Ratio f = 100 MHz	h_{fe}	15 10		10 10			2 -	4 -	- -	- 2	- -	- -	
Collector-to-Base Capacitance	C_{ob}		10		0		-	5	6	-	-	-	pF
Storage Time $R_L = 1\ k\Omega$ (See Fig. 2)	t_s	$V_{CC} = 10$				$I_{B1} = 10$ $I_{B2} = -10$	-	16	60	-	-	25	ns
Turn-On Time (Delay time + rise time) $R_L = 270\ \Omega$	t_{on}	$V_{CC} = 3$		10		$I_{B1} = 3$ $I_{B2} = -1$	-	-	-	-	-	40	ns
Turn-Off Time (Storage time + fall time) $R_L = 270\ \Omega$	t_{off}	$V_{CC} = 3$		10		$I_{B1} = 3$ $I_{B2} = -1$	-	-	-	-	-	75	ns

* Pulsed conditions - Pulse duration ≤ 12 ms, duty factor ≤ 0.02.

DIMENSIONAL OUTLINE

JEDEC No. TO-18





DIMENSIONS IN INCHES

92CS-10605R3

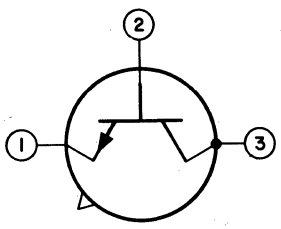
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" − 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

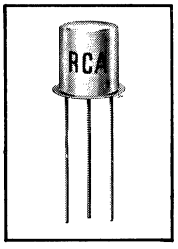
NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM − 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR, CASE

SILICON N-P-N VERY-HIGH-SPEED TRANSISTOR



JEDEC TO-18

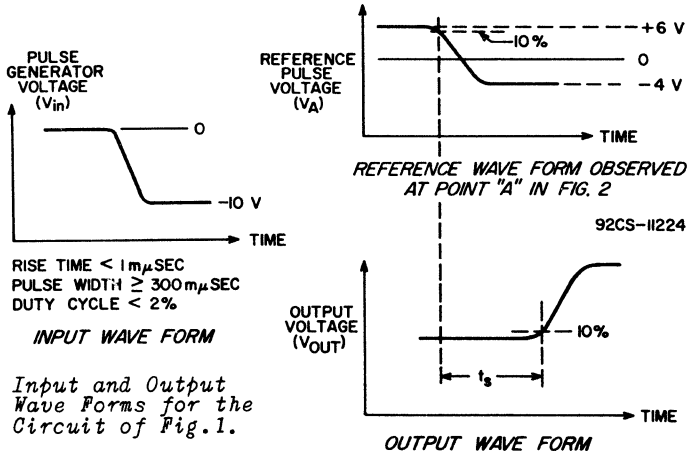
PLANAR TYPE FOR SWITCHING AND AMPLIFIER APPLICATIONS IN MILITARY AND INDUSTRIAL EQUIPMENT

RCA-2N708 is a double-diffused planar transistor of the silicon n-p-n type utilizing the JEDEC TO-18 package. Because of its planar construction and small size, this transistor is especially suitable for use in very-high-speed saturated switching and high-frequency amplifier applications in military and industrial equipment requiring high reliability and high packaging densities.

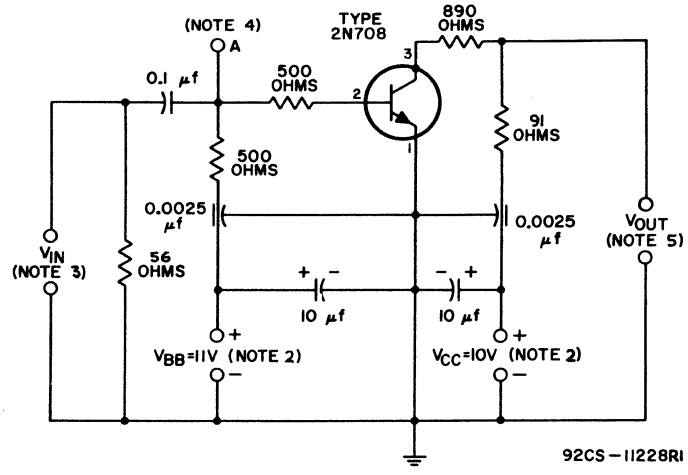
COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER}:		
With external $R_{BE} \leq 10$ ohms between base and emitter. .	20 max.	volts
With base open.	15 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}. .	5 max.	volts
COLLECTOR CURRENT, I_C	Limited by power dissipation	
TRANSISTOR DISSIPATION, P_T:		
At case temperatures[a] up to 25°C . .	1.2 max.	watts
above 25°C .	derate at 6.86	mW/°C
At ambient temperatures up to 25°C . .	0.36 max.	watts
above 25°C .	derate at 2.06	mW/°C
TEMPERATURE RANGE:		
Storage	-65 to +300	°C
Operating (Junction).	200 max.	°C
LEAD TEMPERATURE.	300 max.	°C



Input and Output Wave Forms for the Circuit of Fig. 1.



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1% TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 4: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 5: INPUT AND OUTPUT WAVEFORMS SHOWN ABOVE SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE SIMILAR TO HEWLETT-PACKARD MODEL 185A (OR EQUIVALENT) WITH HIGH-IMPEDANCE PROBE.

Fig. 1 - Circuit used to measure storage time (t_s) for Type 2N708.

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Printed in U.S.A.
2N708 8-66
Supersedes Issue Dated 3-62

Electrical Characteristics, *Free-air temperature = 25° C unless otherwise specified*

Characteristics	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Ma)			Min.	Max.	
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C			
Collector-Cutoff Current:										
At a free-air temperature of: 25° C	I_{CBO}	20	-	-	0	-	-	-	0.025	μa
150° C		20	-	-	0	-	-	-	15	μa
Collector Current: With base forward biased and a free-air temperature of 125° C	I_{CEX}		20	0.25	-	-	-	-	10	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	-	0.001	40	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	0.01	-	0	5	-	volts
Base-to-Emitter Saturation Voltage:										
For free-air temperature of: 25° C	$V_{BE(sat)}$	-	-	-	-	1	10	0.72	0.8	volt
-55° C		-	-	-	-	0.7	7	-	0.9	volt
Collector-to-Emitter Saturation Voltage										
For free-air temperature of: 25° C	$V_{CE(sat)}$	-	-	-	-	1	10	-	0.4	volt
-55° C to +125° C		-	-	-	-	0.7	7	-	0.4	volt
DC Forward-Current Transfer Ratio										
For free-air temperature of: 25° C	h_{FE}	-	1	-	-	-	10	30	120	
25° C		-	1	-	-	-	0.5	15	-	
-55° C		-	1	-	-	-	10	15	-	
Collector-to-Base Capacitance At a frequency of 140 Kc	C_{ob}	10	-	-	0	-	-	-	6	pf
Small-Signal Forward-Current Transfer Ratio: At a frequency of 100 Mc	h_{fe}	-	10				10	3	-	
Base-Spreading Resistance At a frequency of 300 Mc	r_b'▲	-	10	-	-	-	10	-	50	ohms
Emitter-Cutoff Current	I_{EBO}	-	-	4	-	-	0	-	0.08	μa
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$●	-	-	-	-	0	30	15	-	volts
Collector-to-Emitter Sustaining Voltage: With external $R_{BE} \leq 10$ ohms	$V_{CER(sus)}$●	-	-	-	-	-	30	20	-	volts
Thermal Resistance: Junction-to-case	R_T	-	-	-	-	-	-	-	145	°C/watt
Junction-to-free air		-	-	-	-	-	-		480	°C/watt
Storage Time (See *Fig.1*) With collector-supply volts (V_{CC}) = 10	t_s	-	-	-	-	I_{B1}* = 10 I_{B2}* = -10	10	-	25	nsec

* I_{B1} = "Turn-on" base current; I_{B2} = "Turn-off" base current

▲ Base-Spreading Resistance (r_b') is the product of R_e and h_{ie} (small-signal value of the short-circuit input impedance).

● Pulsed conditions.

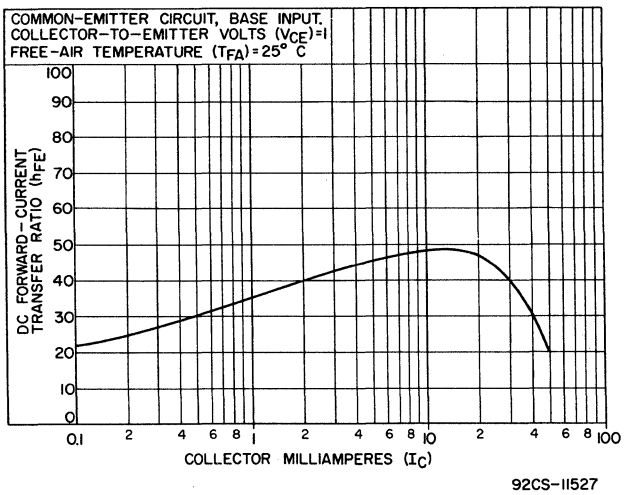


Fig. 2 - Typical DC-Forward-Current Transfer-Ratio Characteristic for Type 2N708.

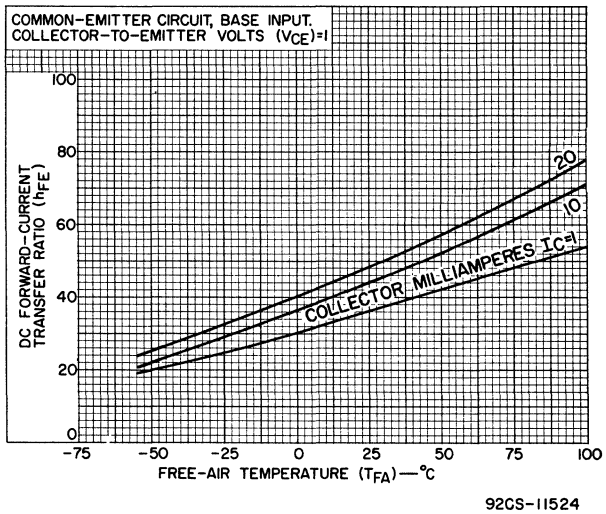


Fig. 3 - Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N708.

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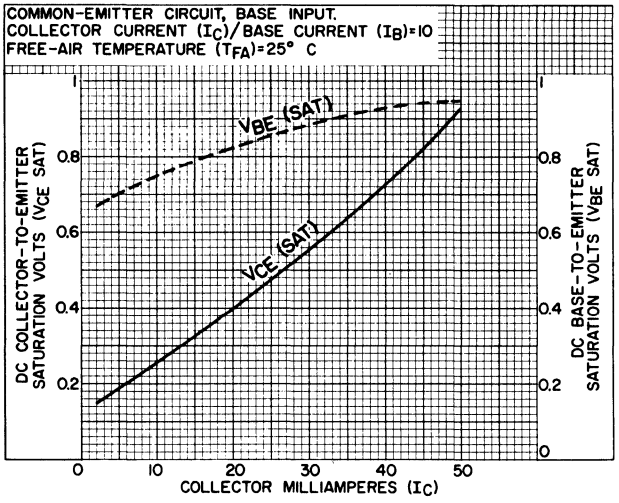


Fig.4 - Typical Saturation Voltage Characteristics for Type 2N708.

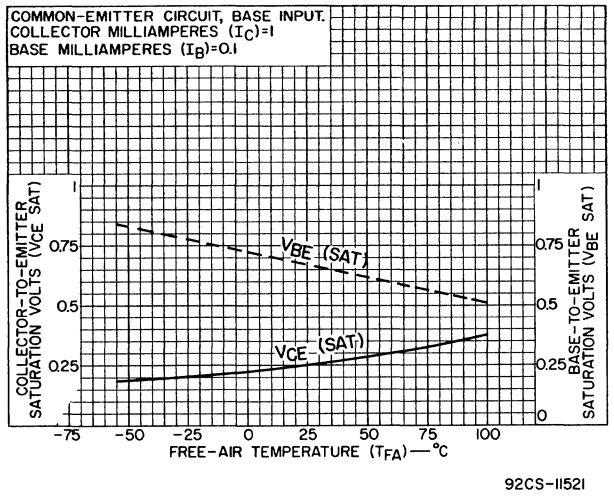


Fig.5 - Typical Saturation Voltage Characteristics for Type 2N708.

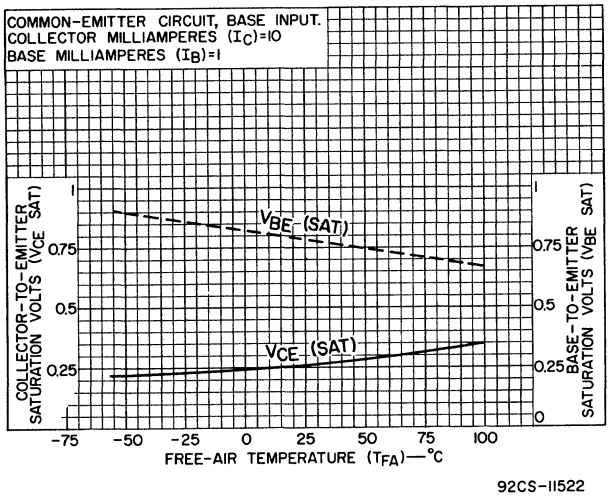


Fig.6 - Typical Saturation Voltage Characteristics for Type 2N708.

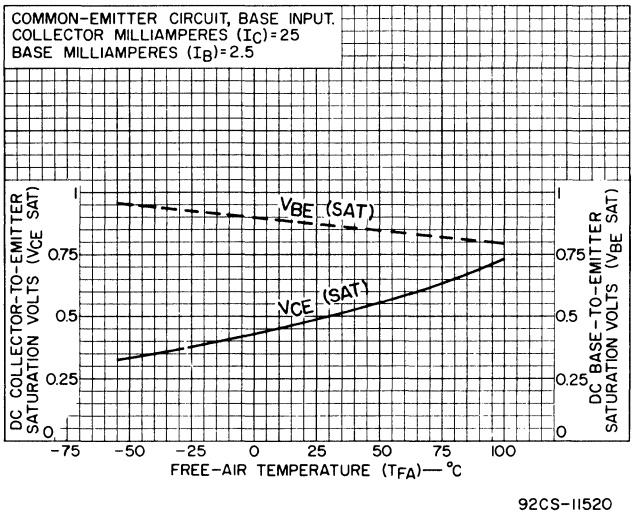


Fig.7 - Typical Saturation Voltage Characteristics for Type 2N708.

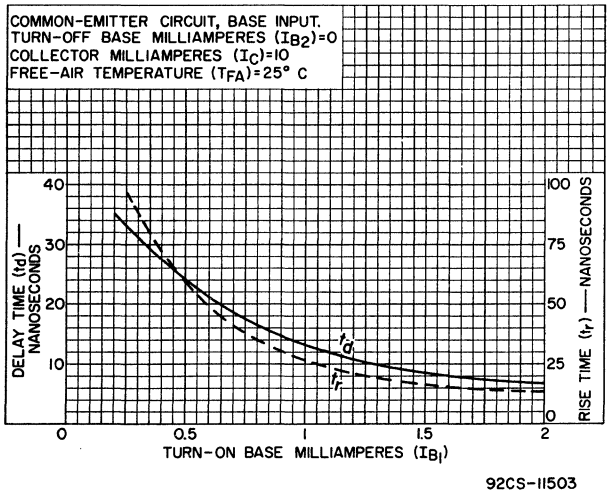


Fig. 8 - Typical Delay and Rise Times vs. Turn-On Base Current for Type 2N708.

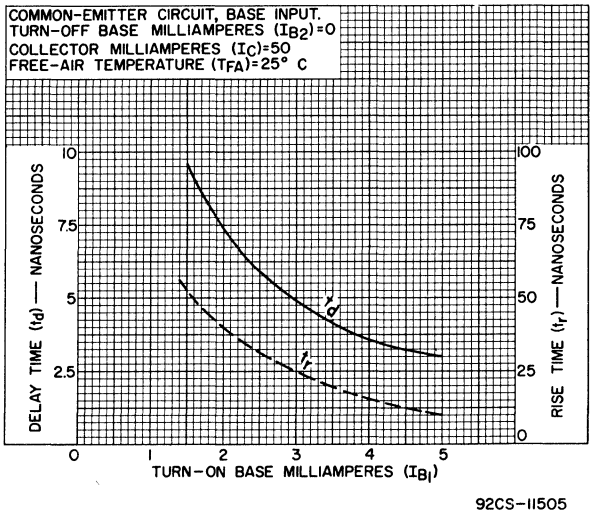


Fig. 9 - Typical Delay and Rise Times vs. Turn-On Base Current for Type 2N708.

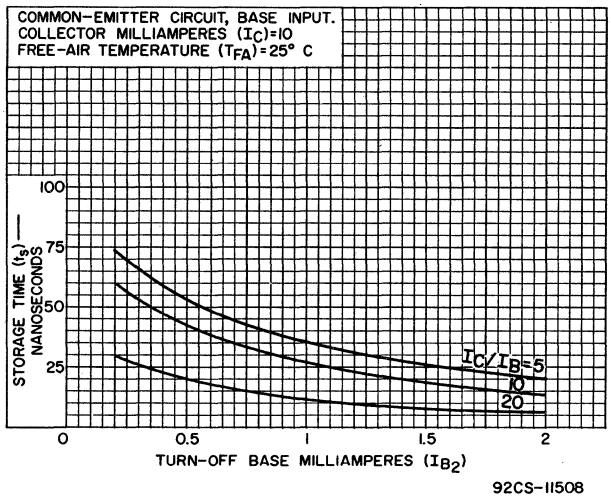


Fig. 10 - Typical Storage Time vs. Turn-Off Base Current for Type 2N708.

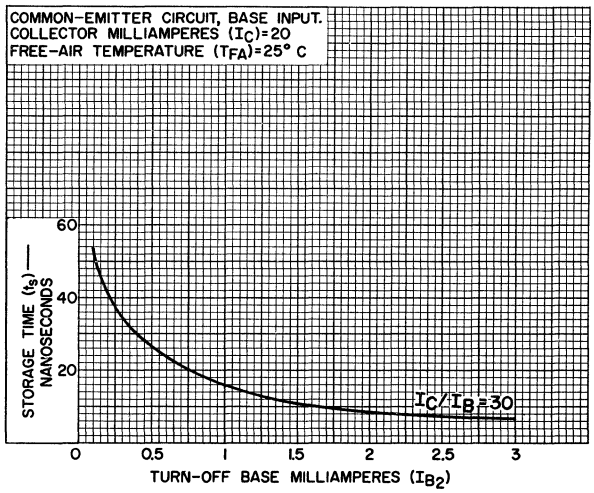


Fig. 11 - Typical Storage Time vs. Turn-Off Base Current for Type 2N708.

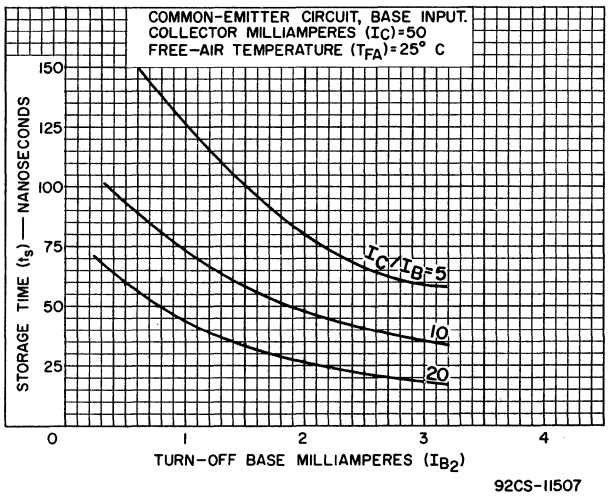


Fig. 12 - Typical Storage Time vs. Turn-Off Base Current for Type 2N708.

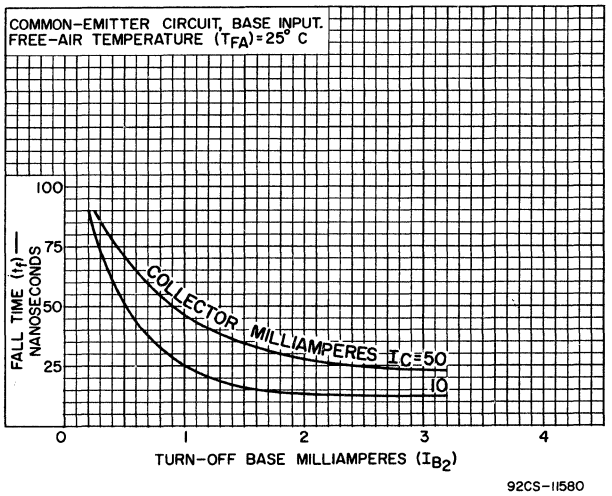
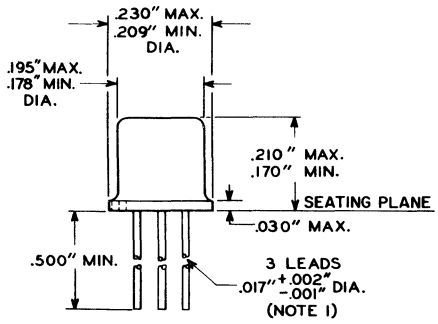
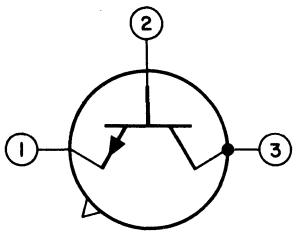


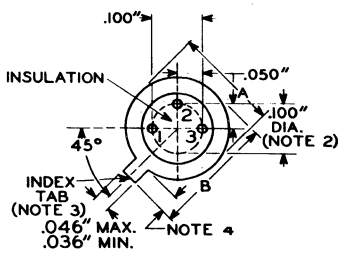
Fig. 13 - Typical Fall Time vs. Turn-Off Base Current for Type 2N708.





TERMINAL DIAGRAM
(Bottom View)

Lead 1 – Emitter
Lead 2 – Base
Lead 3 – Collector, Case



NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE CASE SEAT. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" – 0.000" BELOW CASE SEAT TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT CASE SEAT.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM – 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

SILICON N-P-N PLANAR TRANSISTORS

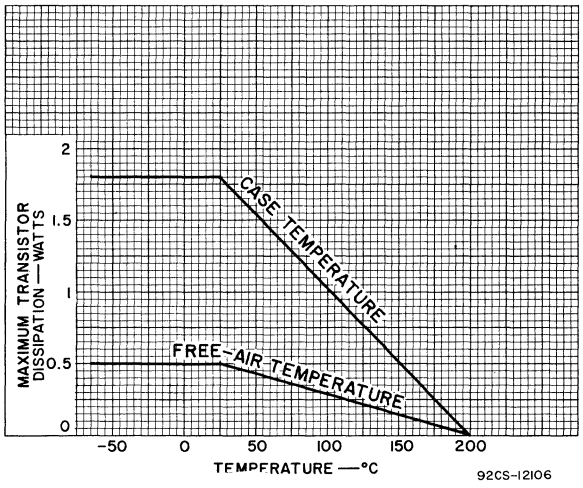
2N718A
2N720A

File No. 36

RCA-2N718A and 2N720A are triple-diffused-junction planar transistors of the silicon n-p-n type intended for a wide variety of small-signal and switching applications in military and industrial equipment. These transistors feature low noise and leakage characteristics, high pulsed beta over a wide range of collector current, and high switching-speed capabilities.

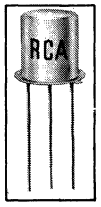
Maximum Ratings, *Absolute-Maximum Values:*

	2N720A	2N718A	
COLLECTOR-TO-BASE VOLTAGE WITH EMITTER OPEN, V_{CBO}.	120	75 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE WITH $R_{BE} \leq 10$ OHMS, V_{CER}	100	50 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE WITH BASE OPEN, V_{CEO}	80	32 max.	volts
EMITTER-TO-BASE VOLTAGE WITH COLLECTOR OPEN, V_{EBO}	7	7 max.	volts
TRANSISTOR DISSIPATION, P_T:			
At case temperatures up to 25° C.	1.8	1.8 max.	watts
above 25° C.	See Rating Chart		
At free-air temperatures up to 25° C.	0.5	0.5 max.	watt
above 25° C.	See Rating Chart		
TEMPERATURE RANGE:			
Storage.	-65 to +300		°C
Operating (Junction) . .	-65 to +200		°C
LEAD TEMPERATURE (DURING SOLDERING): At distances ≥ 1/32 inch from seating surface for 10 seconds maximum . . .	255	255 max.	°C



Rating Chart for Types 2N718A and 2N720A.

For Small-Signal and Switching Applications



JEDEC TO-18

- high minimum gain-bandwidth products:
  60 Mc min. (100 Mc typical) for 2N718A
  50 Mc min. (100 Mc typical) for 2N720A
  useful in applications from dc to 20 Mc
- operation at high junction temperatures— up to 200° C
- low collector-to-emitter saturation voltage — $V_{CE(sat)}$ = 0.3 volt typ. at I_C = 150 ma.
- planar construction — for low noise and low leakage characteristics
- Very low output capacitances:
  15 pf max. for 2N720A
  25 pf max. for 2N718A

RCA-2N718A FEATURES:

- high dc pulsed beta at high collector current — h_{FE} = 20 min. at I_C = 0.5 amp
- high switching speed (non-saturating mode) — 30 nanoseconds max.
- low narrow-band noise figure — 12 db max.

RCA-2N720A FEATURES:

- high voltage ratings:
  V_{CBO} = 120 volts
  V_{CER} = 100 volts for $R_{BE} \leq 10$ ohms
  V_{CEO} = 80 volts

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Printed in U.S.A.
2N718A, 2N720A 6/66
Reprinted from 2N718A, 2N720A 7/63

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	TEST CONDITIONS								LIMITS				Units
		Free-Air Temperature T_{FA}	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N720A		Type 2N718A		
		°C	kc	volts	volts	volts	ma	ma	ma	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	25		90				0		-	0.01	-	-	μa
		150		90				0		-	15	-	-	μa
		25		60				0		-	-	-	0.01	μa
		150		60				0		-	-	-	10	μa
Emitter-Cutoff Current	I_{EBO}	25				5	0			-	0.01	-	0.01	μa
DC Forward-Current Transfer Ratio	h_{FE}	25			10		150[a]			40	120	40	120	
		25			10		500[a]			-	-	20	-	
		25			10		10[a]			35	-	35	-	
		25			10		0.1			20	-	20	-	
		-55			10		10[a]			20	-	20	-	
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0.1	0		120	-	75	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.1		7	-	7	-	volts
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$	25					100[a]		0	80	-	-	-	volts
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance = 10 ohms	$V_{CER(sus)}$	25					100[a]			100	-	50	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25					150[a]		15[a]	-	5	-	1.5	volts
		25					50		5	-	1.2	-	-	volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25					150[a]		15[a]	-	1.3	-	1.3	volts
		25					50		15	-	0.9	-	-	volts
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25	1		5		1			30	100	30	100	
		25	1		10		5			45	-	35	150	
		25	20 Mc		10		50			2.5	-	3	-	
Noise Figure: Generator resistance (R_G) = 510 ohms, circuit bandwidth (BW) = 1 cps	NF	25	1		10		0.3			-	-	-	12	db
Total Switching Time (See *Fig.1*)	$t_d + t_r + t_f$	25								-	-	-	30	nsec
Output Capacitance	C_{ob}	25		10				0		-	15	-	25	pf
Input Capacitance	C_{ib}	25				0.5	0			-	85	-	80	pf
Input Resistance	h_{ib}	25	1		5		1			20	30	24	34	ohms
		25	1		10		5			4	8	4	8	ohms
Voltage-Feedback Ratio	h_{rb}	25	1		5		1			Max. 1.25x10-4		-	3x10-4	
		25	1		10		5			1.5x10-4		-	3x10-4	
Output Conductance	h_{ob}	25	1		5		1			-	0.5	0.1	0.5	μmho
		25	1		10		5			-	0.5	0.1	1	μmho
Thermal Resistance: Junction-to-case	θ_{J-C}	-								-	97	-	97	°C/watt
Junction-to-free air	θ_{J-FA}	-								-	350	-	350	°C/watt

[a] Pulse Test: Pulse duration ≤ 300 μsec; duty factor ≤ 2%.

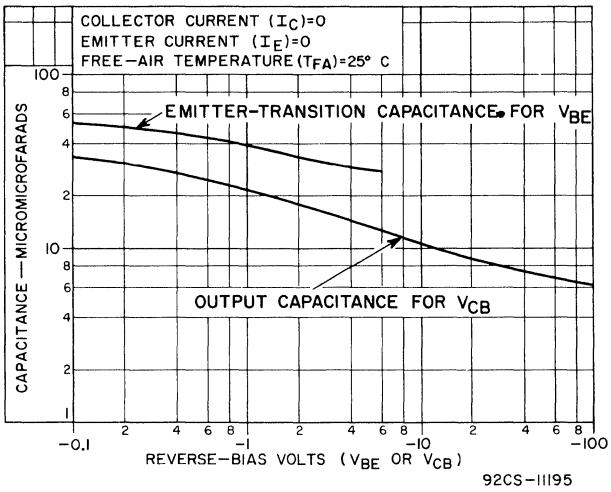
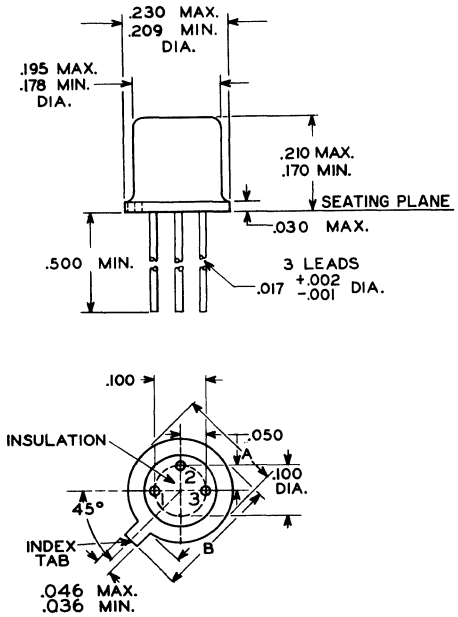


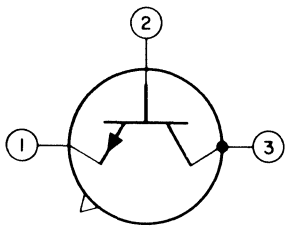
Fig. 11 - Typical Capacitance Characteristics for Types 2N718A and 2N720A.

DIMENSIONAL OUTLINE
JEDEC No. TO-18



92CS-10605R3

TERMINAL DIAGRAM
(Bottom View)



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR, CASE

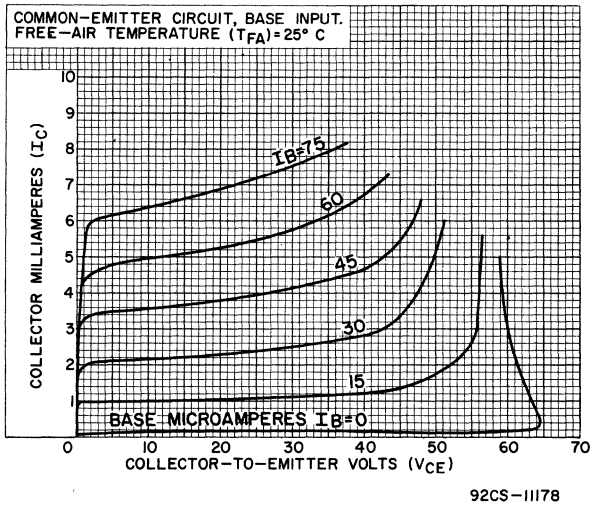


Fig. 5 - Typical Collector Characteristics at 25° C for Type 2N718A.

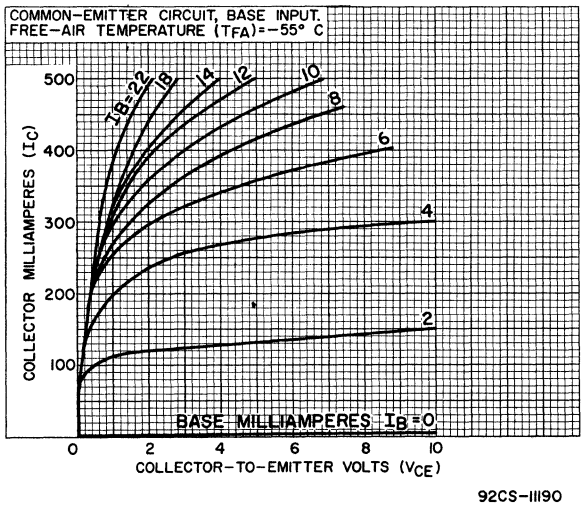


Fig. 6 - Typical Collector Characteristics at -55° C for Types 2N718A and 2N720A.

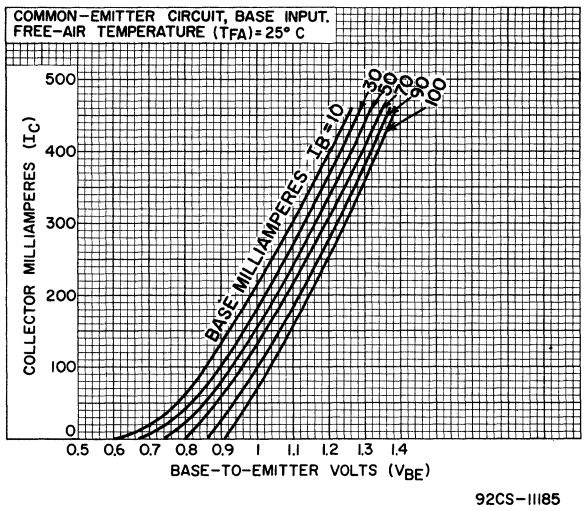


Fig. 7 - Typical Transfer Characteristics for Types 2N718A and 2N720A.

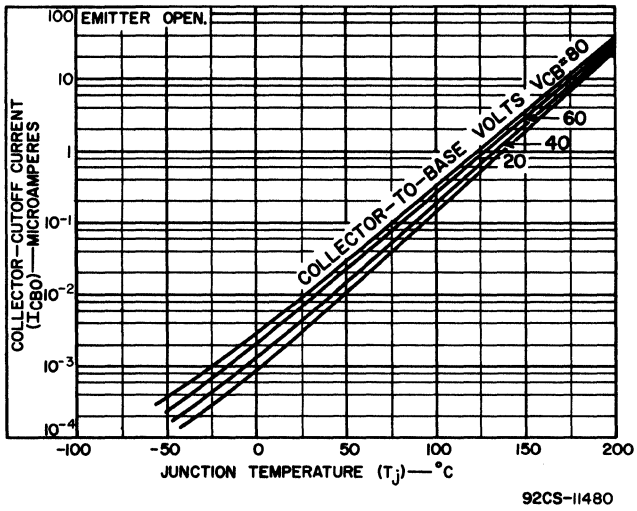


Fig. 8 - Typical Collector-Cutoff-Current Characteristics for Type 2N718A.

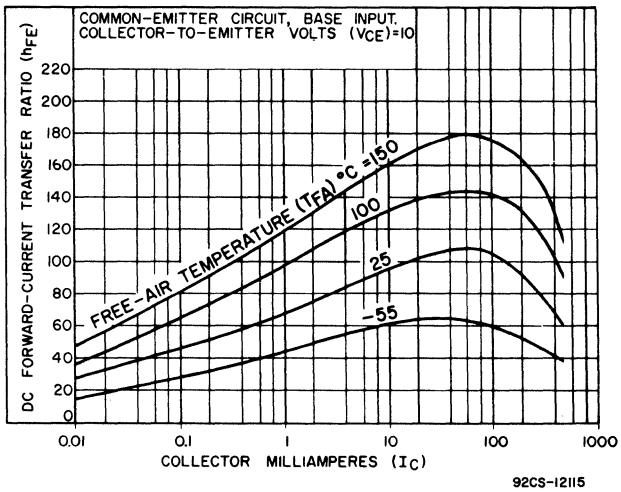


Fig. 9 - Typical DC-Beta Characteristics for Types 2N718A and 2N720A.

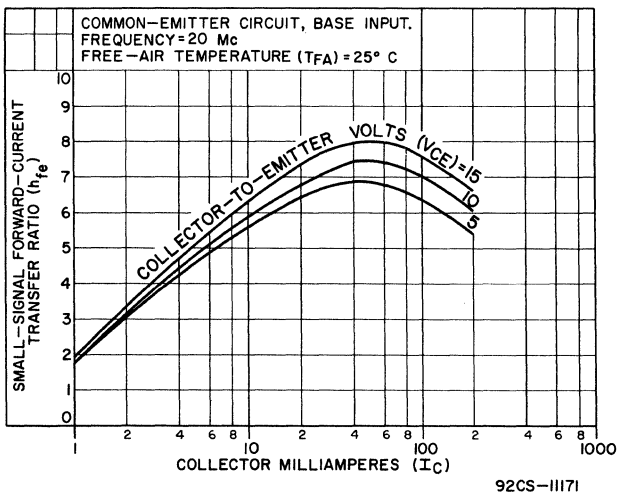


Fig. 10 - Typical Small-Signal-Beta Characteristics for Types 2N718A and 2N720A.

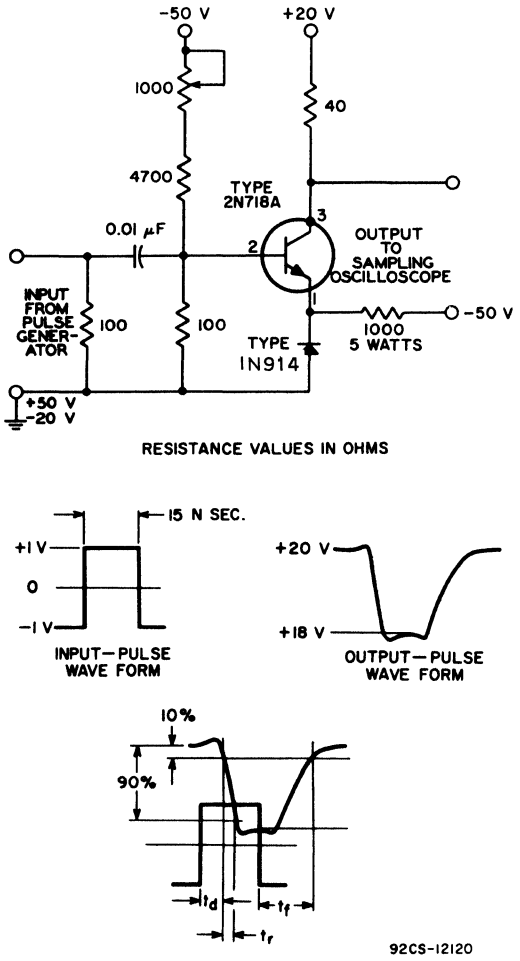


Fig. 1 - Circuit Used to Measure Total Switching Time for Type 2N718A.

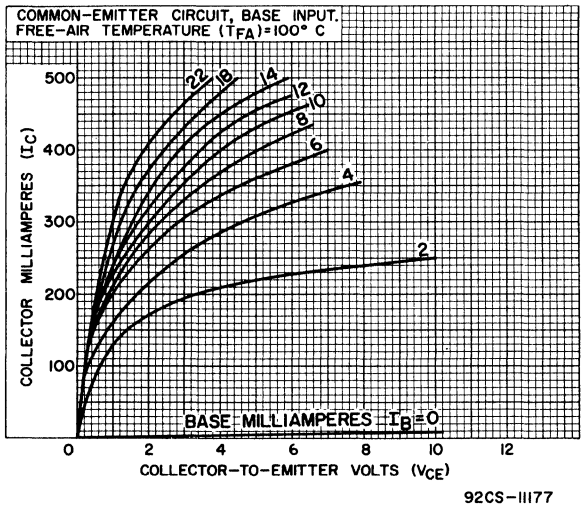


Fig. 2 - Typical Collector Characteristics at 100° C for Types 2N718A and 2N720A.

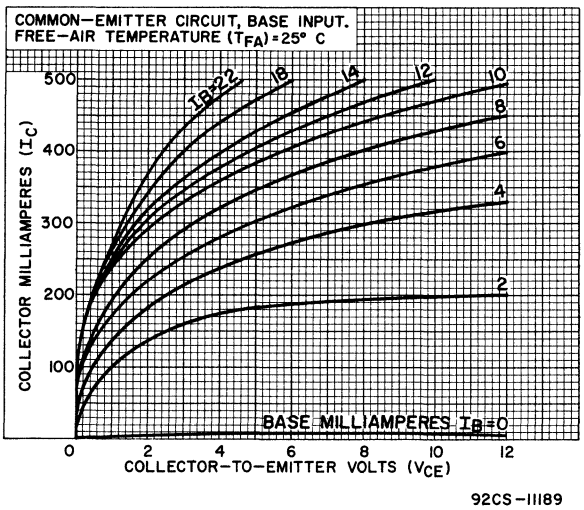


Fig. 3 - Typical Collector Characteristics at 25° C for Types 2N718A and 2N720A.

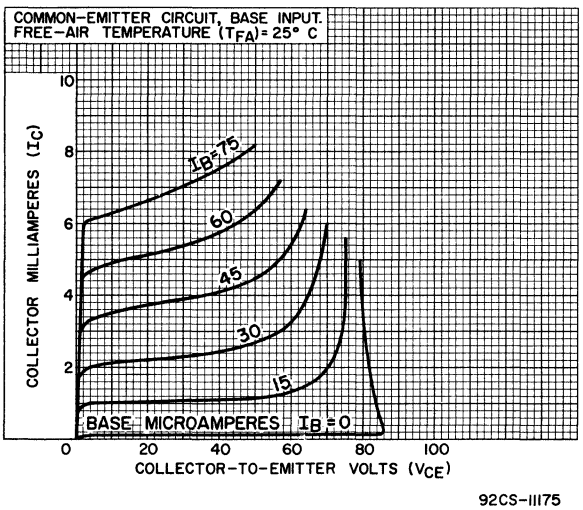
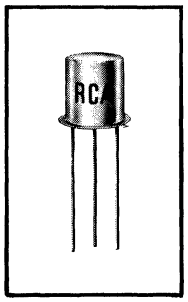


Fig. 4 - Typical Collector Characteristics at 25° C for Type 2N720A.



SILICON N-P-N HIGH-SPEED TRANSISTOR

Epitaxial Type For Switching Applications



JEDEC TO-18

- meets mechanical and environmental requirements of MIL-S-19500B
- epitaxial structure — insures low collector saturation voltage at high collector current
- short storage time — 25 nsec max.

RCA-2N834 is an epitaxial transistor of the silicon n-p-n type. It is especially designed for use in high-speed saturated switching applications in military and industrial equipment requiring high reliability and high packaging densities.

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CES}:		
With R_{BE} = 0	30 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5 max.	volts
COLLECTOR CURRENT, I_C	200 max.	ma
TRANSISTOR DISSIPATION:		
At case temperatures: up to 25° C.	1 max.	watt
At case temperatures: above 25° C.	See *Fig.1*	
At free-air temperatures: up to 25° C.	0.3 max.	watt
At free-air temperatures: above 25° C.	See *Fig.1*	
TEMPERATURE RANGE:		
Storage	-65 to +175	°C
Operating	175 max.	°C
LEAD TEMPERATURE:		
1/16" ± 1/32" from seating surface for 10 seconds max.	240 max.	°C

Electrical Characteristics, *Free-air temperature = 25° C unless otherwise specified*	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (ma)			Min.	Max.	
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C			
Collector-Cutoff Current: With emitter open and a free-air temperature of: 25° C	I_{CBO}	20	-	-	0	-	-	-	0.50	μa
150° C		20	-	-	0	-	-	-	30	μa
Collector Current: With R_{BE} = 0	I_{CES}	-	30	0	-	-	-	-	10	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	-	0.1	40	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	0.1	-	0	5	-	volts
Gain-Bandwidth Product: At a frequency of 100 Mc	f_T		15				10	350	-	Mc
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	-	-	-	1	10	-	0.9	volt
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-	-	-	1	10	-	0.25	volt
						5	50	-	0.40	volt
Collector-to-Base Capacitance: With emitter open and a frequency of 100 kc	C_{ob}	10	-	-	0	-	-	-	4	pf
DC Forward-Current Transfer Ratio	h_{FE}	-	1	-	-	-	10	25	-	
Small-Signal Forward-Current Transfer Ratio: At a frequency of 100 Mc	h_{fe}	-	15	-	-	-	10	3.5	-	
Storage Time (See *Fig.2*): With collector supply volts (V_{CC}) = 10	t_s	-	-	-	-	I_{B1} = 10, I_{B2} = -10	10	-	25	nsec
Turn-On Time (delay time plus rise time); see *Fig.3*.	$t_d + t_r$	-	-	-	-	-	10	-	35	nsec
Turn-Off Time (storage time plus fall time); see *Fig.3*.	$t_s + t_f$	-	-	-	-	-	10	-	75	nsec

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N834 5-67
Supersedes issue dated 3-62

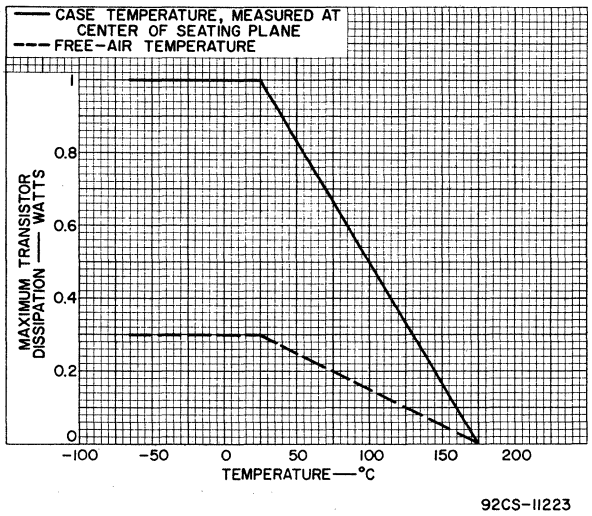
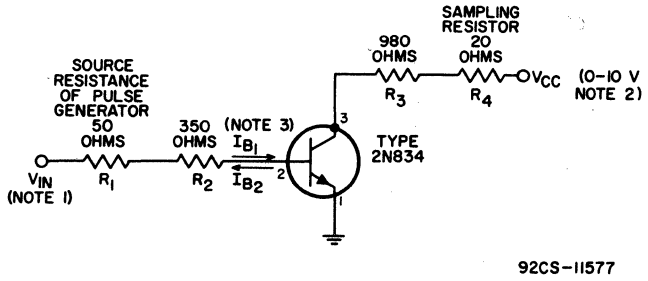


Fig. 1 - Rating Chart for Type 2N834.



Note 1: Test circuit provided by the Tektronix Type R plug-in unit (for Tektronix Model 541 Oscilloscope) for the measurement of t_s. The Type R unit provides the input voltage (V_{IN}) and the collector-supply voltage (V_{CC}). Resistors R_1 and R_4 are included in the Type R unit; resistors R_2 and R_3 are wired to the associated wiring board.

Note 2: V_{CC} is adjusted for I_C = 10 ma.

Note 3: I_{B_1} = Turn-On Base Current
I_{B_2} = Turn-Off Base Current

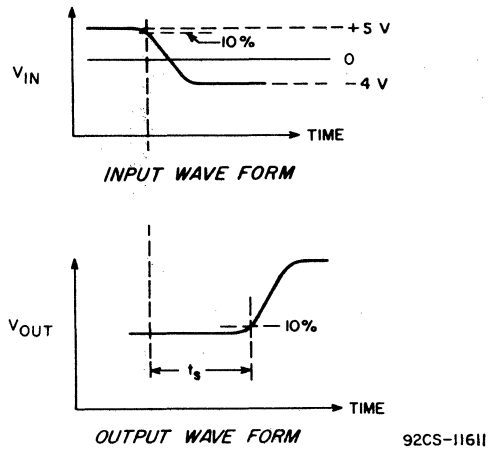
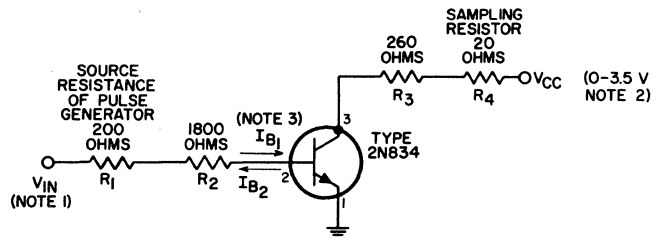


Fig. 2 - Circuit Used to Measure Storage Time (t_s) for Type 2N834.



Note 1: Test circuit provided by the Tektronix Type R plug-in unit (for Tektronix Model 541 Oscilloscope) for the measurement of switching time. The Type R unit provides the input voltage (V_{IN}) and the collector-supply voltage (V_{CC}). Resistors R_1 and R_4 are included in the Type R unit; resistors R_2 and R_3 are wired to the associated wiring board.

Note 2: V_{CC} is adjusted for I_C = 10 ma.

Note 3: I_{B_1} = Turn-On Base Current
I_{B_2} = Turn-Off Base Current

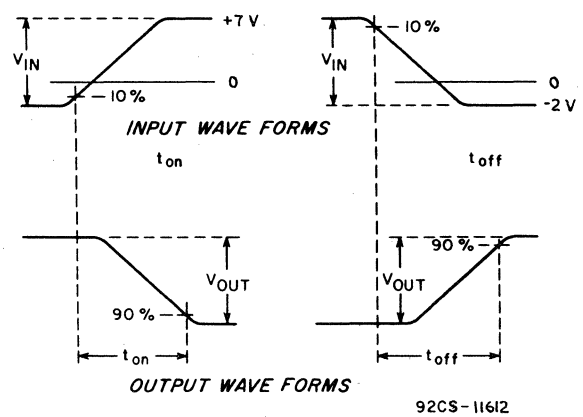
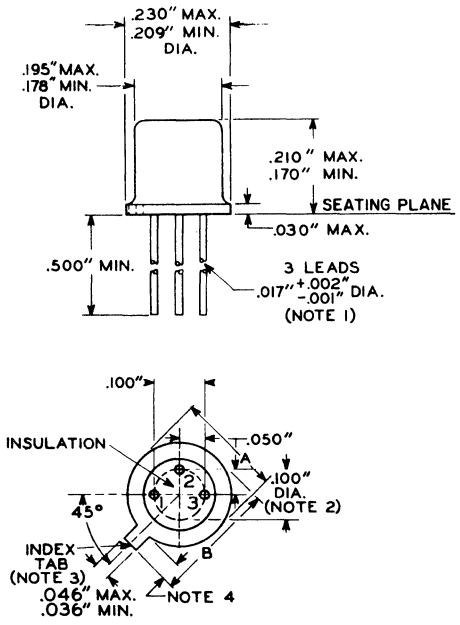


Fig. 3 - Circuit Used to Measure Switching Time for Type 2N834.

DIMENSIONAL OUTLINE

JEDEC No. TO-18



NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD, A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

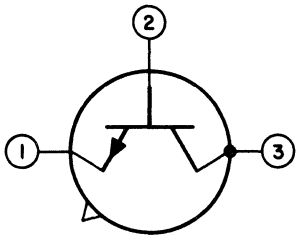
NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM

Bottom View

LEAD 1 – EMITTER

LEAD 2 – BASE



LEAD 3 – COLLECTOR, CASE

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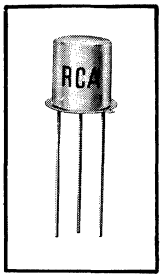
RCA-2N834

SILICON N-P-N
HIGH-SPEED TRANSISTOR

Epitaxial Type
for
Switching Applications

SILICON N-P-N HIGH-SPEED TRANSISTOR

Planar Epitaxial Type For Computer and VHF Amplifier Applications



JEDEC TO-18

RCA-2N914 is a double-diffused planer epitaxial transistor of the silicon n-p-n type. The characteristics of the 2N914 make it expecially suited for use in high-speed saturated logic-switching and VHF amplifier applications.

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO} . . . 40 max. volts

COLLECTOR-TO-EMITTER VOLTAGE, V_{CER}:

With external resistor (R_{BE}) 10 ohms between base and emitter . . . 20 max. volts

With base open . . . . . 15 max. volts

EMITTER-TO-BASE VOLTAGE, V_{EBO} . . . 5 max. volts

COLLECTOR CURRENT, I_C . Limited by power dissipation

TRANSISTOR DISSIPATION:

At case temperatures: up to 25° C. . . . 1.2 max. watts; above 25° C. . . . . See *Fig.1*

At free-air temperatures: up to 25° C. . . . 0.36 max. watt; above 25° C. . . . . See *Fig.1*

TEMPERATURE RANGE:

Storage. . . . . -65 to +200 °C

Operating (Junction) . . . . . 200 max. °C

LEAD TEMPERATURE . . . . . 300 max. °C

Features:

- epitaxial structure — insures low collector saturation voltage
- planar construction — insures low collector cutoff current (I_{CBO}) and wide beta range

ELECTRICAL CHARACTERISTICS *Free-air temperature = 25° C unless otherwise specified*	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (ma)			Min.	Max.	
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C			
Collector-Cutoff Current With emitter open and a free-air temperature of: 25° C	I_{CBO}	20	-	-	0	-	-	-	0.025	μa
150° C		20	-	-	0	-	-	-	15	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	-	0.001	40	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	0.01	-	0	5	-	volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	-	-	-	1	10	0.7	0.8	volt
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-	-	-	20	200	-	0.7	volt
DC Forward-Current Transfer Ratio	h_{FE}	-	1	-	-	-	10	30	120	
		-	5	-	-	-	500	10	-	
Small-Signal Forward-Current Transfer Ratio: At a frequency of 100 Mc.	h_{fe}	-	10	-	-	-	20	3	-	
Collector-to-Base Capacitance With emitter open and a frequency of 140 Kc	C_{ob}	10	-	-	0	-	-	-	6	pf
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO(sus)}$	-	-	-	-	0	30 (pulsed)	15	-	volts
Collector-to-Emitter Sustaining Voltage With external resistor (R_{BE}) ≤ 10 ohms	$V_{CER(sus)}$	-	-	-	-	-	30 (pulsed)	20	-	volts
Collector Current (base forward biased) at 125° C	I_{CEX}		20	0.25					10	μa
Emitter-to-Base Capacitance With collector open and a frequency of 140 Kc	C_{ib}			-0.5	-	-	0	-	9	pf
Saturation Stored-Charge Time Constant: V_{CC} = 5 volts, I_{B_1} = 20 ma, See *Fig.2.*, R_C = 240 ohms, I_{B_2} = 20 ma	τ_s	-	-	-	-	-	20	-	20	nsec
"Turn-On" Time (delay time plus rise time): V_{CC} = 5 volts, I_{B_1} = 40 ma, See *Fig.4.*, R_C = 23 ohms, I_{B_2} = 20 ma	$t_d + t_r$	-	-	-	-	-	200	-	40	nsec
"Turn-Off" Time (storage time plus fall time): V_{CC} = 5 volts, I_{B_1} = 40 ma, See *Fig.4.*, R_C = 23 ohms, I_{B_2} = 20 ma	$t_s + t_f$	-	-	-	-	-	200	-	40	nsec
Thermal Resistance: Junction-to-case	θ_{J-C}	-	-	-	-	-	-	-	145	°C/watt
Junction-to-free air	θ_{J-FA}	-	-	-	-	-	-	-	480	°C/watt

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Printed in U.S.A.
2N914 7-66
Supersedes issue dated 3-62

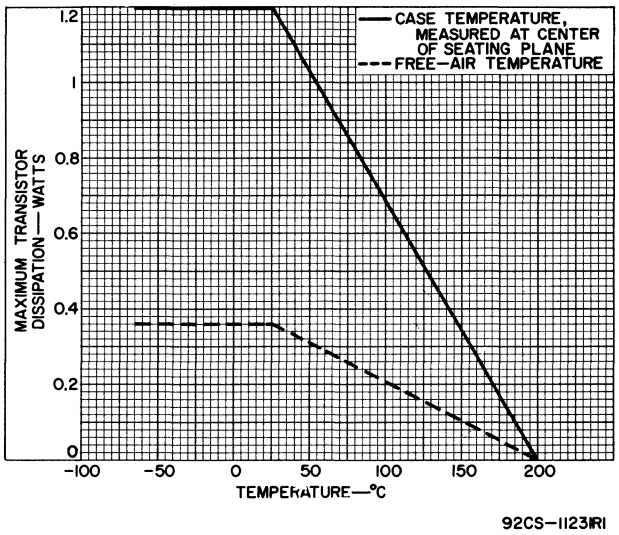
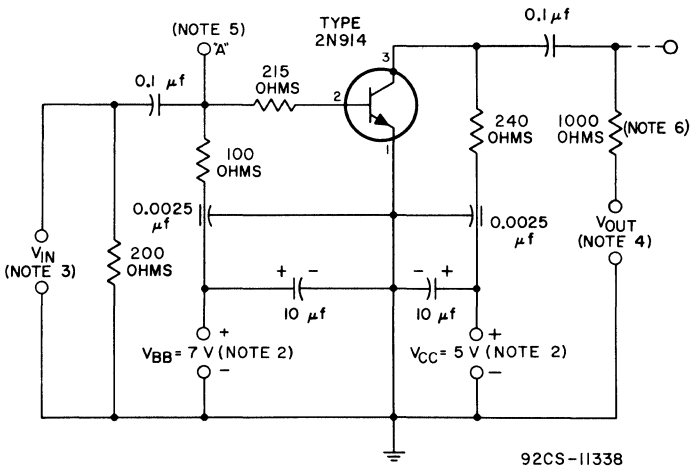


Fig. 1 - Rating Chart for Type 2N914.



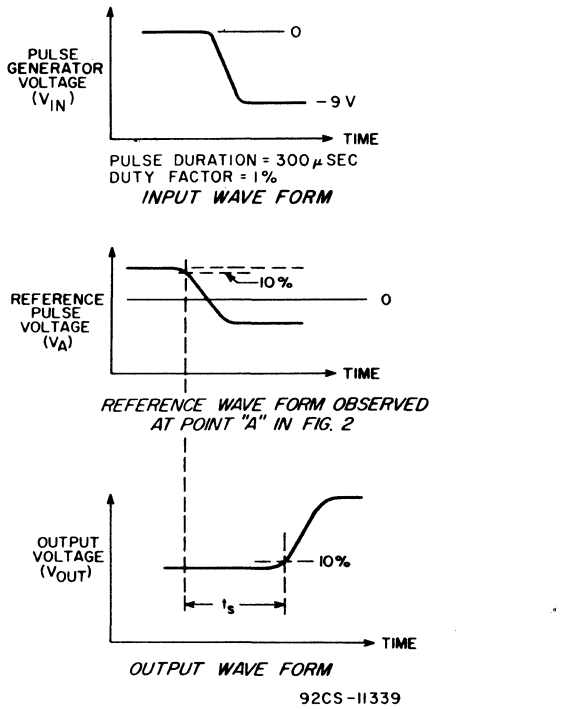


Fig. 3 - Input and Output Wave Forms for the Circuit of Fig. 2.

NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

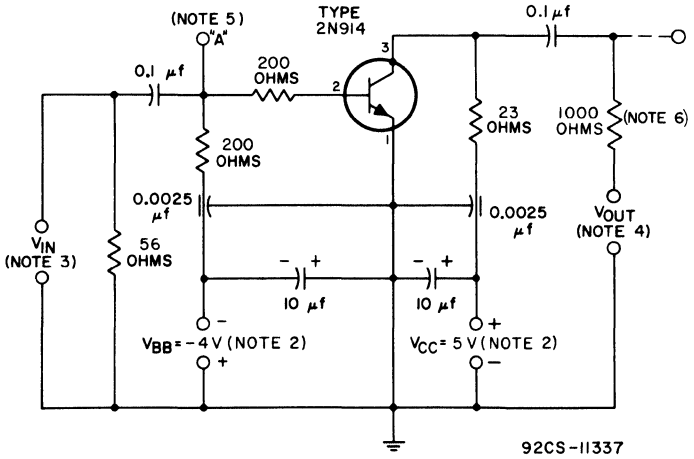
NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOWN IN FIG. 3 SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 6: THIS RESISTOR SHOULD BE OMITTED IF A SAMPLING OSCILLOSCOPE (HAVING A HIGH VALUE OF INPUT IMPEDANCE) IS USED.

Fig. 2 - Circuit Used to Measure Saturation Stored-Charge Time Constant (τ_s) for Type 2N914.

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NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOWN IN FIG. 5 SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 6: THIS RESISTOR SHOULD BE OMITTED IF A SAMPLING OSCILLOSCOPE (HAVING A HIGH VALUE OF INPUT IMPEDANCE) IS USED.

Fig. 4 - Circuit Used to Measure "Turn-On" Time (t_{on}) and "Turn-Off" Time (t_{off}) for Type 2N914.

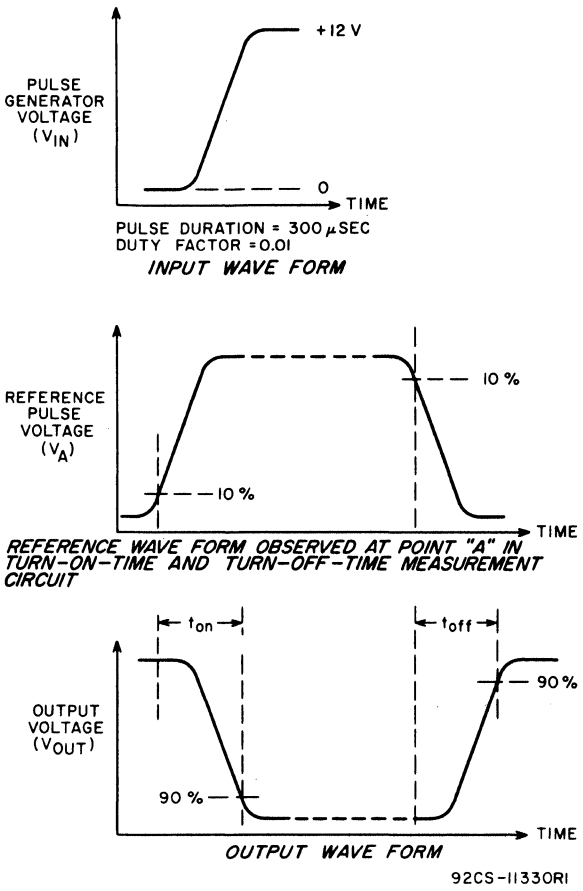
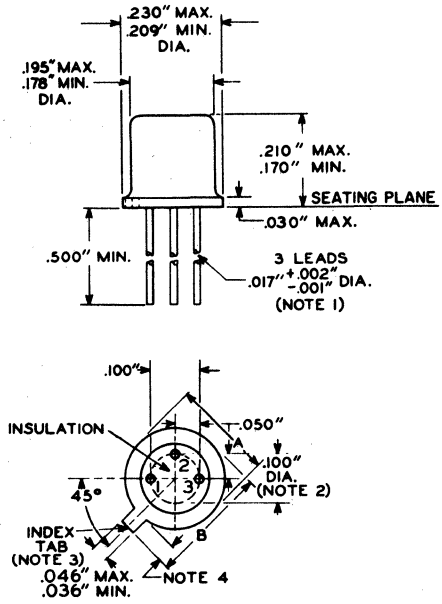


Fig. 5 - Input and Output Wave Forms for the Circuit of Fig. 4.

DIMENSIONAL OUTLINE
JEDEC No. TO-18



92CS-10605R2

NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD, A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

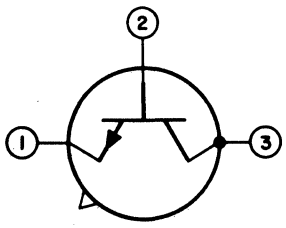
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NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM
Bottom View

LEAD 1 - EMITTER
LEAD 2 - BASE



LEAD 3 - COLLECTOR, CASE

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-72

For VHF Applications In Military, Communications, and Industrial Equipment

RCA-2N917 is an epitaxial planar transistor of the silicon n-p-n type. The 2N917 is extremely useful in low-noise-amplifier, oscillator, and converter applications at VHF frequencies.

This device utilizes a hermetically sealed four-lead JEDEC-TO-72 package. All active elements of the transistor are insulated from the case. The case may be grounded by means of a fourth lead in applications requiring minimum feedback capacitance, shielding of the device, or both.

FEATURES:

- **High Gain-Bandwidth Product**
- **Low Leakage Currents**
- **High Unneutralized Power Gain**

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO}	30 max.	V
Collector-to-Emitter Voltage, V_{CEO}	15 max.	V
Emitter-to-Base Voltage, V_{EBO}	3 max.	V
Collector Current, I_C	Limited by transistor dissipation	
Transistor Dissipation, P_T:		
For operation at case temperatures*: up to 25°C	300 max.	mW
above 25°C	Derate at 1.17	mW/°C
For operation at ambient temperatures: up to 25°C	200 max.	mW
above 25°C	Derate at 1.14	mW/°C
Temperature Range: Storage and Operating (Junction)	-65 to +200	°C
Lead Temperature (During Soldering): At distances greater than 1/16 inch from seating surface for 60 seconds max.	300 max.	°C

* Measured at center of seating surface.

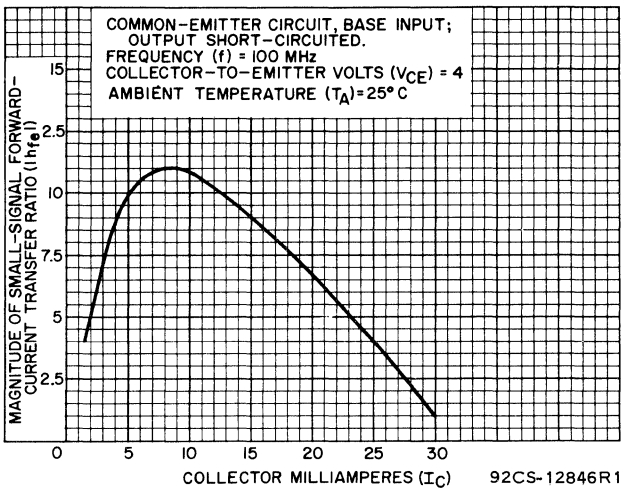


Fig. 1 - Small Signal Beta Characteristics for Type 2N917.

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2N917 9-66
Supersedes issue dated 12-64

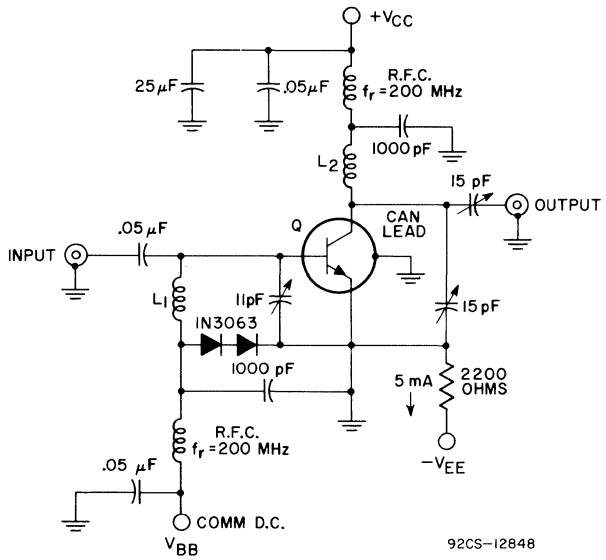
Electrical Characteristics:

Characteristics	Symbols	TEST CONDITIONS								LIMITS			Units
		Ambient Temperature T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N917			
		°C	MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25 150		15 15			0 0			- -	- -	0.001 0.1	μA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.001		30	-	-	V
Collector-to-Emitter Sustaining Voltage	$BV_{CEO}(sus)$	25						3	0	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.01	0		3	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25						3	0.15	-	-	0.5	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25						3	0.15	-	-	0.87	V
Static Forward Current Transfer Ratio	h_{FE}	25			1			3		20	-	200	
Magnitude of Small-Signal Forward Current Transfer Ratio [a]	$\|h_{fe}\|$	25	100		10			4		5	-	-	
Collector-to-Base [b] Output Capacitance	C_{cb}	25	0.1 to 1	10			0			-	-	1.7	pF
Common-Base Input Capacitance [b]	C_{ib}	25	0.1 to 1			0.5		0		-	-	1.6	pF
Collector-to-Base Time Constant [a]	$r_b'C_c$	25	40	10				4		-	30	75	ps
Small-Signal Power Gain in Unneutralized Common-Emitter Amplifier Circuit (See Fig.2) [a]	G_{pe}	25	200		10			5		9	11.5	-	dB
Power Output in Common-Emitter Oscillator Circuit (See Fig.3) [b]	P_o	25	500	15			8			10	-	-	mW
Noise Figure [a,c]	NF	25	60		6			1		-	3.5	6	dB

a - Fourth lead (case) grounded

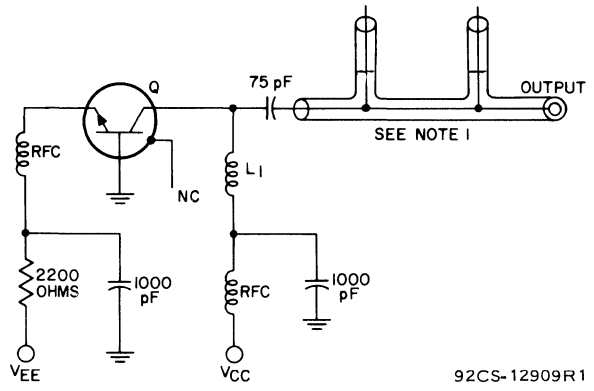
b - Fourth lead (case) floating

c - Generator Resistance (R_g) = 400Ω



Q = Type 2N917
L_1 = 1 Loop #12 wire, 13/16" I.D.
L_2 = 1/2 Loop #12 wire, 1-3/16" I.D.

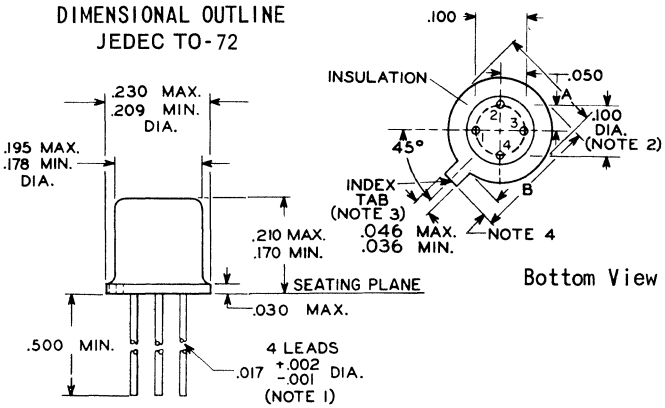
Fig. 2 - Circuit used to Measure 200-MHz Unneutralized Power Gain for RCA Type 2N917.



Note 1 - Coaxial-Line output network consisting of
2 General Radio Type 874 TEE or equivalent
1 General Radio Type 874-D20 adjustable stub or equivalent
1 General Radio Type 874-LA adjustable line or equivalent
1 General Radio Type 874-WN3 short-circuit termination or equivalent
L_1 = 2 turns #16AWG wire, 3/8 inch OD, 1-1/4 inch long

Fig. 3 - Circuit used to Measure 500-MHz Oscillator Output for RCA Type 2N917.

DIMENSIONAL OUTLINE
JEDEC TO-72



92CS-12817

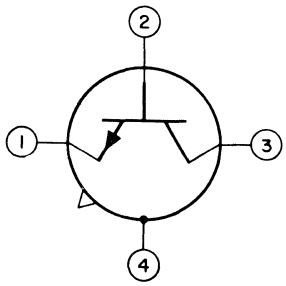
NOTE 1: The Specified Lead Diameter Applies in the Zone Between 0.050" and 0.250" from the Seating Plane. From 0.250" to the End of the Lead a Maximum Diameter of 0.021" is Held. Outside of these Zones, the Lead Diameter is not Controlled.

NOTE 2: Maximum Diameter Leads at a Gauging Plane 0.054" + 0.001" - 0.000" Below Seating Plane to be within 0.007" of their true Location Relative to Max. Width Tab and to the Maximum 0.230" Diameter Measured with a Suitable Gauge. When Gauge is not used, Measurement will be made at Seating Plane.

NOTE 3: For Visual Orientation Only.

NOTE 4: Tab Length to be 0.028" Minimum - 0.048" Maximum, and will be Determined by Subtracting Diameter A from Dimension B.

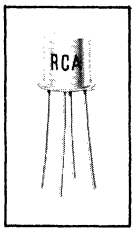
TERMINAL DIAGRAM (Bottom View)



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR
LEAD 4 – CONNECTED TO CASE

SILICON N-P-N EPITAXIAL PLANAR TRANSISTORS

For VHF Applications In Military, Communications, and Industrial Equipment



JEDEC TO-72

RCA-2N918 and RCA-2N3600 are double-diffused epitaxial planar transistors of the silicon n-p-n type. They are extremely useful in low-noise-amplifier, oscillator, and converter applications at VHF frequencies.

These devices utilize a hermetically sealed four-lead JEDEC TO-72 package. All active elements of the transistor are insulated from the case, which may be grounded by means of the fourth lead in applications requiring minimum feedback capacitance, shielding of the device, or both.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N918	2N3600		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30	30	max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15	15	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	3	max.	V
COLLECTOR CURRENT, I_C	50	*	max.	mA
TRANSISTOR DISSIPATION, P_T:				
For operation with heat sink:				
At case temperatures** up to 25°C	300	300	max.	mW
At case temperatures** above 25°C	Derate at 1.71 mW/°C			
For operation at ambient temperatures:				
At ambient temperatures up to 25°C	200	200	max.	mW
At ambient temperatures above 25°C	Derate at 1.14 mW/°C			
TEMPERATURE RANGE:				
Storage and Operating (Junction)	-65 to +200			°C
LEAD TEMPERATURE (During Soldering):				
At distances ≥ 1/16 inch from seating surface for 60 seconds max.	300	300	max.	°C

* Limited by transistor dissipation.

** Measured at center of seating surface.

FEATURES

- high gain-bandwidth product
- hermetically sealed four-lead package
- low leakage current
- high 200-MHz power gain

2N3600

- low noise figure
  NF = 4.5 dB max. at 200 MHz
- low collector-to-base time constant
  $r_b'C_c$ = 15 ps max.
- high power gain as neutralized amplifier
  G_{pe} = 17 dB min. at 200 MHz

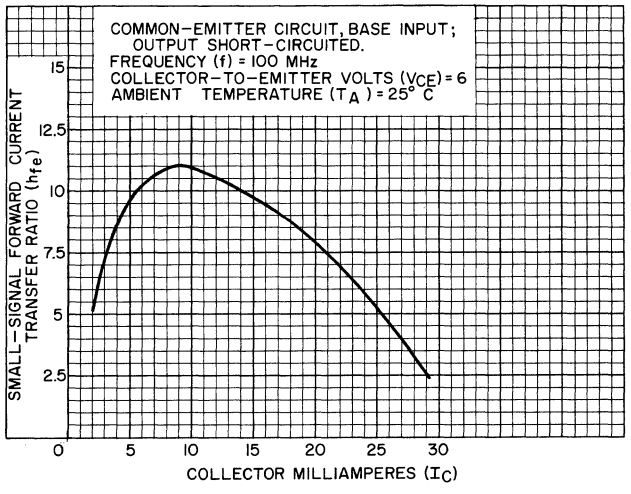


Fig. 1 - Small-signal beta characteristic for types 2N918 and 2N3600.

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ELECTRICAL CHARACTERISTICS

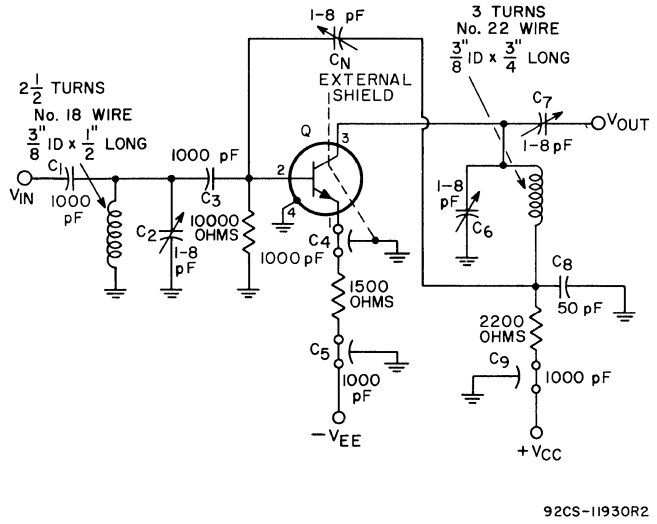
Characteristics	Symbols	TEST CONDITIONS								LIMITS						Units
		Ambient Temperature	Frequency	DC Collector-to-Base Voltage	DC Collector-to-Emitter Voltage	DC Emitter-to-Base Voltage	DC Emitter Current	DC Collector Current	DC Base Current	Type 2N918			Type 2N3600			
		T_A	f	V_{CB}	V_{CE}	V_{EB}	I_E	I_C	I_B							
		°C	MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25 150		15 15			0 0			- -	- -	0.01 1	- -	- -	0.01 1	μA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.001		30	-	-	30	-	-	V
Collector-to-Emitter Sustaining Voltage	$BV_{CEO(sus)}$	25						3	0	15	-	-	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.01	0		3	-	-	3	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25						10	1	-	-	0.4	-	-	0.4	V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25						10	1	-	-	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}	25			1			3		20	-	-	20	-	150	
Small-Signal Forward Current-Transfer Ratio[a]	h_{fe}	25	100 100 1 kHz		10 6 6			4 5 2		6 - -	- - -	- - -	- 8.5 40	- - -	- 15 200	
Common-Base Output Capacitance[b]	C_{ob}	25	0.1 to 1	10 0			0 0			- -	- -	1.7 3	- -	- -	- -	pF pF
Collector-to-Base Feedback Capacitance[b]	C_{cb}	25	0.1 to 1	10			0			-	-	-	-	-	1	pF
Common-Base Input Capacitance[c]	C_{ib}	25	0.1 to 1			0.5		0		-	-	2	-	1.4	-	pF
Collector-to-Base Time Constant[a]	$r_b'C_c$	25	40 31.9	6 6				2 5		- -	15 -	- -	- 4	- -	- 15	ps ps
Small-Signal Power Gain in Neutralized Common-Emitter Amplifier Circuit[a] (See Fig.2 & Fig.3)	G_{pe}	25	200		12 6			6 5		15 -	21 -	- -	- 17	- -	- 24	dB dB
Small-Signal Power Gain in Unneutralized Common-Emitter Amplifier Circuit[a] (See Fig.4)	G_{pe}	25	200		10			5		-	13	-	-	-	-	dB
Power Output in Common-Emitter Oscillator Circuit[c] (See Fig.5)	P_o	25	≥ 500	10			12			30	-	-	20	-	-	mW
Nose Figure[a] (See Fig.2)	NF	25	200		6			1.5		-	-	-	-	-	4.5	dB
Noise Figure[a,d]	NF	25	60		6			1		-	-	6	-	-	3	dB

[a] Lead No.4 (case) grounded.

[b] Three-terminal measurement of the collector-to-base capacitance with the case and emitter leads connected to the guard terminal.

[c] Lead No.4 (case) floating.

[d] Generator Resistance (R_g) = 400 ohms.

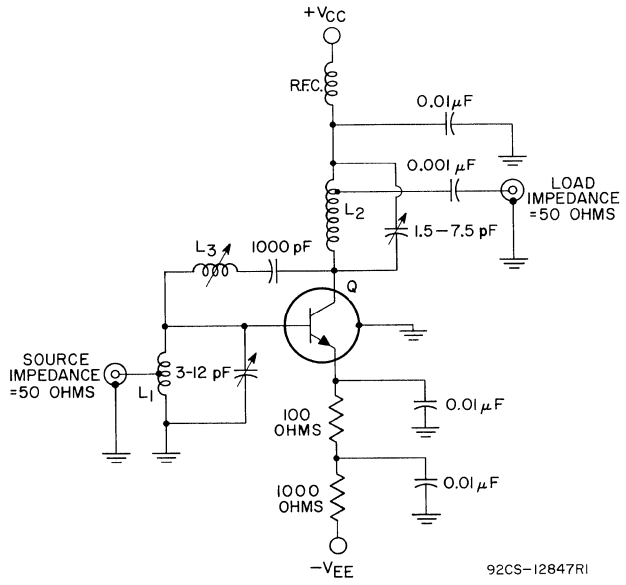


92CS-11930R2

NOTE: (Neutralization Procedure): (a) Connect a 50-Ω rf voltmeter to the output of a 200-MHz signal generator (R_g = 50 Ω), and adjust the generator output to 5 mV. (b) Connect the generator to the input and the rf voltmeter to the output of the amplifier, as shown above. (c) Apply V_{EE} and V_{CC}, and adjust the generator output to provide an amplifier output of 5 mV. (d) Tune C_2, C_6, and C_7 for maximum amplifier output, readjusting the generator output, as required, to maintain an output of 5 mV from the amplifier. (e) Interchange the connections to the signal generator and the rf voltmeter. (f) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the amplifier input. (g) Repeat steps (a), (b), (c), and (d) to determine if retuning is necessary.

Q = Type 2N3600

Fig.2 - Neutralized amplifier circuit used to measure power gain and noise figure at 200 MHz for type 2N3600.



92CS-12847RI

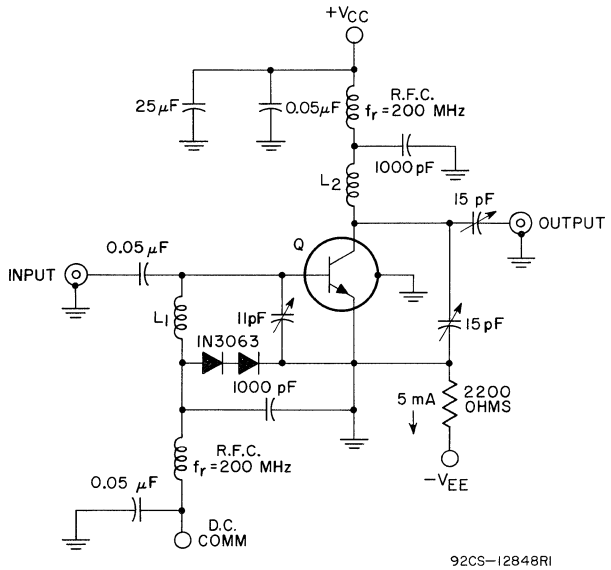
L_1 - 3.5 turns No.16 tinned copper wire; 5/16" dia.; 7/16" long; turns ratio ≃ 4:2

L_2 - 8 turns No.16 tinned copper wire; 1/8" dia.; 7/8" long; turns ratio ≃ 8:1

L_3 - MILLER #4303 (0.4 - 0.65 μH) or equivalent

Q = Type 2N918

Fig.3 - Neutralized amplifier circuit used to measure power gain at 200 MHz for type 2N918.



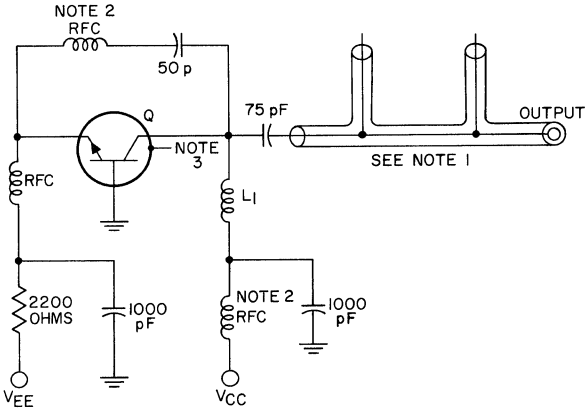
92CS-12848RI

L_1 - 1 loop #12 AWG wire; I_D = 13/16"

L_2 - 1/2 loop #12 AWG wire; I_D = 1-3/16"

Q = 2N918

Fig.4 - Circuit used to measure 200-MHz unneutralized power gain for type 2N918.



92CS-12849R2

Note 1 - Coaxial-Line output network consisting of:
- 2 General Radio Type 874 TEE or equivalent
- 1 General Radio Type 874-D20 Adjustable Stub or equivalent
- 1 General Radio Type 874-LA Adjustable Line or equivalent
- 1 General Radio Type 874-WN3 Short-circuit termination or equivalent

Note 2 - RFC = 0.2 μH Ohmite #2-460 or equivalent

Note 3 - Lead Number 4 (case) floating

L_1 - 2 turns #16AWG wire, 3/8 inch OD, 1-1/4 inch long

Q = 2N918 or 2N3600

Fig.5 - Circuit used to measure 500-MHz oscillator power output for types 2N918 and 2N3600.

TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF COLLECTOR CURRENT (I_C) FOR RCA TYPES 2N918 AND 2N3600

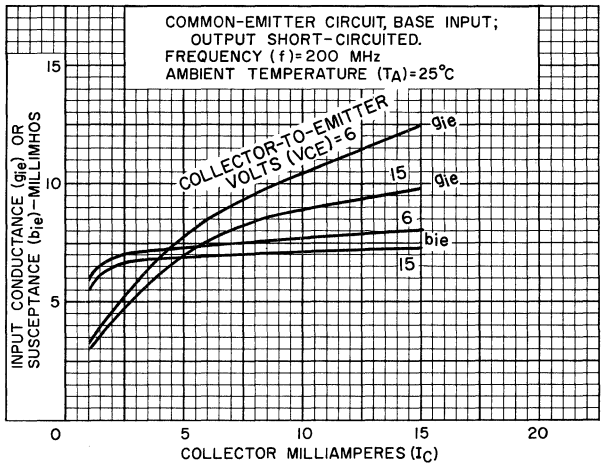


Fig.6 - Input admittance (y_{ie}).

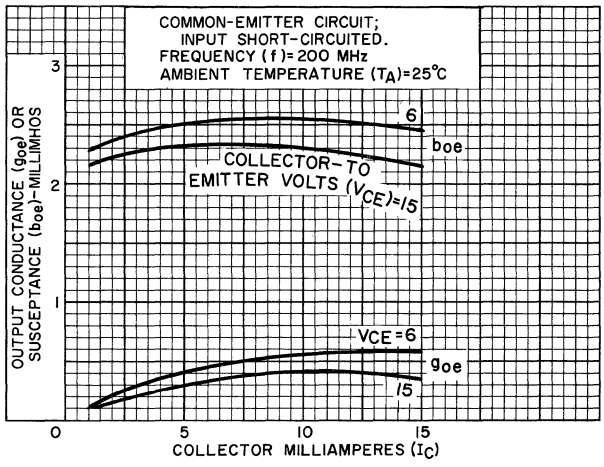


Fig.7 - Output admittance (y_{oe}).

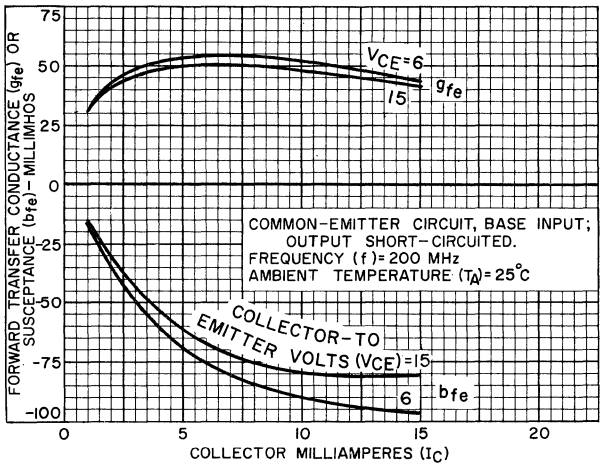


Fig.8 - Forward transadmittance (y_{fe}).

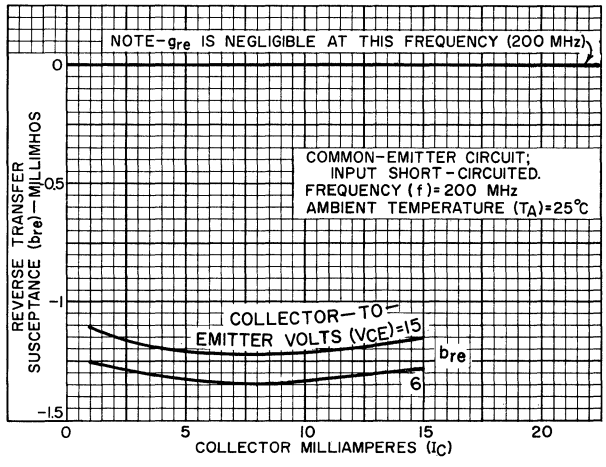
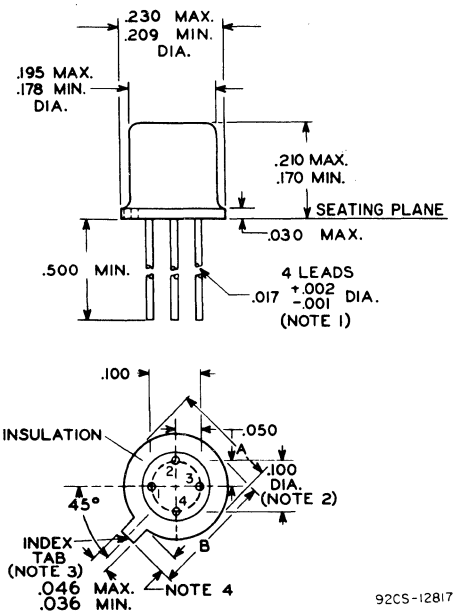


Fig.9 - Reverse transadmittance (y_{re}).

DIMENSIONAL OUTLINE TO-72



Dimensions in Inches

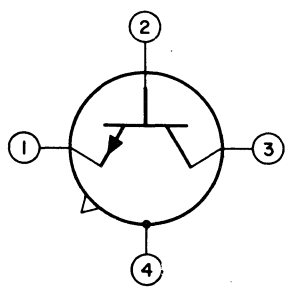
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM (Bottom View)



LEAD 1 - EMITTER

LEAD 2 - BASE

LEAD 3 - COLLECTOR

LEAD 4 - CONNECTED TO CASE

GERMANIUM POWER TRANSISTORS

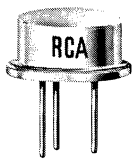
2N1183-2N1184 Families

File No. 4

The transistors in the 2N1183-2N1184 families are germanium p-n-p alloy-junction types for use in intermediate power-switching and low-frequency applications in military and industrial equipment. The transistors are especially useful in devices such as dc-to-dc converters, choppers, solenoid drivers, and relay controls; in oscillator, regulator, multivibrator, and pulse-amplifier circuits, and as class A and class B amplifiers for servo and linear amplifier applications.

These transistors which feature low saturation resistance and low leakage currents, provide the equipment designer with a choice of voltage ratings and beta ranges for flexibility of circuit design.

For Power Switching and Amplifier Applications



2N1183 2N1184
2N1183A 2N1184A
2N1183B 2N1184B

JEDEC TO-8

Maximum Ratings, *Absolute-Maximum Values:*

	2N1183 2N1184	*2N1183A 2N1184A*	*2N1183B 2N1184B*	
COLLECTOR-TO-BASE VOLTAGE. . .	-45	-60	-80 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base connected to emitter.	-35	-50	-60 max.	volts
With base open	-20	-30	-40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (V_{EB}) = -1.2 volts	-45	-60	-80 max.	volts
EMITTER-TO-BASE VOLTAGE. . . .	-20	-20	-20 max.	volts
COLLECTOR CURRENT.	-3.0	-3.0	-3.0 max.	amp
EMITTER CURRENT.	3.5	3.5	3.5 max.	amp
BASE CURRENT	-0.5	-0.5	-0.5 max.	amp
TRANSISTOR DISSIPATION: (See Rating Chart Fig. 1):				
With heat sink and case temperature = 25° C. . . .	7.5	7.5	7.5 max.	watts
In free air at ambient temperature = 25° C. . . .	1.0	1.0	1.0 max.	watt
AMBIENT TEMPERATURE:				
Storage.	-65 to + 100	-65 to + 100	-65 to + 100	°C
Operating.	-65 to + 100	-65 to + 100	-65 to + 100	°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N1183-2N1184 Families 6/66
Reprinted from ICE-206 1/60

CHARACTERISTICS

At mounting-base temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS				RANGE VALUES												Units
		DC Collector Voltage (volts)		DC Collector Current (ma)	DC Emitter Current (ma)	Type 2N1183		Type 2N1183A		Type 2N1183B		Type 2N1184		Type 2N1184A		Type 2N1184B		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	-1.5			0		-30		-30		-30		-30		-30		-30	μa
		-45			0		-250						-250					μa
		-60			0				-250						-250			μa
		-80			0						-250						-250	μa
Emitter Cutoff Current For V_{EB} = -20 volts and collector open	I_{EBO}			0			-100		-100		-100		-100		-100		-100	μa
Emitter-to-Base Voltage	V_{EB}		-2	-400			1.5		1.5		1.5		1.5		1.5		1.5	volts
Collector-to-Emitter Voltage																		
With V_{EB} = -1.2 volts	V_{CEX}			-250		-45		-60		-80		-45		-60		-80		volts
With base connected to emitter	V_{CES}			-50		-35		-50		-60		-35		-50		-60		volts
With base open	V_{CEO}			-50		-20		-30		-40		-20		-30		-40		volts
Collector Saturation Resistance With I_B = -40 ma	R_S			-400			1.25		1.25		1.25		1.25		1.25		1.25	ohms
Alpha-Cutoff Frequency	$f_{\alpha b}$	-6			1	500		500		500		500		500		500		Kc
DC Current Transfer Ratio	h_{FE}		-2	-400		20	60	20	60	20	60	40	120	40	120	40	120	
Thermal Resistance																		
Junction-to-mounting base	R_T						10		10		10		10		10		10	°C/watt
Junction-to-free air							75		75		75		75		75		75	°C/watt

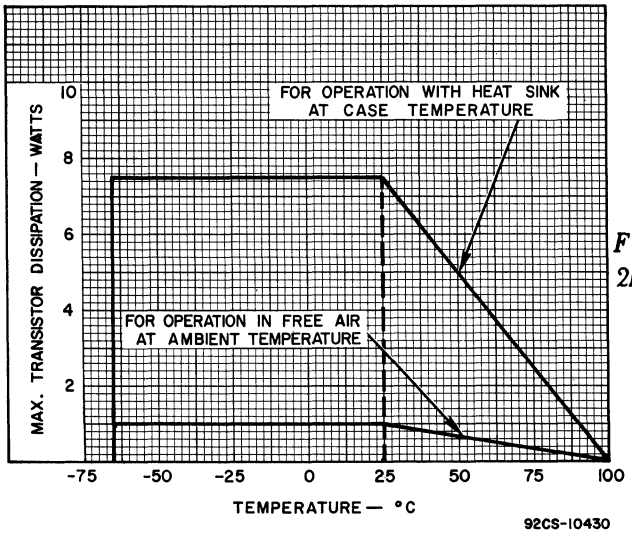


Fig. 1 - Rating Chart for Types 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A and 2N1184B

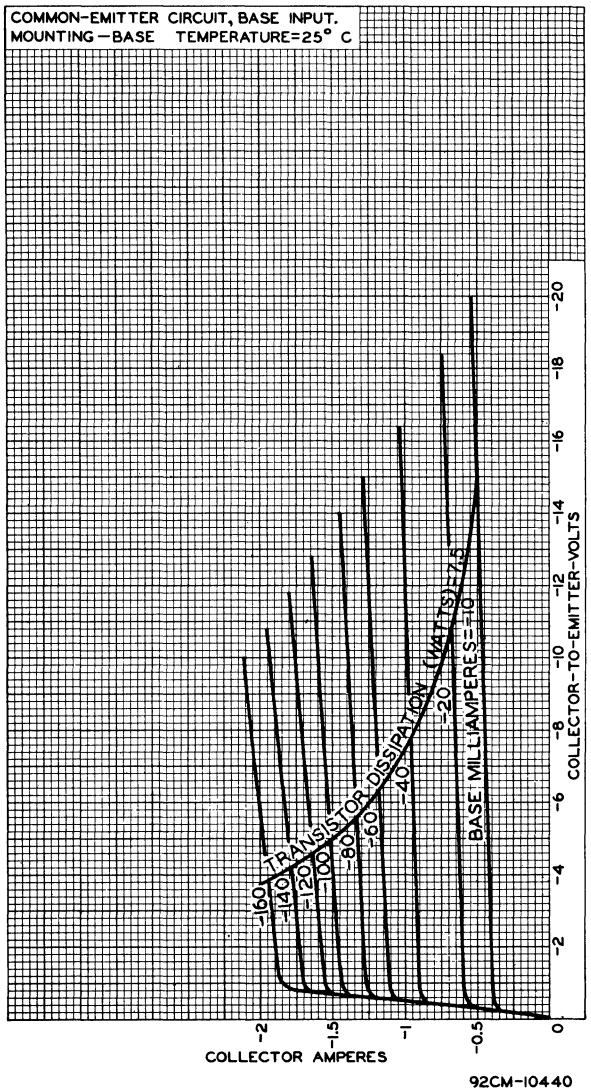


Fig. 3 - Typical Collector Characteristics for Types 2N1183, 2N1183A and 2N1183B.

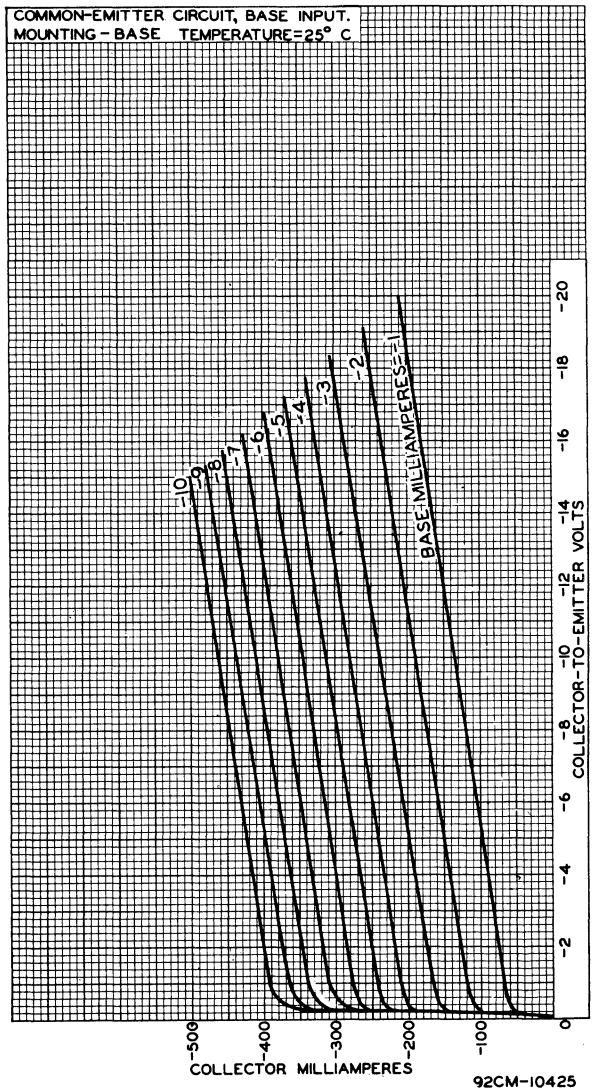


Fig. 4 - Typical Collector Characteristics for Types 2N1183, 2N1183A and 2N1183B.

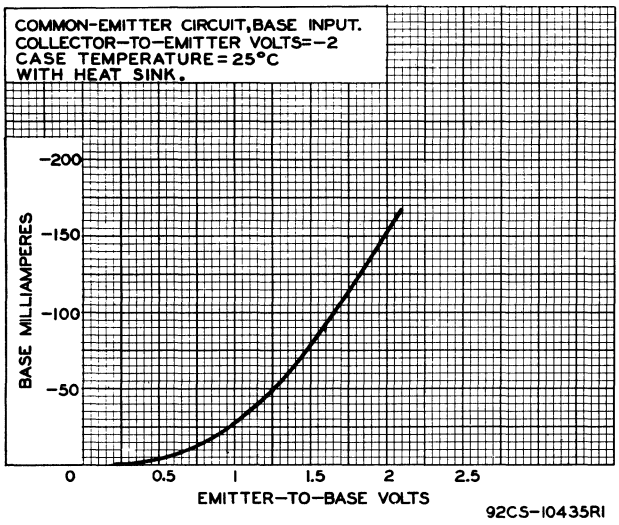


Fig. 5 - Typical Operation Characteristics for Types 2N1183, 2N1183A and 2N1183B.

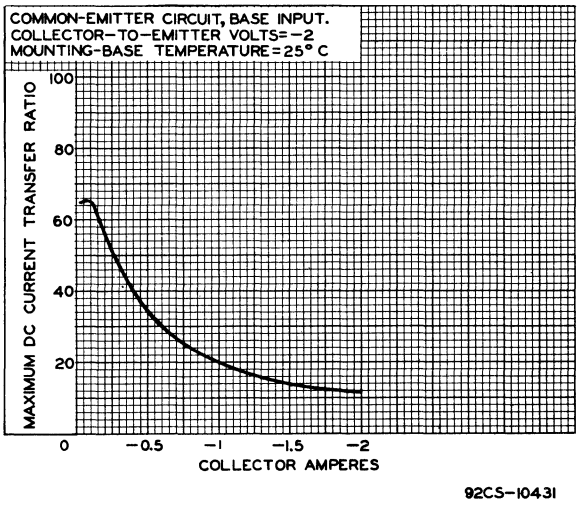


Fig. 6 - Typical Operation Characteristics for Types 2N1183, 2N1183A and 2N1183B.

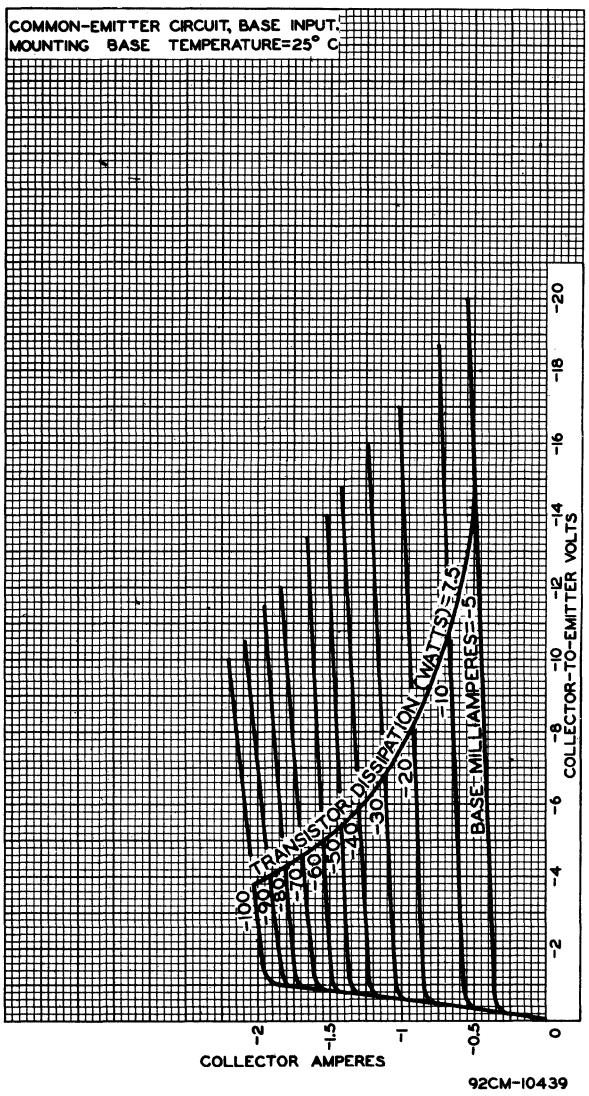


Fig. 7 - Typical Collector Characteristics for Types 2N1184, 2N1184A and 2N1184B.

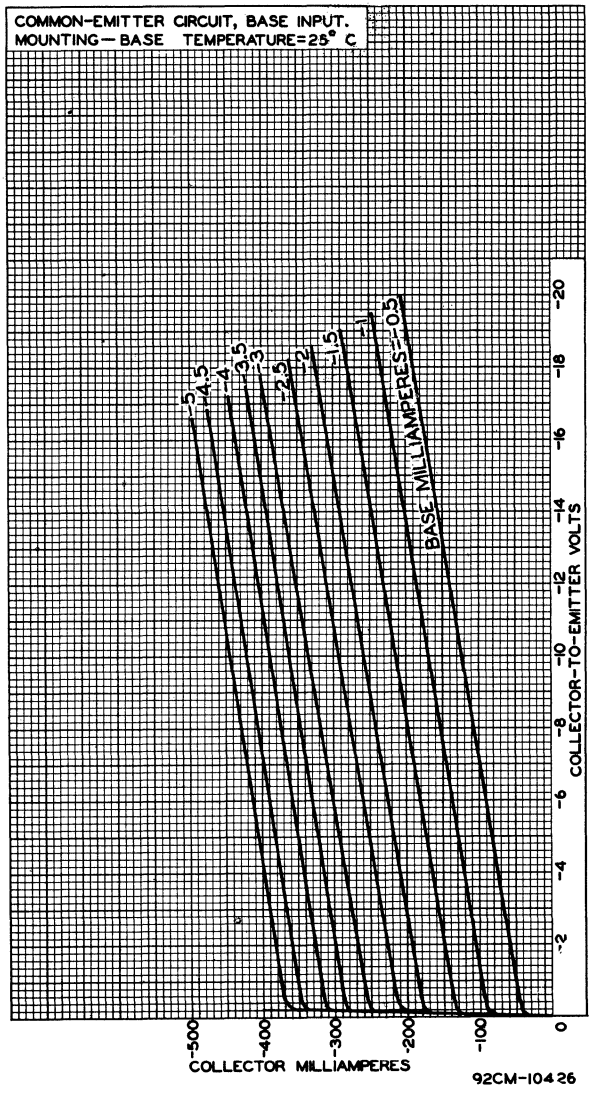


Fig. 8 - Typical Collector Characteristics for Types 2N1184, 2N1184A and 2N1184B.

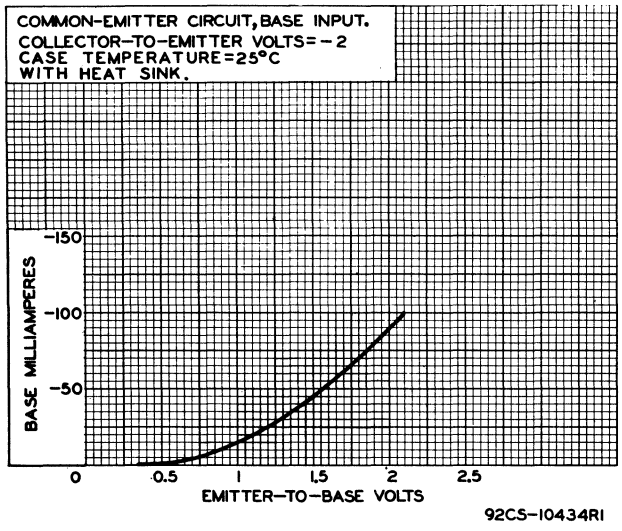


Fig. 9 - Typical Operation Characteristics for Types 2N1184, 2N1184A and 2N1184B.

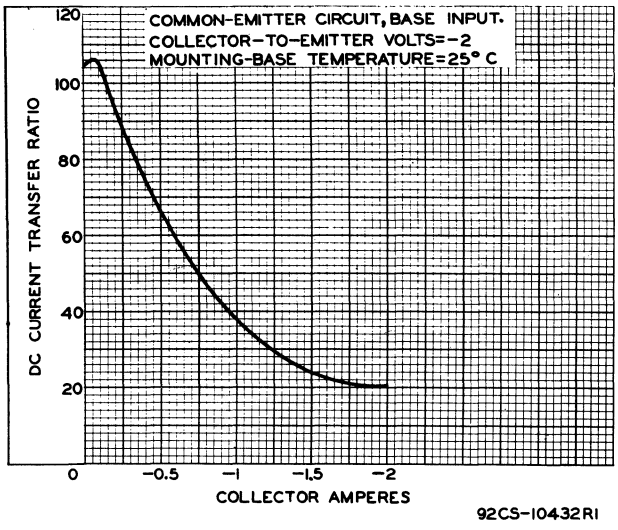


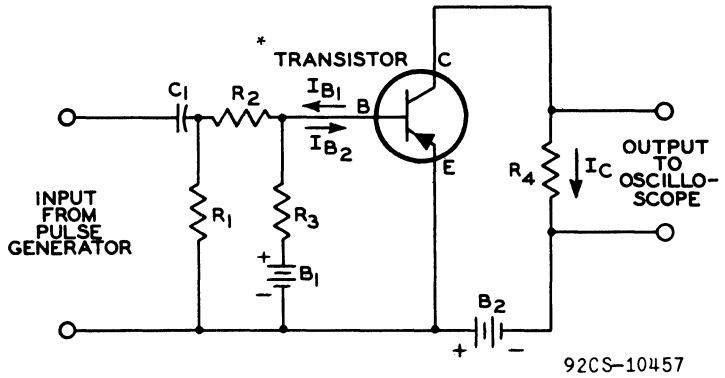
Fig. 10 - Typical Operation Characteristics for Types 2N1184, 2N1184A, and 2N1184B.

Typical Operation of the 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A and 2N1184B in the Power-Switching Circuit of Fig.2:

At a Mounting-Base Temperature of 25° C

Generator Resistance	50	ohms
"On" DC Collector Current	-400	ma
"Turn-On" Base Current (I_{B1})	-40	ma
"Turn-Off" Base Current (I_{B2})	40	ma
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r)	2.0	μsec
Storage Time (t_s)	1.8	μsec
Fall Time (t_f)	1.4	μsec

B_1, B_2 = 12 volts
C_1 = 10 μf, electrolytic 25 volts
R_1 = 51 ohms, 2 watts
R_2 = 120 ohms, 2 watts
R_3 = 230 ohms, 1 watt
R_4 = 29.5 ohms. 5 watts



* Type 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A, or 2N1184B

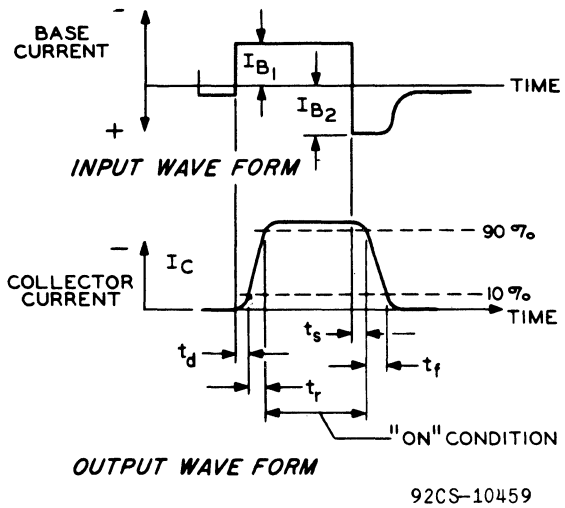


Fig. 2 - Typical Power-Switching Circuit Utilizing Types 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A and 2N1184B

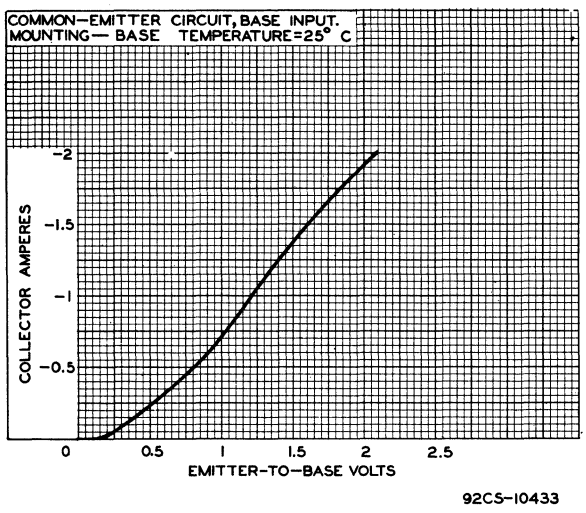
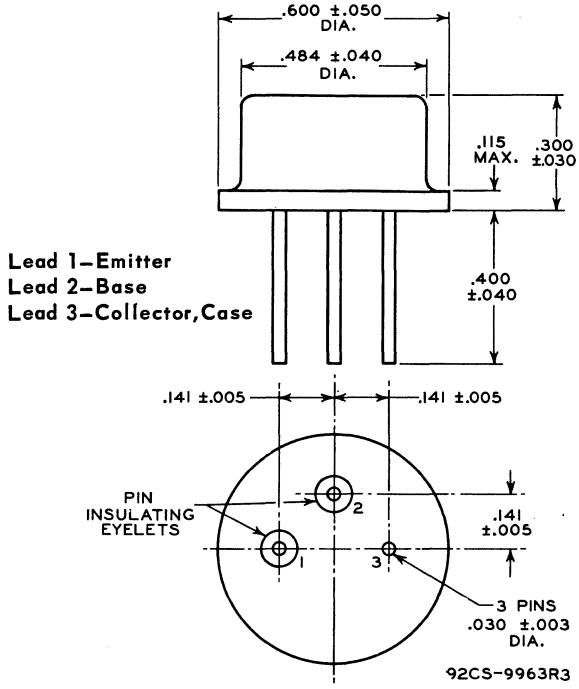


Fig. 11 - Typical Transfer Characteristic for Types 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A and 2N1184B.

DIMENSIONAL OUTLINE For 2N1183–2N1184 Families



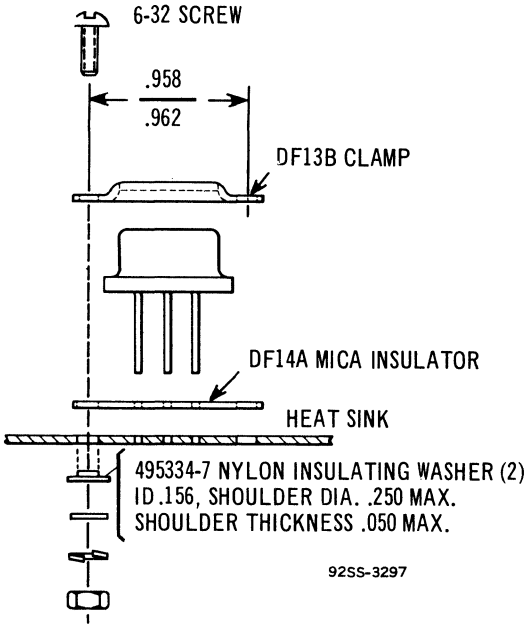


Fig. 12 - Suggested Mounting Arrangement for Types 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A and 2N1184B.

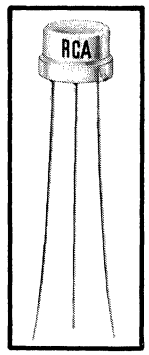
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RCA COMPUTER TRANSISTORS

2N1300
2N1301
2N1683

GERMANIUM P-N-P TRANSISTORS

For Switching Service In Electronic Data-Processing Systems



JEDEC TO-5

RCA-2N1300, 2N1301 and 2N1683 are germanium p-n-p diffused-junction Mesa transistors specifically designed for high-speed switching applications in commercial and military data-processing equipment.

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

	2N1300	2N1301 2N1683	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-13 max.	-13 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-12 max.	-12 max.	V
EMITTER-TO-BASE VOLTAGE▲, V_{EBO}	-1 max.	-4 max.	V
COLLECTOR CURRENT, I_C	-100 max.	-100 max.	mA
EMITTER CURRENT, I_E	100 max.	100 max.	mA
TRANSISTOR DISSIPATION●, P_T:			
At ambient temperature of 25° C	150 max.	150 max.	mW
At ambient temperature of 55° C	75 max.	75 max.	mW
At ambient temperature of 71° C	35 max.	35 max.	mW
AMBIENT TEMPERATURE:			
Operating	-65 to +85	-65 to +85	°C
Storage	-65 to +85	-65 to +85	°C
LEAD TEMPERATURE: At distances not closer than 1/32 inch to seating surface for 10 seconds max.	225 max.	225 max.	°C

▲This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter dissipation is limited to 30 milliwatts at 25°C. For ambient temperatures above 25°C, reduce the dissipation by 0.5 milliwatt/°C.

●For higher dissipation values in switching applications under transient operating conditions, the maximum dissipation can be computed by utilization of the method described in RCA Application Note "Transistor Dissipation Ratings for Pulse and Switching Service" (AN-181).

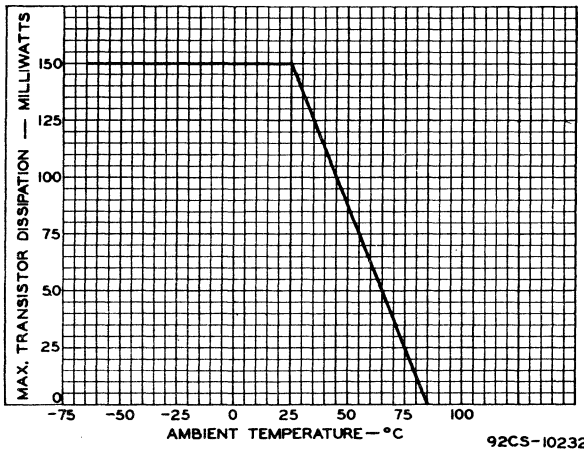


Fig. 1 - Rating Chart.

FEATURES:

- **high minimum beta:**
  2N1300, 30 min @ I_C = -10 mA
  2N1301, 40 min } @ I_C = -40 mA
  2N1683, 50 min }
- **low stored base charge in saturating circuits.**
- **operation at pulse-repetition rates up to 10 MHz.**
- **hermetically sealed JEDEC TO-5 package.**

Typical Operation:

In an inverter circuit at an ambient temperature of 25° C.

	2N1300	2N1301	2N1683	
Collector-To-Emitter Voltage	-5	-5	-5	V
Base Resistor	5000	2400	3000	ohms
Collector Resistor	500	120	120	ohms
"Turn-On" Base Voltage	-5	-5	-5	V
"Turn-Off" Base Voltage	5	5	5	V
"ON" Collector Current	-10	-40	-40	mA
"TURN-ON" Base Current	0.66	2	1.6	mA
"TURN-OFF" Base Current	-0.66	-2	-1.6	mA
Switching Time:				
Delay Time (t_d)	0.14	0.08	0.07	μs
Rise Time (t_r)	0.16	0.07	0.06	μs
Storage Time (t_s)	0.14	0.12	0.08	μs
Fall Time (t_f)	0.11	0.07	0.05	μs

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N1300, 2N1301, 2N1683 8-66
Supersedes ICE-218A dated 10-61

ELECTRICAL CHARACTERISTICS AT T_A = 25° C

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS									UNITS
		Collector-To-Base Voltage V_{CB}	Collector-To-Emitter Voltage V_{CE}	Collector Current I_C	Emitter Current I_E	Base Current I_B	2N1300			2N1301			2N1683			
		V	V	mA	mA	mA	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			-0.02	0		-13	–	–	-13	–	–	-13	–	–	V
Collector-to-Emitter Breakdown Voltage	BV_{CERL}*						-12	–	–	-12	–	–	-12	–	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	0.1		-1	–	–	-4	–	–	-4	–	–	V
Collector Cutoff-Current	I_{CBO}	-6			0		–	-1	-3	–	-1	-3	–	-1	-3	μA
Base-to-Emitter Voltage	V_{BE}			-40 -10		-1 -0.33	– –	– -0.3	– -0.4	– –	-0.4 –	-0.6 –	– –	-0.4 –	-0.6 –	V V
Static Forward Current-Transfer Ratio	h_{FE}		-0.3 -0.5	-10 -40			30 –	50 –	– –	30 40	50 75	– –	50 50	75 85	– –	
Gain-Bandwidth Product	f_T		-3	-10			25	40	–	35	60	–	50	80	–	MHz
Collector-to-Case Capacitance	C_c	-6			0		–	8	12	–	8	12	–	8	12	pF
Stored Base Charge	Q_s		-10 -40 -10 -40			-1 -2 -0.4 -1.6	– – – –	250 – – –	400 – – –	– – – –	225 600 – –	325 800 – –	– – – –	– – 110 200	– – 160 410	pC pC pC pC
Thermal Resistance Junction-to-Ambient	θ_{J-A}						–	–	400	–	–	400	–	–	400	°C/w

*See RCA Application Note SMA-5, "Collector-to-Emitter Breakdown (BV_{CERL}) Voltage Test Under Operating Conditions".

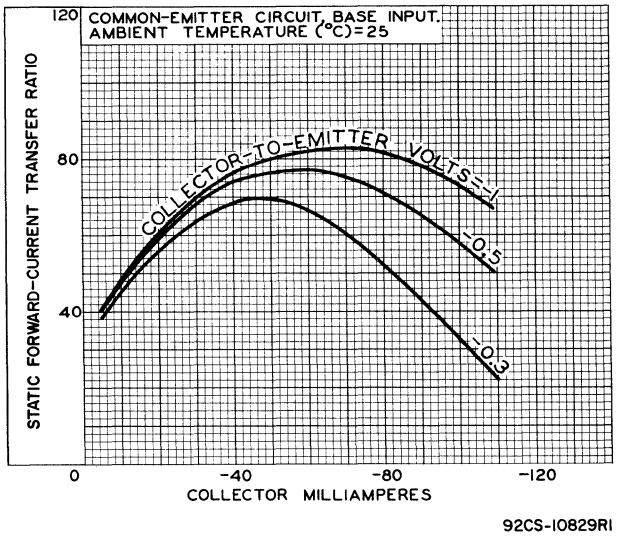


Fig. 2 - Typical Static Forward Current-Transfer-Ratio Characteristics for Types 2N1300, and 2N1301.

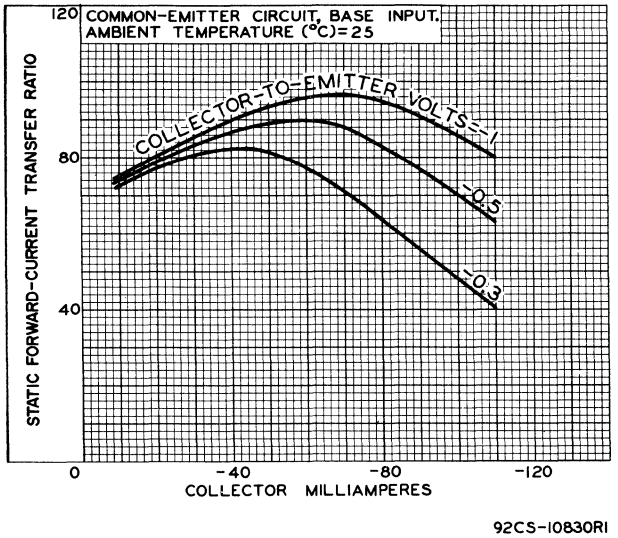


Fig. 3 - Typical Static Forward Current-Transfer-Ratio Characteristics for Type 2N1683.

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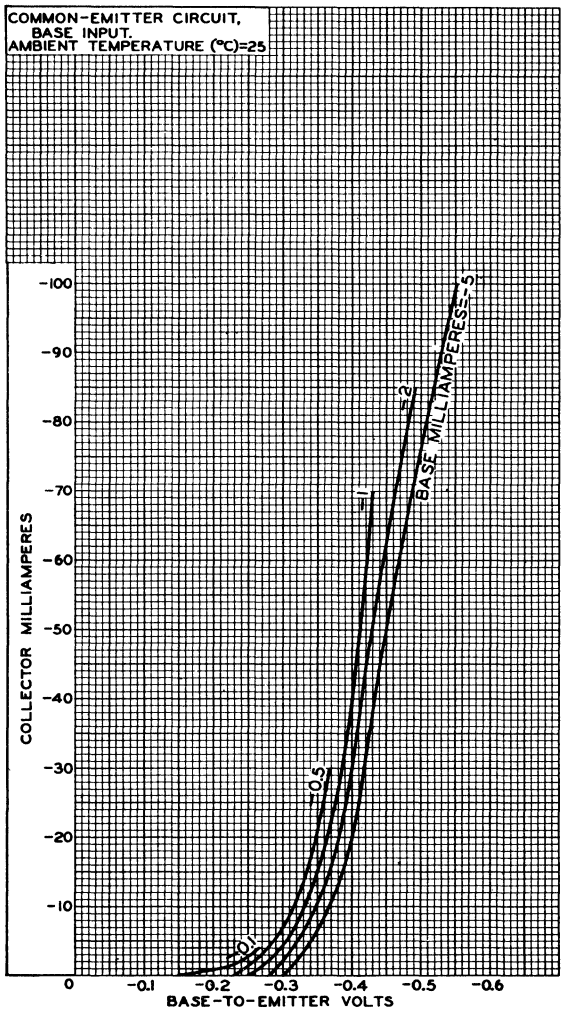


Fig. 4 - Typical Transfer Characteristics for Types 2N1300, 2N1301, and 2N1683.

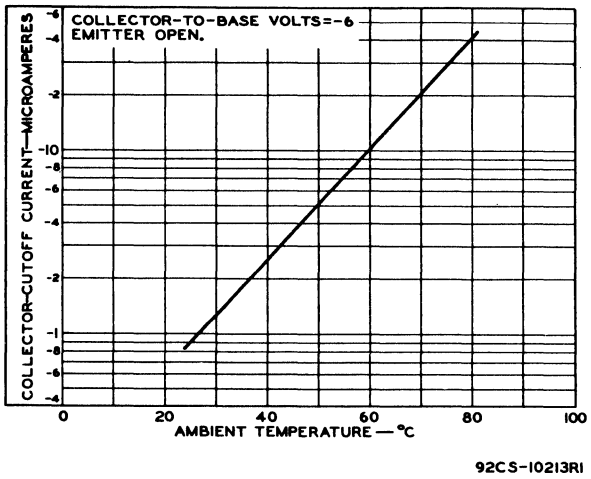


Fig. 5 - Typical Collector-Cutoff-Current Characteristic for Types 2N1300, 2N1301, and 2N1683.

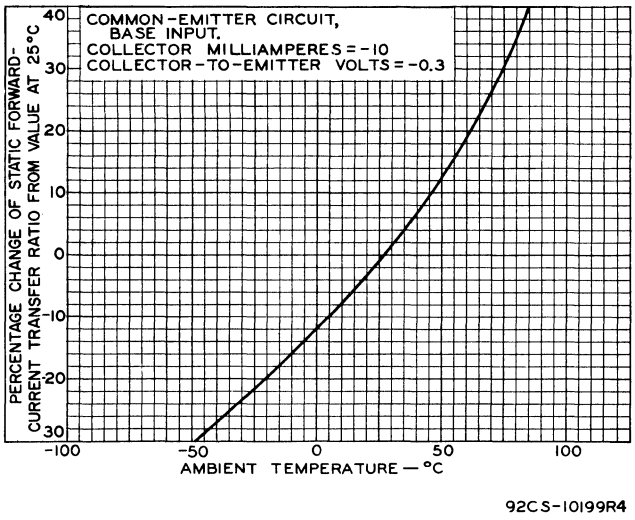


Fig. 6 - Typical Characteristic for Types 2N1300, 2N1301, and 2N1683.

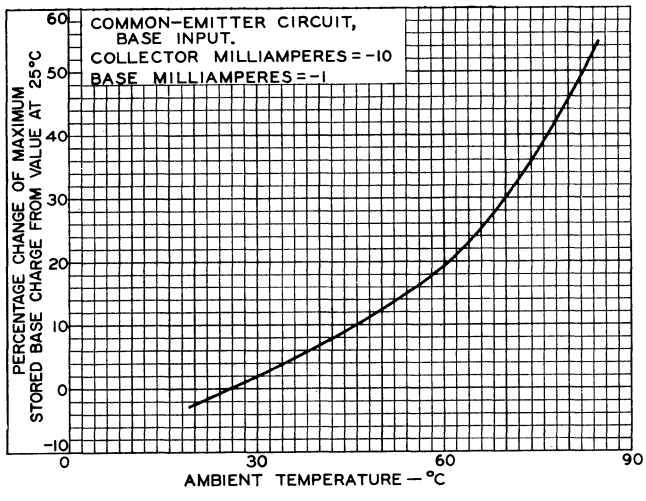


Fig. 7 - Operation Characteristic for Types 2N1300, 2N1301, and 2N1683.

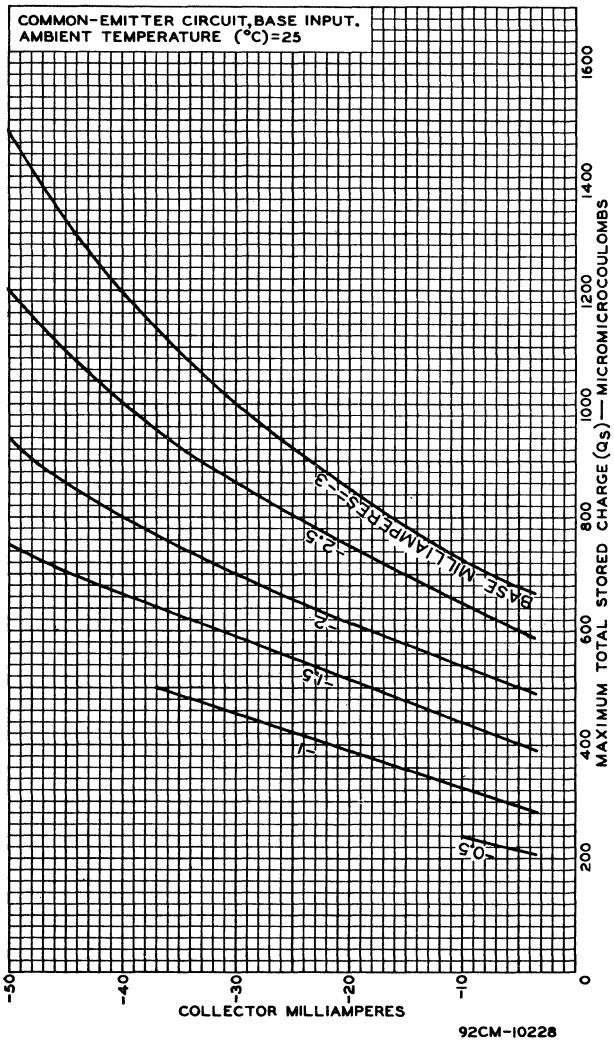


Fig. 8 - Maximum-Total-Stored-Charge Characteristics for Type 2N1301.

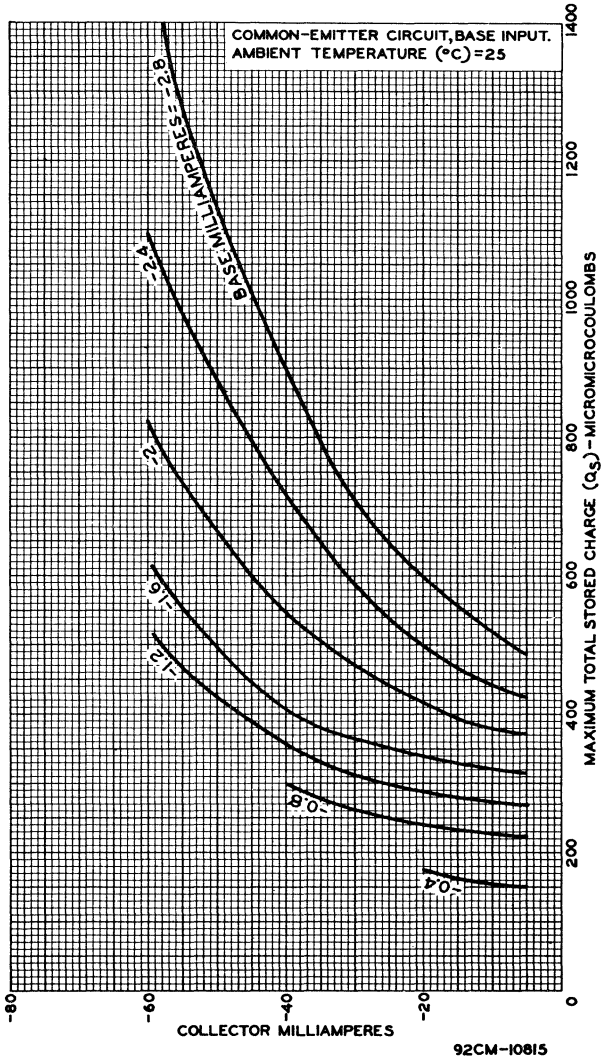
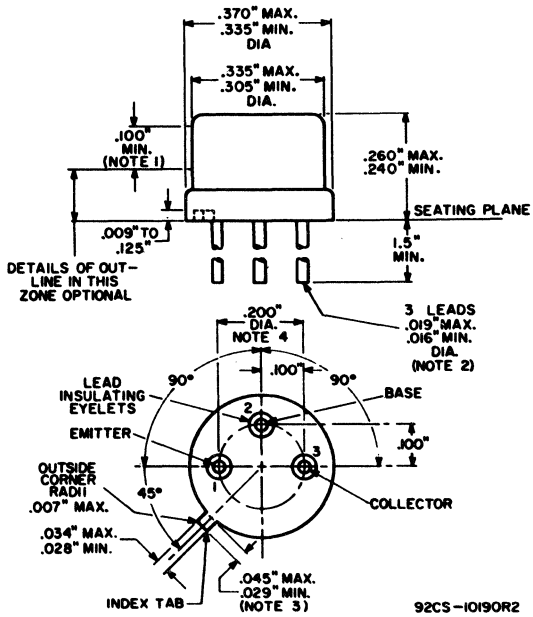
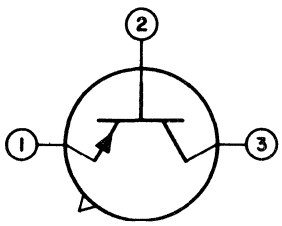


Fig. 9 - Maximum-Total-Stored Charge Characteristics for Type 2N1683.

DIMENSIONAL OUTLINE
for Types 2N1300, 2N1301, 2N1683



TERMINAL DIAGRAM
(Bottom View)



LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5" A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

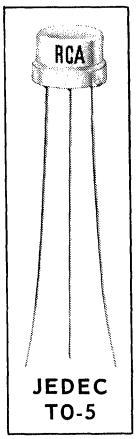
NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

RCA COMPUTER TRANSISTORS

2N1302 2N1304
2N1306 2N1308

GERMANIUM N-P-N MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



RCA-2N1302, 2N1304, 2N1306, and 2N1308 are germanium n-p-n alloy-junction transistors specifically designed for medium-speed switching applications in data-processing equipment. These four transistor types are the n-p-n complements of the p-n-p types 2N1303, 2N1305, 2N1307, and 2N1309, respectively.

- high collector-current rating — 300 ma
- four types — provide a wide range of characteristics values
- complementary p-n-p types available
- tested in strict accordance with military specification MIL-S-19500B
- rugged four-poster, double-weld construction for reliable performance

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}.	25 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}. .	25 max.	volts
COLLECTOR CURRENT, I_C.	300 max.	ma
TRANSISTOR DISSIPATION:		
At free-air temperatures up to 25° C . .	150 max.	mw
At free-air temperatures above 25° C	See *Fig.1*	
TEMPERATURE RANGE:		
Storage.	-65 to +100	°C
Operating (Junction)	-65 to +85	°C
LEAD TEMPERATURE:		
1/16" ± 1/32" from seating surface for 10 seconds max.. .	230 max.	°C

ELECTRICAL CHARACTERISTICS, *Free-Air Temperature = 25° C*

Characteristics	Symbol	TEST CONDITIONS						LIMITS								Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N1302		Type 2N1304		Type 2N1306		Type 2N1308		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	25			0			-	6	-	6	-	6	-	6	μa
Emitter-Cutoff Current	I_{EBO}			25			0	-	6	-	6	-	6	-	6	μa
Base-to-Emitter Voltage	V_{BE}					0.5	10	0.15	0.4	0.15	0.35	0.15	0.35	0.15	0.35	volt
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					0.5	10	-	0.2							volt
						0.25	10			-	0.2					volt
						0.17	10					-	0.2			volt
						0.13	10							-	0.2	volt
DC Collector-to-Emitter Reach-Through Voltage*	V_{RT}							25	-	20	-	15	-	15	-	volts
DC Forward-Current Transfer Ratio	h_{FE}		1				10	20	-	40	200	60	300	80	-	
			0.35				200	10	-	15	-	20	-	20	-	
Alpha-Cutoff Frequency	$f_{\alpha b}$	5			-1			3	-	5	-	10	-	15	-	Mc
Collector-to-Base Capacitance	C_{ob}	5			0			-	20	-	20	-	20	-	20	pf

* The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of +1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.

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2N1302, 2N1304, 2N1306, 2N1308 6-66
Reprinted from Issue dated 1-62

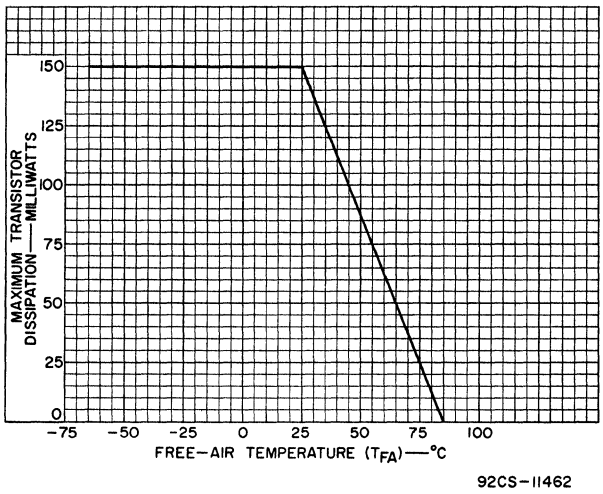
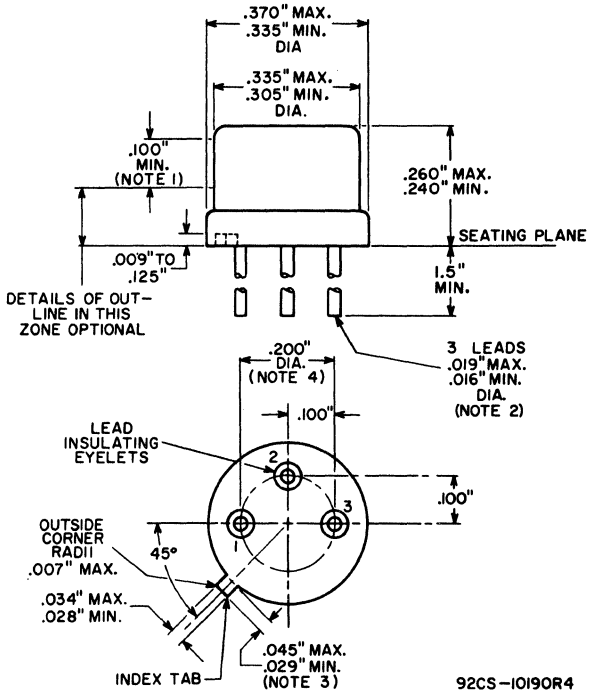
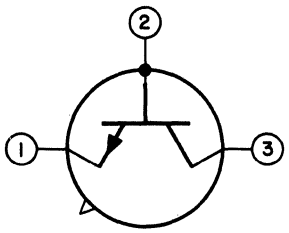


Fig. 1 - Rating Chart for Types 2N1302, 2N1304, 2N1306, and 2N1308.

DIMENSIONAL OUTLINE
(JEDEC No. TO-5)



TERMINAL DIAGRAM
(Bottom View)



Lead 1 - Emitter
Lead 2 - Base, Case
Lead 3 - Collector

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

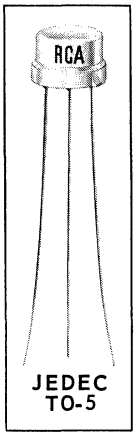
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RCA COMPUTER TRANSISTORS

RCA-2N1303, 2N1305, 2N1307, and 2N1309 are germanium p-n-p alloy-junction transistors specifically designed for medium-speed switching applications in data-processing equipment. These four transistor types are p-n-p complements of the n-p-n types 2N1302, 2N1304, 2N1306, and 2N1308, respectiviely.

GERMANIUM P-N-P MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-30 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-25 max.	volts
COLLECTOR CURRENT, I_C	-300 max.	ma
TRANSISTOR DISSIPATION:		
At free-air temperatures: up to 25° C.	150 max.	mw
above 25° C.	See *Fig.1*	
TEMPERATURE RANGE:		
Storage	-65 to +100	°C
Operating (Junction)	-65 to +85	°C
LEAD TEMPERATURE:		
1/16" ± 1/32" from seating surface for 10 seconds max.	230 max.	°C

FEATURES

- high collector-current rating — 300 ma
- four types — provide a wide range of characteristics values
- complementary n-p-n types available
- tested in strict accordance with military specification MIL-S-19500B
- rugged four-poster, double-weld construction for reliable performance

ELECTRICAL CHARACTERISTICS, *Free-Air Temperature = 25° C*

Characteristics	Symbol	TEST CONDITIONS						LIMITS								Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N1303		Type 2N1305		Type 2N1307		Type 2N1309		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	-25			0			-	-6	-	-6	-	-6	-	-6	μa
Emitter-Cutoff Current	I_{EBO}			-25			0	-	-6	-	-6	-	-6	-	-6	μa
Base-to-Emitter Voltage	V_{BE}					-0.5	-10	-0.15	-0.4	-0.15	-0.35	-0.15	-0.35	-0.15	-0.35	volt
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					-0.5	-10	-	-0.2							volt
						-0.25	-10			-	-0.2					volt
						-0.17	-10					-	-0.2			volt
						-0.13	-10							-	-0.2	volt
DC Collector-to-Emitter Reach-Through Voltage*	V_{RT}							-25	-	-20	-	-15	-	-15	-	volts
DC Forward-Current Transfer Ratio	h_{FE}		-1				-10	20	-	40	200	60	300	80	-	
			-0.35				-200	10	-	15	-	20	-	20	-	
Alpha-Cutoff Frequency	$f_{\alpha b}$	-5			1			3	-	5	-	10	-	15	-	Mc
Collector-to-Base Capacitance	C_{ob}	-5			0			-	20	-	20	-	20	-	20	pf

* The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.

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2N1303, 2N1305, 2N1307, 2N1309 6-66
Reprinted from Issue dated 1-62

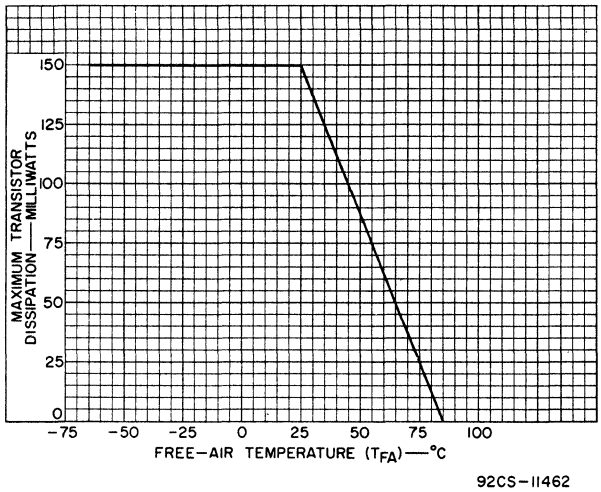
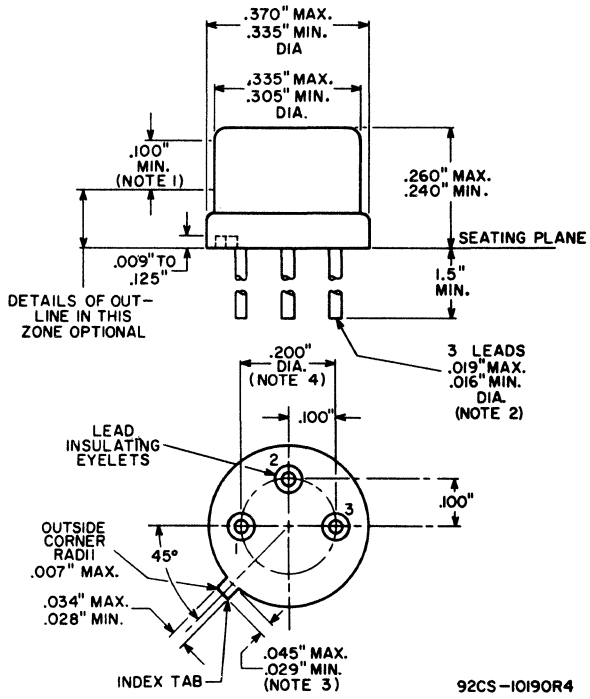
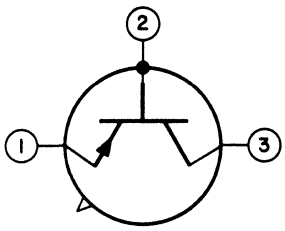


Fig. 1 - Rating Chart for Types 2N1303, 2N1305, 2N1307, and 2N1309.

DIMENSIONAL OUTLINE
(JEDEC No. TO-5)



TERMINAL DIAGRAM
(Bottom View)



Lead 1 - Emitter
Lead 2 - Base, Case
Lead 3 - Collector

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

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SILICON POWER TRANSISTORS

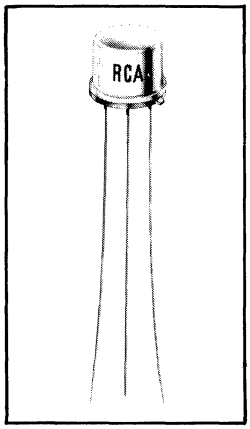
2N1479 2N1480
2N1481 2N1482

File No. 135

RCA-2N1479–2N1482 are diffused-junction power transistors of the silicon n-p-n type. These transistors are intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high beta at high current, and excellent high temperature performance.

Medium-Power Types



JEDEC-TO-5

- Maximum dissipation rating of 5 watts at a case temperature of 25°C

Maximum Ratings, *Absolute-Maximum Values:*

	2N1479 2N1481	*2N1480 2N1482*		
COLLECTOR-TO-BASE VOLTAGE	60	100	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (sustaining voltage)	40	55	max.	volts
With emitter-to-base reverse biased (V_{EB} = 1.5 volts)	60	100	max.	volts
EMITTER-TO-BASE VOLTAGE	12	12	max.	volts
COLLECTOR CURRENT	1.5	1.5	max.	amp
EMITTER CURRENT	-1.75	-1.75	max.	amp
BASE CURRENT	1	1	max.	amp
TRANSISTOR DISSIPATION:▲				
(See Rating Chart Fig. 1):				
At case temperature of 25°C	5	5	max.	watts
At case temperature of 100°C	2.86	2.86	max.	watts
TEMPERATURE RANGE:				
Operating and Storage	-65 to +200			°C

▲For Transistor dissipation in pulse operation refer to RCA Application Note AN-181, "Transistor Dissipation Ratings for Pulse and Switching Service."

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Printed in U.S.A.
2N1479, 2N1480, 2N1481, 2N1482 6/66
Reprinted from ICE-205-B 5/60

ELECTRICAL CHARACTERISTICS

Case temperature = 25°C unless otherwise specified

Characteristic	Symbol	TEST CONDITIONS					LIMITS								
		DC Collector Voltage (volts)		DC Emitter Voltage (volts)	DC Collector Current (ma)	DC Base Current (ma)	Type 2N1479		Type 2N1480		Type 2N1481		Type 2N1482		Units
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With I_E = 0 and at a case temperature of;	I_{CBO}														
25°C		30						10		10		10		10	μa
150°C		30						500		500		500		500	μa
Emitter-Cutoff Current	I_{EBO}			12	0			10		10		10		10	μa
Collector-To-Emitter Voltage: (Emitter-to-base reverse bias)	V_{CEX}			1.5	0.25		60		100		60		100		volts
(Base-open sustaining voltage)	$V_{CEO(sus)}$				50	0	40		55		40		55		volts
DC Current Transfer Ratio	h_{FE}		4		200		20	60	20		35	100	35	100	
DC Collector-To-Emitter Saturation Resistance	R_s				200	20		7		7					ohms
					200	10						7		7	ohms
Base-To-Emitter Voltage	V_{BE}		4		200			3		3		3		3	volts
Thermal Resistance:	R_T														
Junction-to-case								35		35		35		35	°C/w
Junction-to-free air								200		200		200		200	°C/w

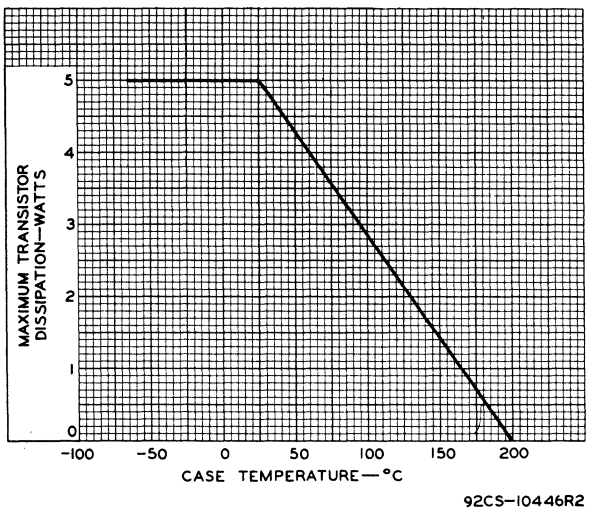


Fig. 1 - Rating Chart for Types 2N1479, 2N1480, 2N1481, and 2N1482.

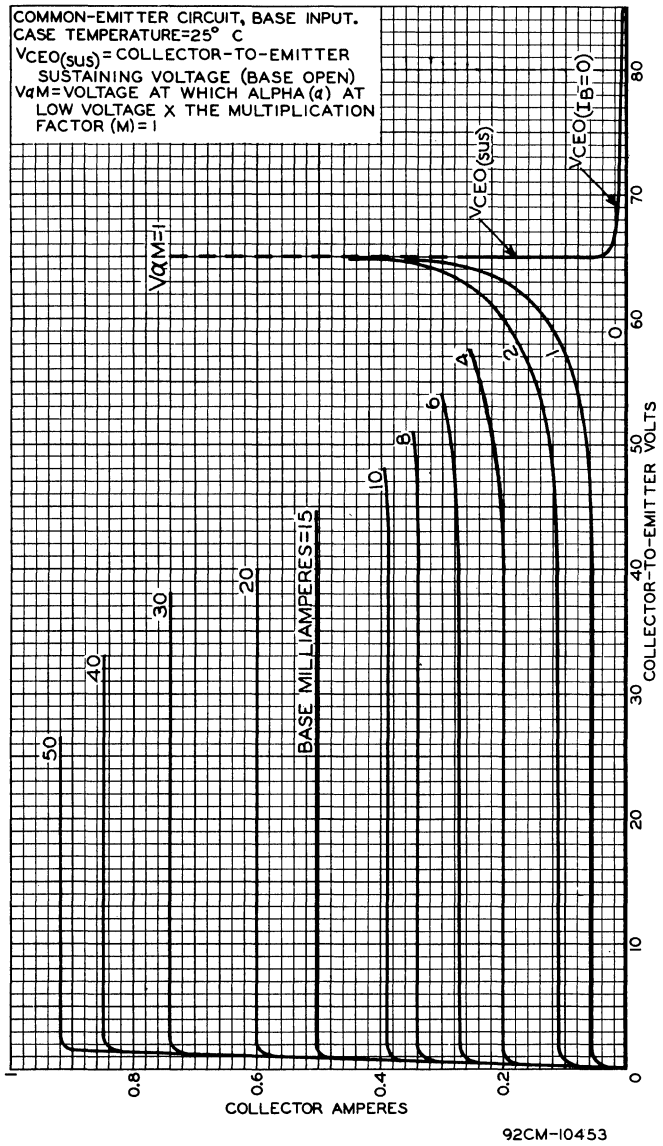


Fig. 3 - Typical Collector Characteristics for Types 2N1479, 2N1480, 2N1481, and 2N1482.

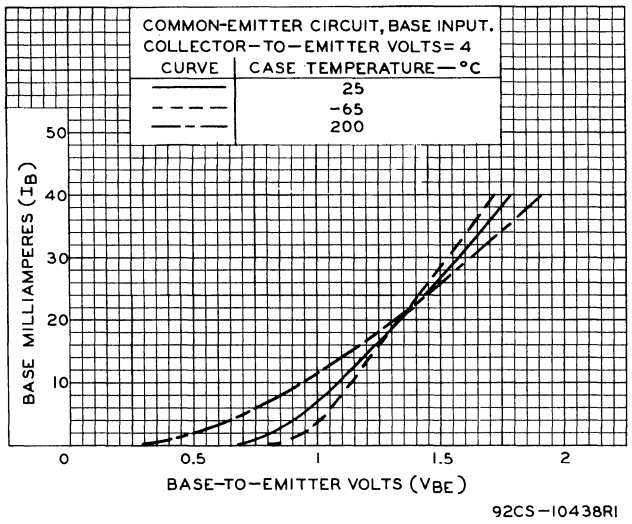


Fig. 4 - Typical Input Characteristics for Types 2N1479, 2N1480, 2N1481, and 2N1482.

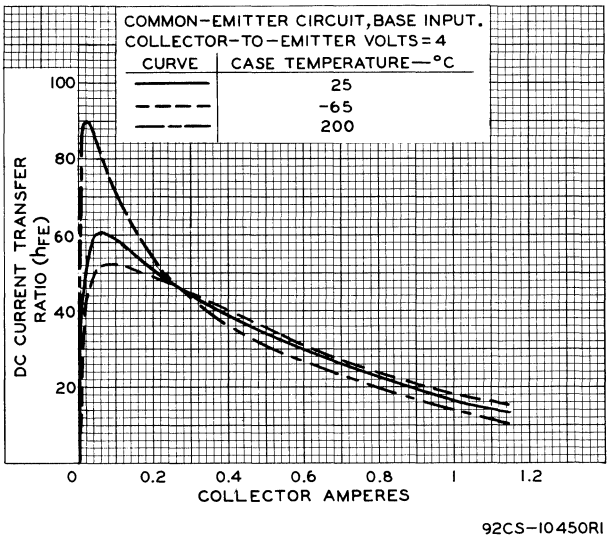


Fig. 5 - Typical Operation Characteristics for Types 2N1479, 2N1480, 2N1481, and 2N1482.

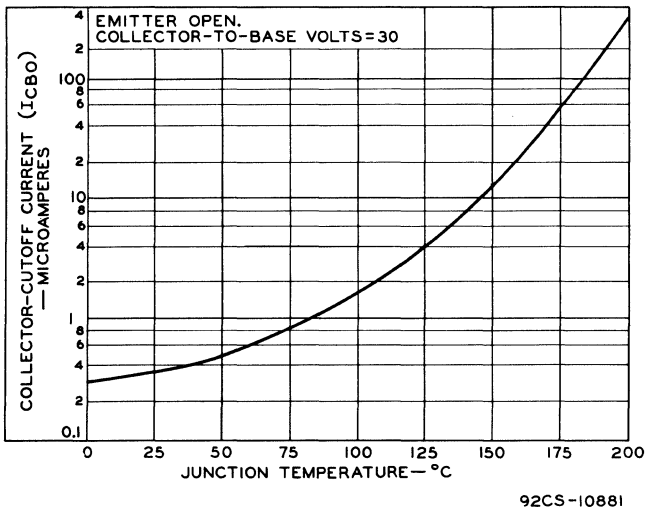
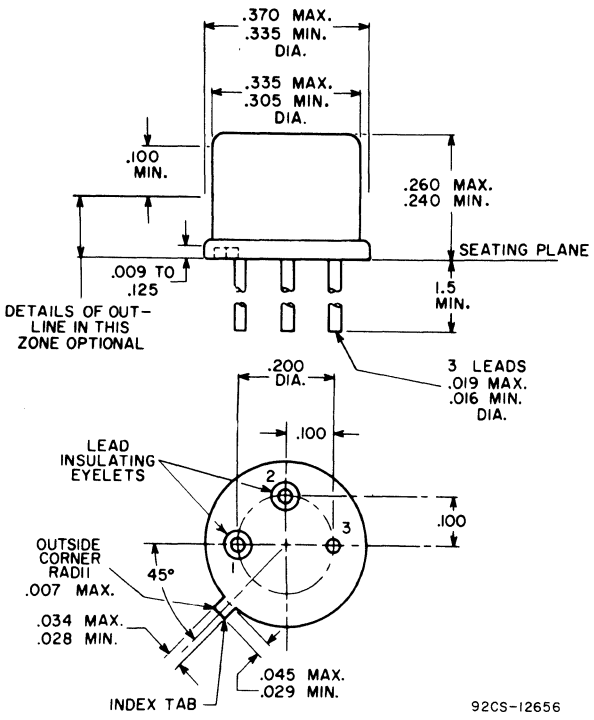


Fig. 6 - Typical Operation Characteristic for Types 2N1479, 2N1480, 2N1481, and 2N1482.

DIMENSIONAL OUTLINE
for Types
2N1479, 2N1480, 2N1481, and 2N1482

JEDEC No. TO-5



TERMINAL CONNECTIONS

Lead No. 1 - Emitter

Lead No. 2 - Base

Lead No. 3 - Collector, Case

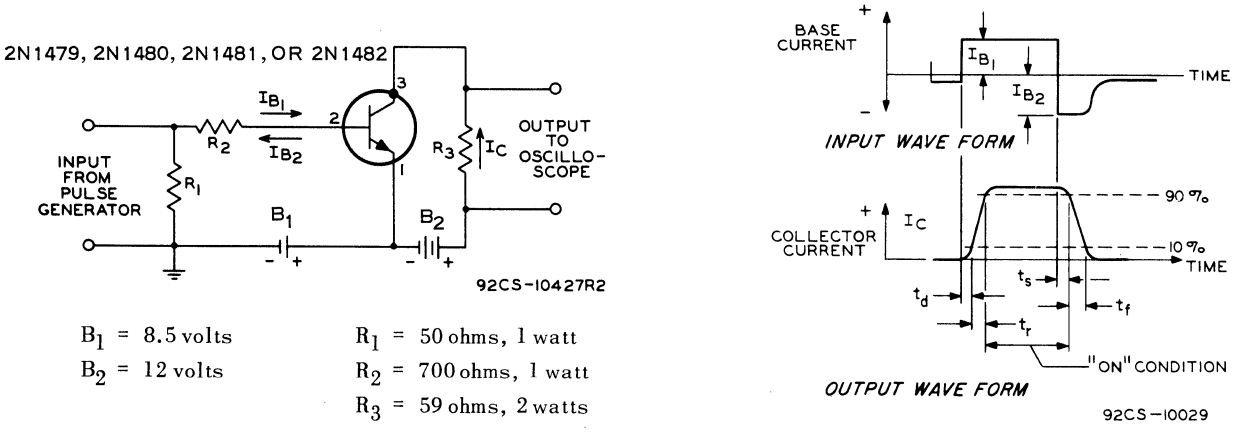
Typical Operation of the 2N1479, 2N1480, 2N1481, and 2N1482 in the Power–Switching Circuit of Fig. 2:

At a Case Temperature of 25°C

DC Supply Voltage (B_2)	12	volts
DC Base Bias Voltage (B_1)	-8.5	volts
Generator Resistance	50	ohms
"On" DC Collector Current	200	ma
"Turn-On" Base Current (I_{B_1})	20	ma
"Turn-Off" Base Current (I_{B_2})	-8.5	ma
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r)	1.0	μsec
Storage Time (t_s)	0.6	μsec
Fall Time (t_f)	1.0	μsec

Typical Characteristics of the 2N1479, 2N1480, 2N1481, and 2N1482, at a Case Temperature of 25°C:

Small-Signal Current Transfer Ratio: h_{fe}		
(I_C = 5ma, V_{CE} = 4volts)	50	
Collector-to-Base Capacitance: C_{ob}		
(V_{CB} = 40volts)	150	μμf
Thermal Time Constant, τ_1	10	msec
Alpha-Cutoff Frequency: f_{a_b}		
(V_{CB} = 28volts, I_C = 5ma)	1.5	Mc



B_1 = 8.5 volts
B_2 = 12 volts

R_1 = 50 ohms, 1 watt
R_2 = 700 ohms, 1 watt
R_3 = 59 ohms, 2 watts

Fig. 2 - Typical Power-Switching Circuit.



2N1479 2N1480 2N1481 2N1482

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SILICON POWER TRANSISTORS

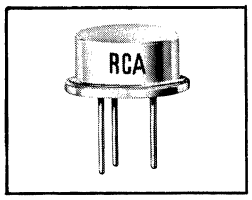
2N1483 2N1484
2N1485 2N1486

File No. 137

RCA-2N1483–2N1486 are diffused-junction power transistors of the silicon n-p-n type. These transistors are intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high beta at high current, and excellent high temperature performance.

Intermediate-Power Types



JEDEC-TO-8

- Maximum dissipation rating of 25 watts at a case temperature of 25°C
- 2N1485 and 2N1486 have a maximum saturation resistance of 1 ohm

Maximum Ratings, *Absolute-Maximum Values:*

	2N1483 2N1485	*2N1484 2N1486*		
COLLECTOR-TO-BASE VOLTAGE	60	100	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (sustaining voltage)	40	55	max.	volts
With emitter-to-base reverse biased (V_{EB} = 1.5 volts)	60	100	max.	volts
EMITTER-TO-BASE VOLTAGE	12	12	max.	volts
COLLECTOR CURRENT	3	3	max.	amp
EMITTER CURRENT	-3.5	-3.5	max.	amp
BASE CURRENT	1.5	1.5	max.	amp
TRANSISTOR DISSIPATION:▲				
(See Rating Chart Fig. 1):				
At case temperature of 25°C	25	25	max.	watts
At case temperature of 100°C	14.1	14.1	max.	watts
TEMPERATURE RANGE:				
Operating and Storage	-65 to +200			°C

▲For Transistor dissipation in pulse operation refer to RCA Application Note AN-181, "Transistor Dissipation Ratings for Pulse and Switching Service."

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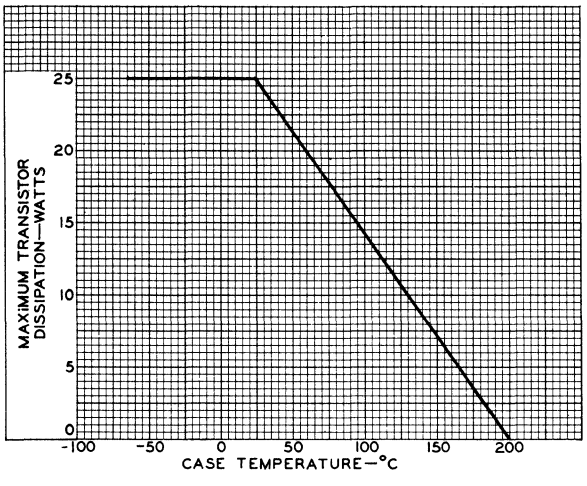
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Printed in U.S.A.
2N1483, 2N184, 2N1485, 2N1486 6/66
Reprinted from ICE-205-B 5/60

ELECTRICAL CHARACTERISTICS

Case temperature = 25°C unless otherwise specified.

Characteristic	Symbol	TEST CONDITIONS					LIMITS								Units
		DC Collector Voltage (volts)		DC Emitter Voltage (volts)	DC Collector Current (ma)	DC Base Current (ma)	Type 2N1483		Type 2N1484		Type 2N1485		Type 2N1486		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With I_E = 0 and at a Case Temperature of;	I_{CBO}														
25°C		30						15		15		15		15	μa
150°C		30						750		750		750		750	μa
Emitter-Cutoff Current	I_{EBO}			12	0			15		15		15		15	μa
Collector-To-Emitter Voltage: (Emitter-to-base reverse bias)	V_{CEX}			1.5	0.25		60		100		60		100		volts
(Base open sustaining voltage)	$V_{CEO(sus)}$				100	0	40		55		40		55		volts
DC Current Transfer Ratio	h_{FE}		4		750		20	60	20	60	35	100	35	100	
DC Collector-To-Emitter Saturation Resistance	R_S				750	75		2.67		2.67					ohms
					750	40						1		1	ohm
Base-To-Emitter Voltage	V_{BE}		4		750			3.5		3.5		2.5		2.5	volts
Thermal Resistance: Junction-to-case	R_T							7		7		7		7	°C/w
Junction-to-free air								100		100		100		100	°C/w



92CS-10442R2

Fig. 1 - Rating Chart for Types 2N1483, 2N1484, 2N1485, and 2N1486.

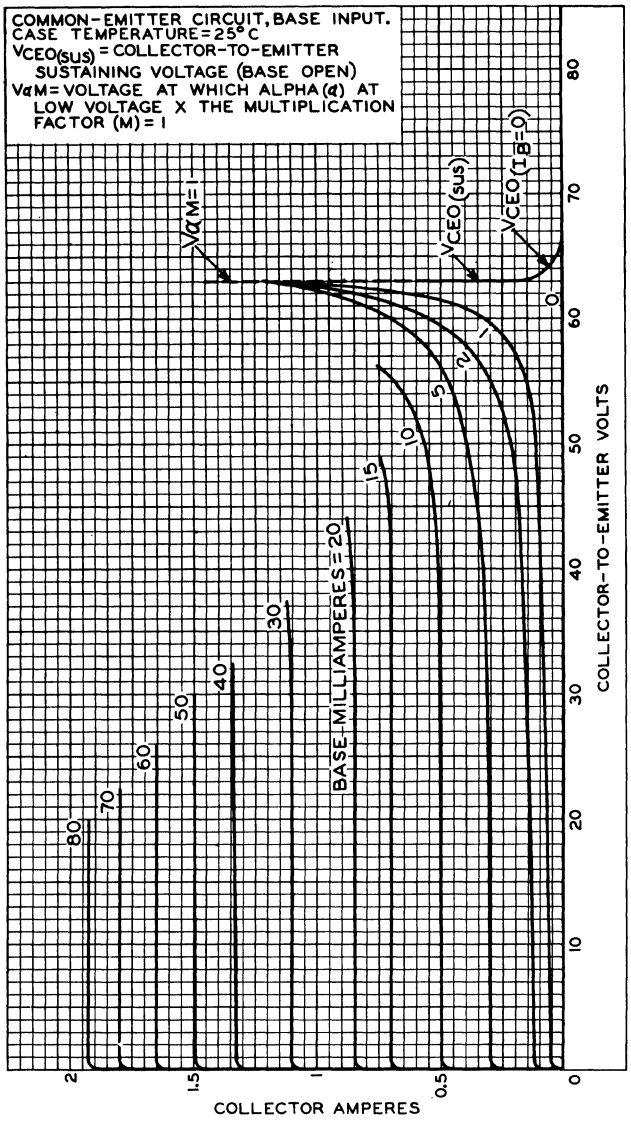


Fig. 3 - Typical Collector Characteristics for Types 2N1483, 2N1484, 2N1485, and 2N1486.

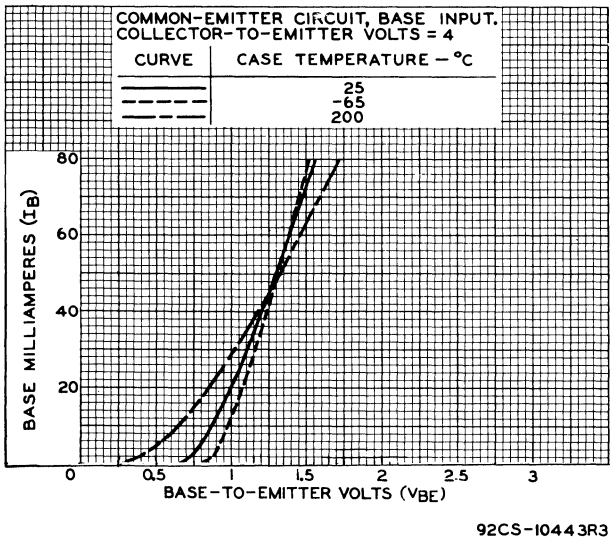


Fig. 4 - Typical Input Characteristics for Types 2N1483, 2N1484, 2N1485, and 2N1486.

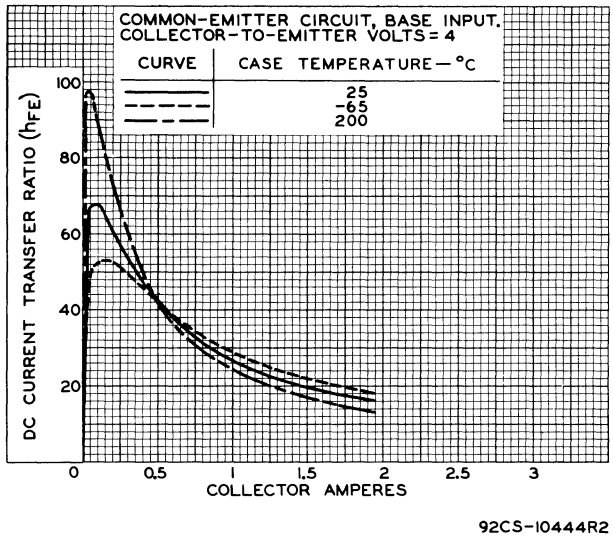


Fig. 5 - Typical Operation Characteristics for Types 2N1483, 2N1484, 2N1485, and 2N1486.

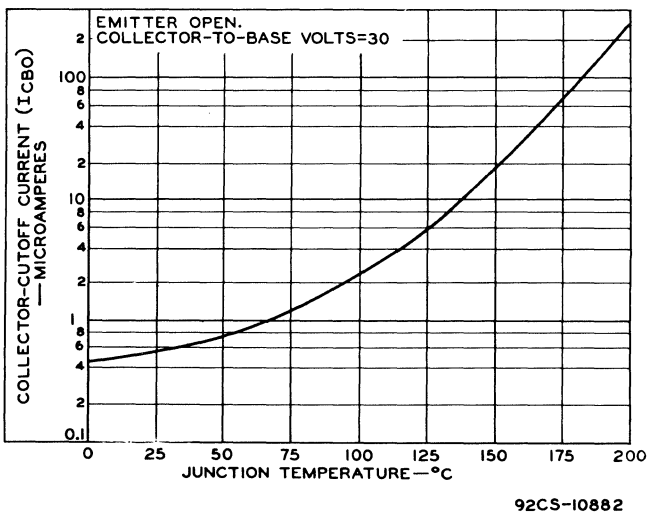


Fig. 6 - Typical Operation Characteristics for Types 2N1483, 2N1484, 2N1485, and 2N1486.

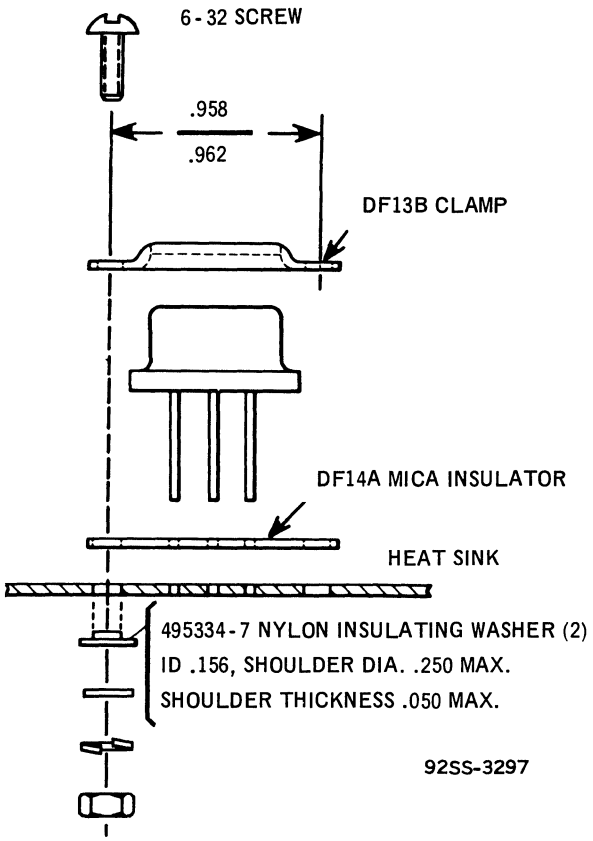
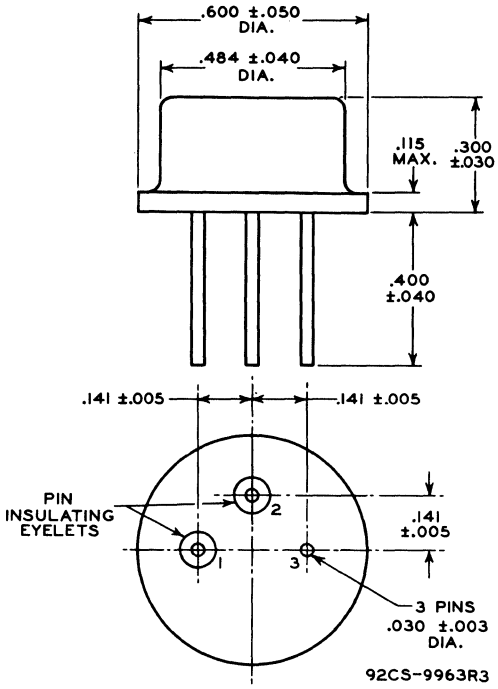


Fig. 7 - Suggested Mounting Arrangement for Types 2N1483, 2N1484, 2N1485, or 2N1486.

DIMENSIONAL OUTLINE
for Types
2N1483, 2N1484, 2N1485, and 2N1486

JEDEC TO-8



TERMINAL CONNECTIONS

Lead No. 1 - Emitter
Lead No. 2 - Base
Lead No. 3 - Collector, Case

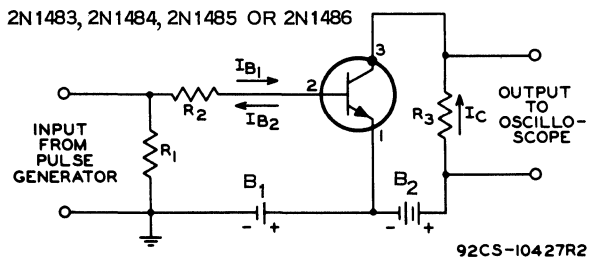
Typical Operation of the 2N1483, 2N1484, 2N1485, and 2N1486 in the Power–Switching Circuit of Fig. 2:

At a Case Temperature of 25°C

DC Supply Voltage (B_2)	12	volts
DC Base Bias Voltage (B_1)	-8.5	volts
Generator Resistance	50	ohms
"On" DC Collector Current	750	ma
"Turn-On" Base Current (I_{B_1})	65	ma
"Turn-Off" Base Current (I_{B_2})	-35	ma
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r)	1.0	μsec
Storage Time (t_s)	0.8	μsec
Fall Time (t_f)	1.1	μsec

Typical Characteristics of the 2N1483, 2N1484, 2N1485, and 2N1486 at a Case Temperature of 25°C:

Collector-to-Base Capacitance: C_{ob}		
(V_{CB} = 40 volts)	175	μμf
Thermal Time Constant, τ_1	10	msec
Alpha-Cutoff Frequency: f_{ab}		
(V_{CB} = 28 volts, I_C = 5 ma)	1.25	Mc



B_1 = 8.5 volts
B_2 = 12 volts

R_1 = 50 ohms, 1 watt
R_2 = 220 ohms, 1 watt
R_3 = 15.9 ohms, 2 watts

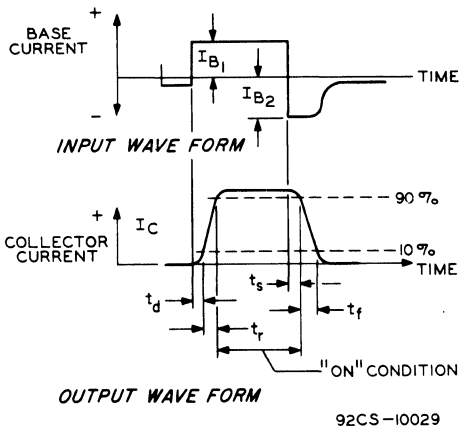


Fig. 2 - Typical Power-Switching Circuit.



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SILICON POWER TRANSISTORS

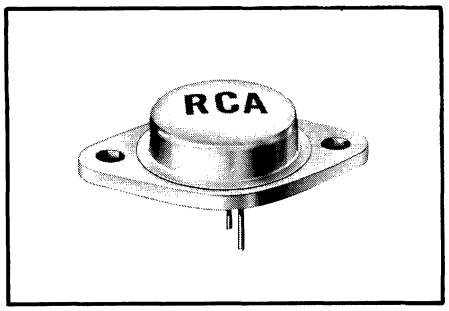
2N1487 2N1488
2N1489 2N1490

File No. 139

High-Power Types

RCA-2N1487–2N1490 are diffused-junction power transistors of the silicon n-p-n type. These transistors are intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high power-dissipation ratings, high beta at high current, and excellent high temperature performance.



JEDEC TO-3

- Maximum dissipation rating of 75 watts at a mounting flange temperature of 25°C
- 2N1489 and 2N1490 have a maximum saturation resistance of 0.67 ohm

Maximum Ratings, *Absolute-Maximum Values:*

	2N1487 2N1489	*2N1488 2N1490*		
COLLECTOR-TO-BASE VOLTAGE	60	100	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (sustaining voltage)	40	55	max.	volts
With emitter-to-base reverse biased (V_{EB} = 1.5 volts)	60	100	max.	volts
EMITTER-TO-BASE VOLTAGE	10	10	max.	volts
COLLECTOR CURRENT	6	6	max.	amp
EMITTER CURRENT	-8	-8	max.	amp
BASE CURRENT	3	3	max.	amp
TRANSISTOR DISSIPATION:▲				
(See Rating Chart Fig. 1):				
At mounting-flange temperature of 25°C	75	75	max.	watts
At mounting-flange temperature of 100°C	43	43	max.	watts
TEMPERATURE RANGE:				
Operating and Storage	-65 to +200			°C

▲For Transistor dissipation in pulse operation refer to RCA Application Note AN-181, "Transistor Dissipation Ratings for Pulse and Switching Service."

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Printed in U.S.A.
2N1487, 2N1488, 2N1489, 2N1490 6/66
Reprinted from ICE-205-B 5/60

ELECTRICAL CHARACTERISTICS

Mounting-flange temperature = 25°C unless otherwise specified.

Characteristic	Symbol	TEST CONDITIONS					LIMITS								Units
		DC Collector Voltage (volts)		DC Emitter Voltage (volts)	DC Collector Current (ma)	DC Base Current (ma)	Type 2N1487		Type 2N1488		Type 2N1489		Type 2N1490		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With I_E = 0 and at mounting flange temperature of;	I_{CBO}														
25°C		30						25		25		25		25	μa
150°C		30						1000		1000		1000		1000	μa
Emitter-Cutoff Current	I_{EBO}			10	0			25		25		25		25	μa
Collector-To-Emitter Voltage: (Emitter-to-base reverse bias)	V_{CEX}			1.5	0.5		60		100		60		100		volts
(Base open sustaining voltage)	$V_{CEO(sus)}$				100	0	40		55		40		55		volts
DC Current Transfer Ratio	h_{FE}		4		1.5amps		15	45	15	45	25	75	25	75	
DC Collector-To-Emitter Saturation Resistance	R_S				1.5amps	300		2		2					ohms
					1.5amps	100						0.67		0.67	ohm
Base-To-Emitter Voltage	V_{BE}		4		1.5amps			3.5		3.5		2.5		2.5	volts
Thermal Resistance: Junction-to-mounting flange flange	R_T							2.33		2.33		2.33		2.33	°C/w

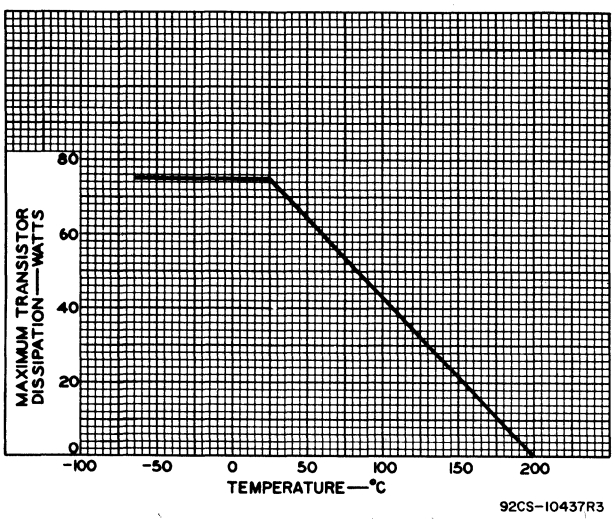


Fig. 1 - Rating Chart for Types 2N1487, 2N1488, 2N1489, and 2N1490.

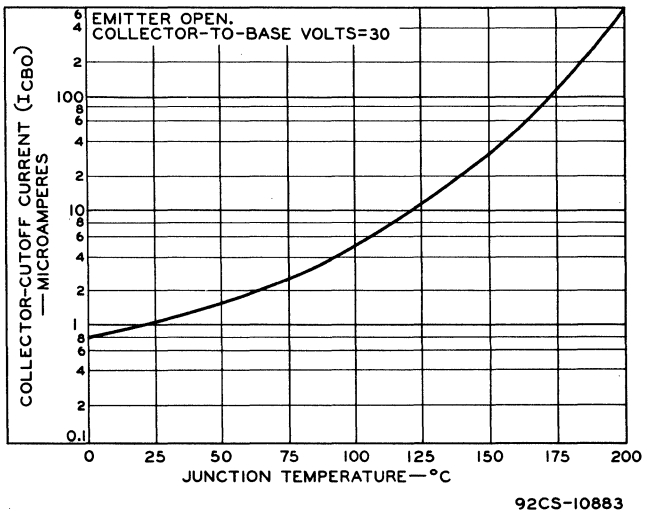


Fig. 2 - Typical Operation Characteristics for Types 2N1487, 2N1488, 2N1489, and 2N1490.

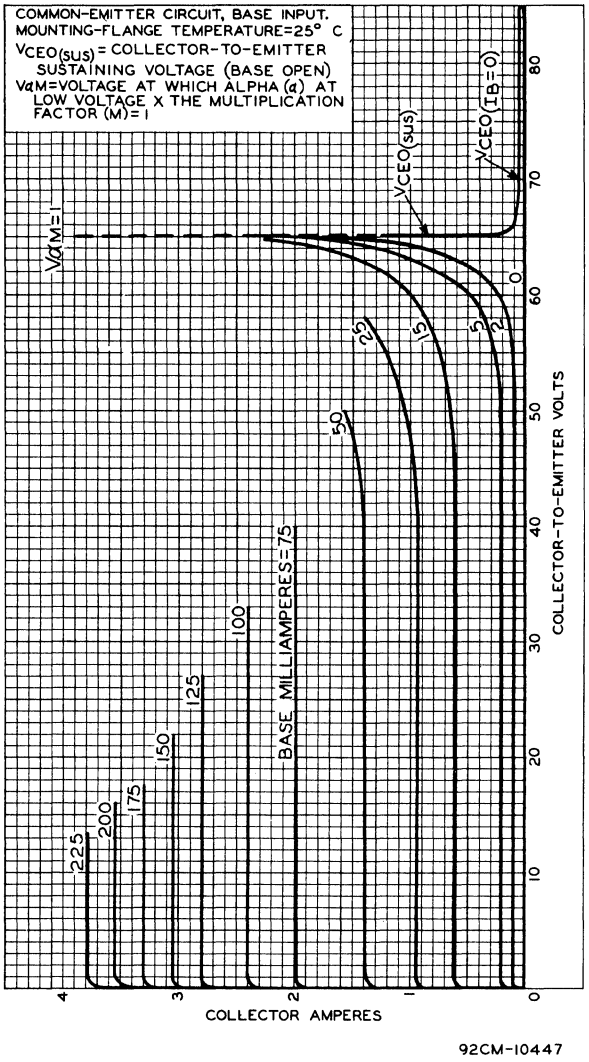


Fig. 4 - Typical Collector Characteristics for Types 2N1487, 2N1488, 2N1489, and 2N1490.

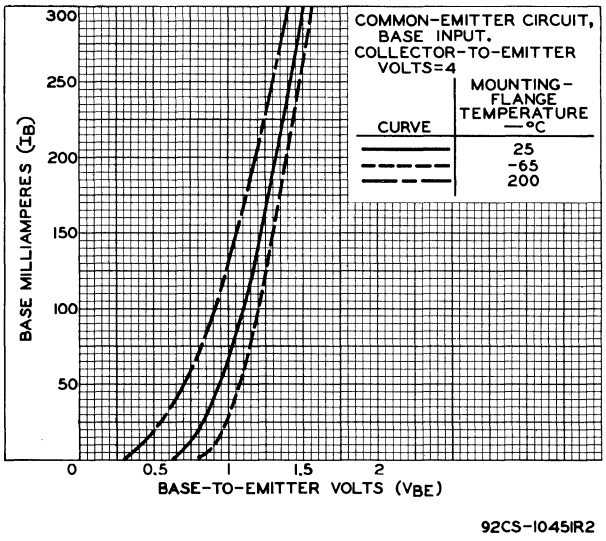


Fig. 5 - Typical Input Characteristics for Types 2N1487, 2N1488, 2N1489, and 2N1490.

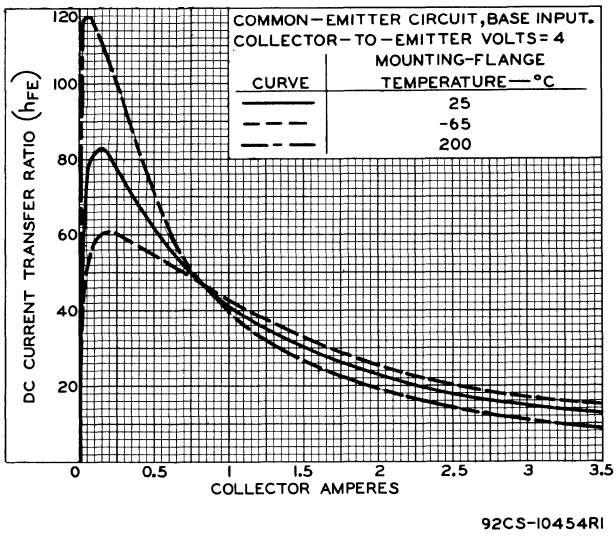
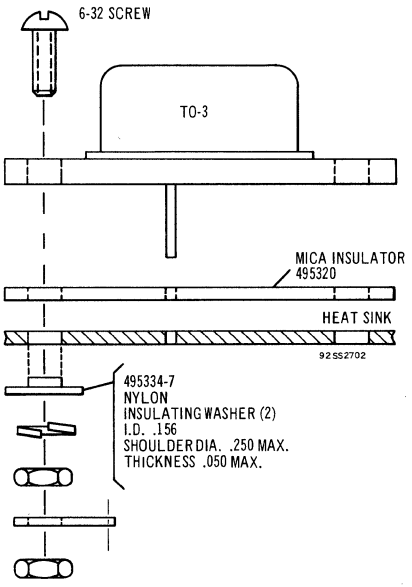


Fig. 6 - Typical Operation Characteristics for Types 2N1487, 2N1488, 2N1489, and 2N1490.

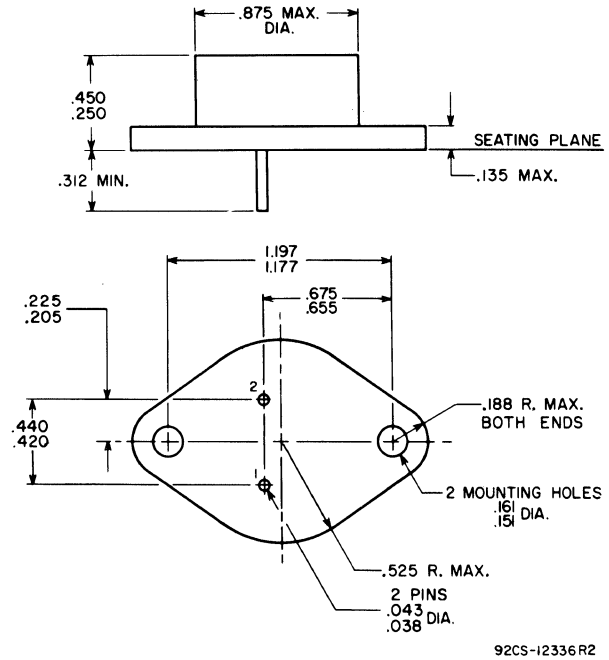


NOTE: Hardware With Part Numbers Supplied.

Fig. 7 - Suggested Mounting Arrangement for Types 2N1487, 2N1488, 2N1489, and 2N1490.

DIMENSIONAL OUTLINE for Types 2N1487, 2N1488, 2N1489, and 2N1490

JEDEC No. TO-3



TERMINAL CONNECTIONS

Pin No. 1 - Base

Pin No. 2 - Emitter

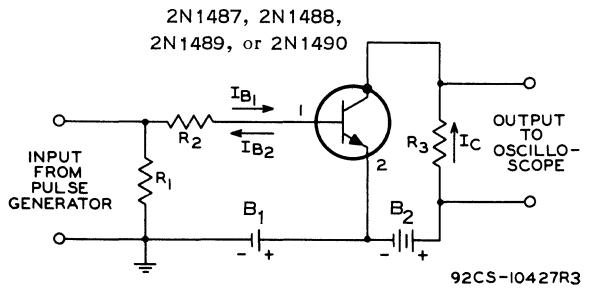
Mounting Flange - Collector, Case

Typical Operation of the 2N1487, 2N1488, 2N1489, and 2N1490 in the Power–Switching Circuit of Fig. 3:

DC Supply Voltage (B_2)	12	volts
DC Base Bias Voltage (B_1)	-8.5	volts
Generator Resistance	50	ohms
"On" DC Collector Current	1.5	amp
"Turn-On" Base Current (I_{B_1})	300	ma
"Turn-Off" Base Current (I_{B_2})	-150	ma
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r)	1.0	μsec
Storage Time (t_s)	1.0	μsec
Fall Time (t_f)	1.2	μsec

Typical Characteristics of the 2N1487, 2N1488, 2N1489, and 2N1490 at a Mounting-Flange Temperature of 25°C:

Collector-to-base capacitance: C_{ob} (V_{CB} = 40 volts)	200	$\mu\mu$f
Thermal Time Constant, τ_1	12	msec
Alpha-Cutoff Frequency f_{ab} (V_{CB} = 12 volts, I_c = 100 ma)	1	Mc



B_1 = 8.5 volts
B_2 = 12 volts
R_1 = 50 ohms, 1 watt
R_2 = 30 ohms, 1 watt
R_3 = 7.8 ohms, 2 watts

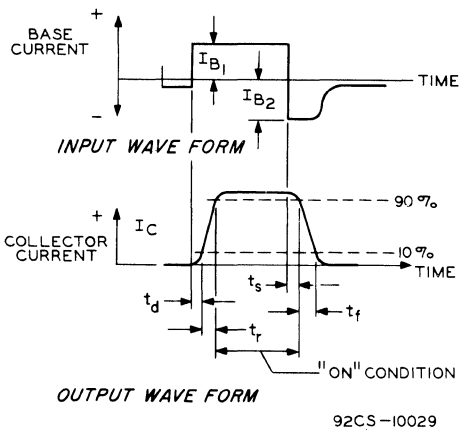


Fig. 3 - Typical Power-Switching Circuit.



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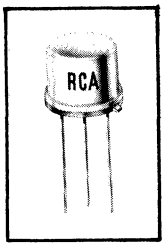
SILICON N-P-N PLANAR TRANSISTORS

2N1491
2N1492
2N1493

File No. 10

RCA-2N1491, 2N1492, and 2N1493 are triple-diffused transistors of the silicon n-p-n type. These transistors are intended for a wide variety of applications in industrial and military electronic equipment. They are particularly useful in large-signal power-amplifier, video-amplifier, and oscillator circuits operating in the HF and VHF regions over wide ranges of ambient temperature.

VHF Amplifier & Oscillator Service



JEDEC TO-39

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

		2N1491	2N1492	2N1493	
COLLECTOR-TO-BASE VOLTAGE . . .	V_{CBO}	30	60	100	max. V
COLLECTOR-TO-EMITTER VOLTAGE:					
With emitter-to-base reverse biased. .	V_{CEV}	30	60	100	max. V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	1	2	4.5	max. V
COLLECTOR CURRENT	I_C	500	500	500	max. mA
EMITTER CURRENT		500	500	500	max. mA
TRANSISTOR DISSIPATION, See *Fig.3:*	P_T				
Operation in free air:					
Ambient temperature = 25° C . . .		0.5	0.5	0.5	max. W
Ambient temperature = 100° C . . .		0.25	0.25	0.25	max. W
Operation with heat sink:					
Case temperature = 25° C		3	3	3	max. W
Case temperature = 100° C		1.5	1.5	1.5	max. W
AMBIENT TEMPERATURE RANGE:					
Operating and storage		−65 to +175			°C

- **High V_{CB} Ratings – up to 100 V**
- **High Transistor-Dissipation Ratings – up to 3 watts**
- **High Typical f_T at I_C = 25 mA – up to 380 MHz**
- **High Typical Power Gain at 70 MHz – up to 12 db at 500-mW output**
- **JEDEC TO-39 Package**

ELECTRICAL CHARACTERISTICS, *Ambient Temperature = 25° C*

Characteristics	Symbol	TEST CONDITIONS				LIMITS						Units
		DC Collector Voltage (volts)		DC Collector Current (mA)	DC Emitter Current (mA)	Type 2N1491		Type 2N1492		Type 2N1493		
		V_{CB}	V_{CE}			Min.	Max.	Min.	Max.	Min.	Max.	
Collector Breakdown Voltage	BV_{CBO}			0.1	0	30		60		100		volts
Collector Cutoff Current	I_{CBO}	12			0		10		10		10	μA
Emitter Cutoff Current	I_{EBO}		V_{EB} 0.5	0			100		100		100	μA
Collector-to-Base and Stem Capacitance	–	30			0		5		5		5	pF
Small-Signal Current Transfer Ratio: at 1 KHz	h_{fe}		20	15		15	200	15	200	15	200	
Power Gain at 70 MHz Power Output (mW) See *Fig.11*	PG											
= 10		20			−15	13						dB
= 100		30			−15			13				dB
= 500		50			−25					10		dB
Thermal Resistance Junction-to-case	R_T						50		50		50	°C/W

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2N1491, 2N1492, 2N1493 5/66
Reprinted from ICE-209 4/61

PERFORMANCE CHARACTERISTICS

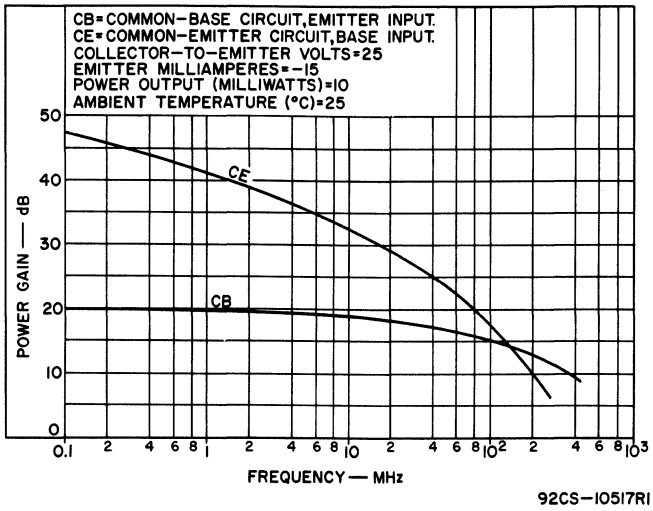


Fig. 1

DISSIPATION DERATING GRAPH

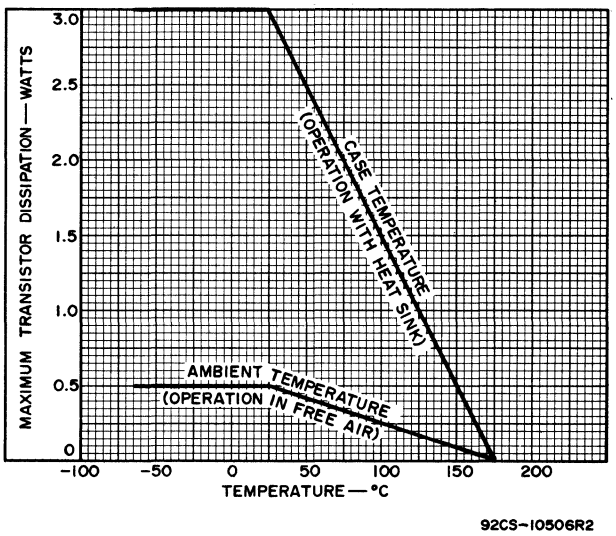


Fig. 3

TYPICAL COLLECTOR CHARACTERISTICS

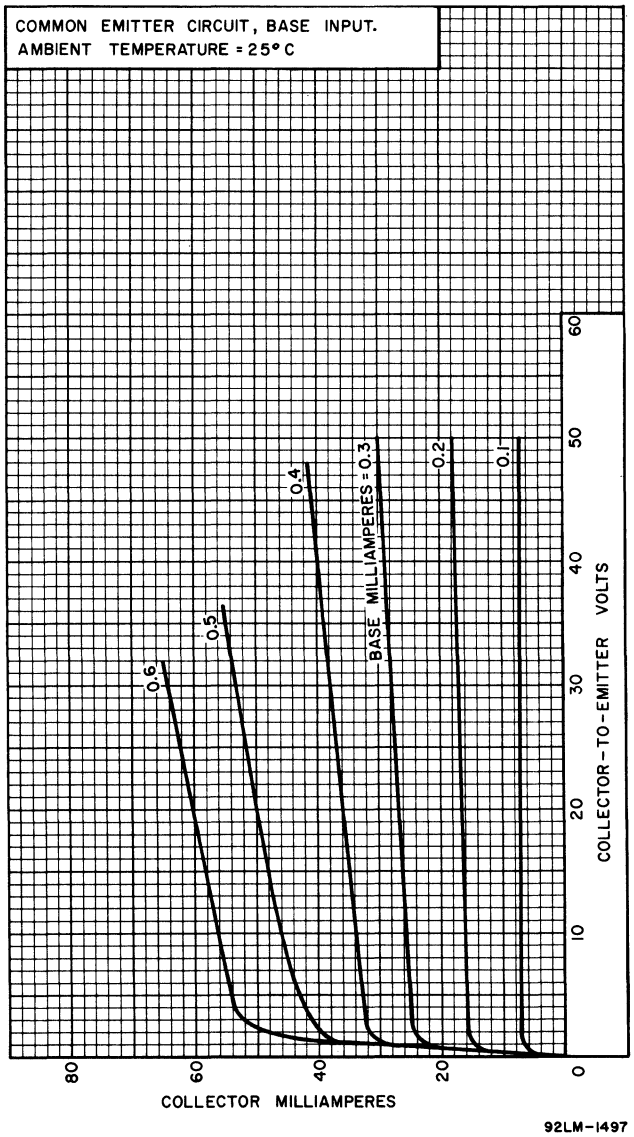


Fig. 2

TYPICAL CHARACTERISTICS

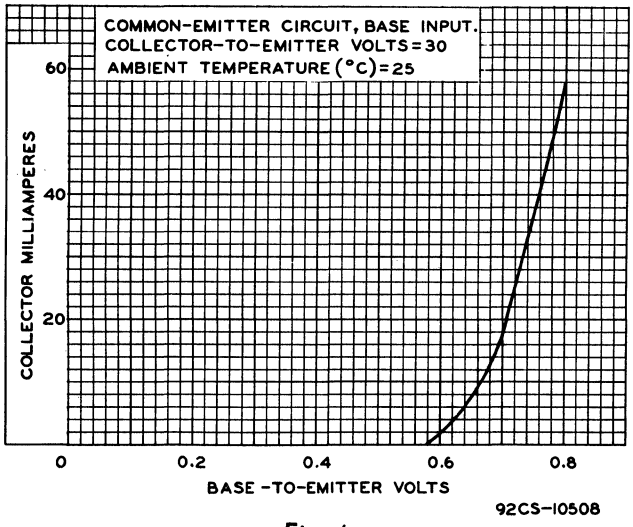


Fig. 4

TYPICAL DC BETA CHARACTERISTICS

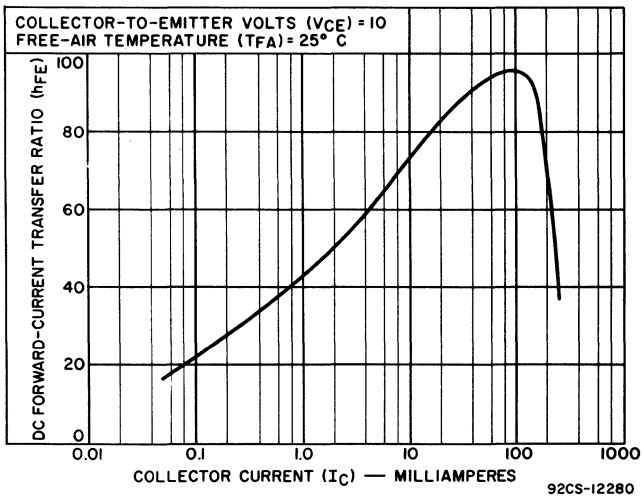


Fig. 5

TYPICAL SMALL-SIGNAL OPERATION CHARACTERISTICS

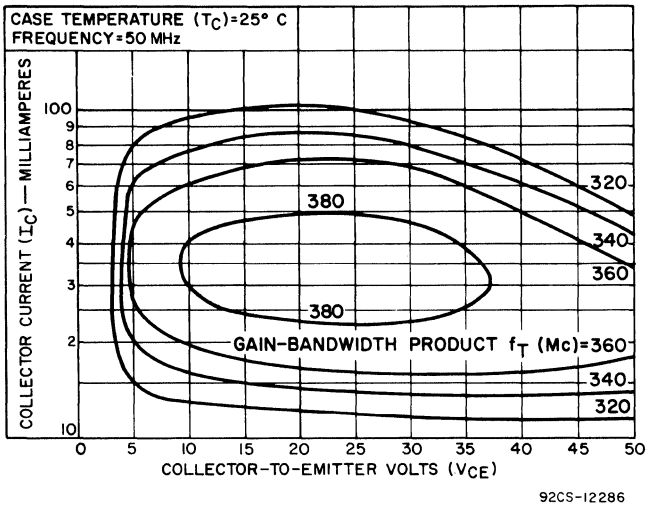


Fig. 6

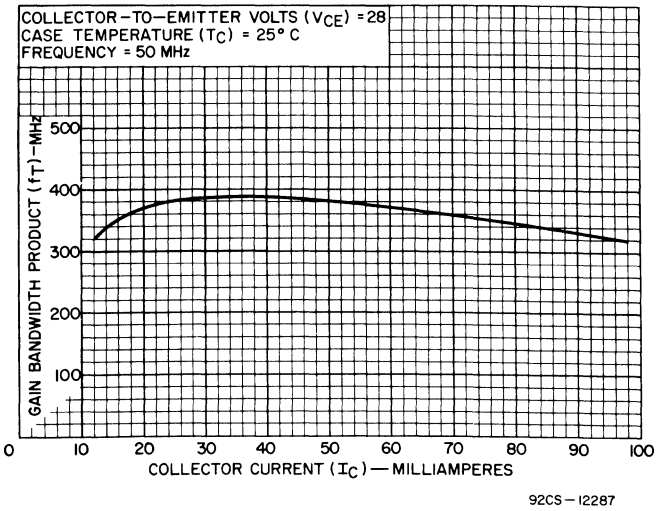


Fig. 7

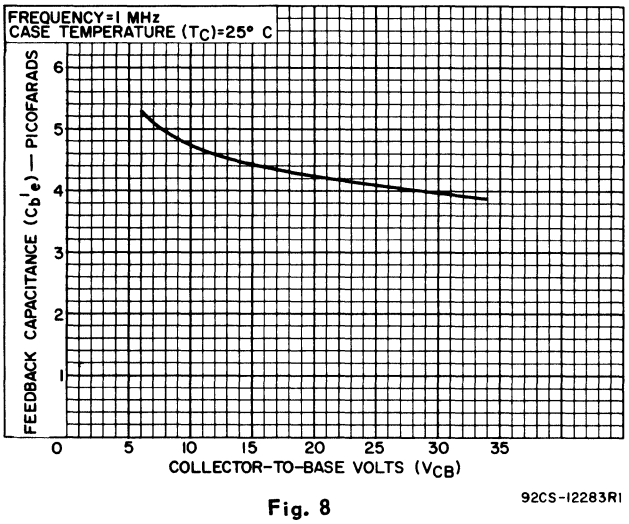


Fig. 8

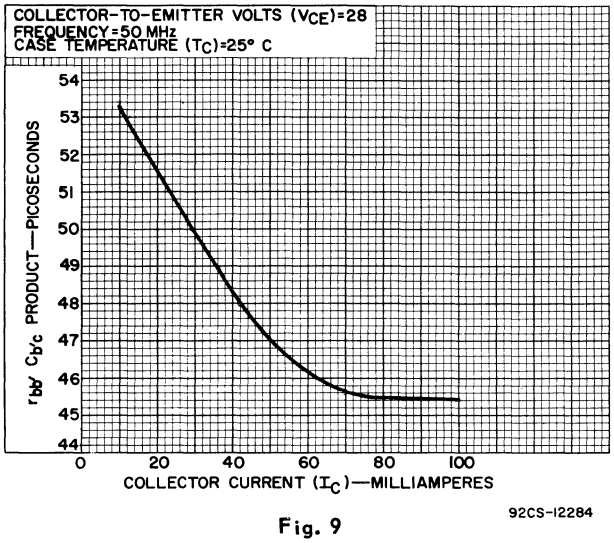


Fig. 9

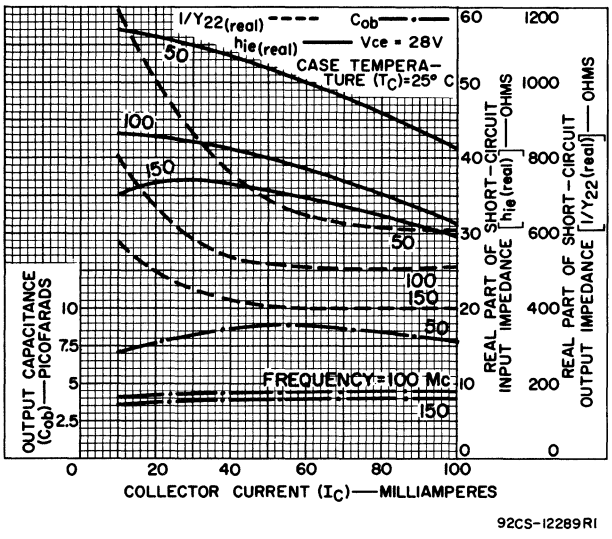


Fig. 10

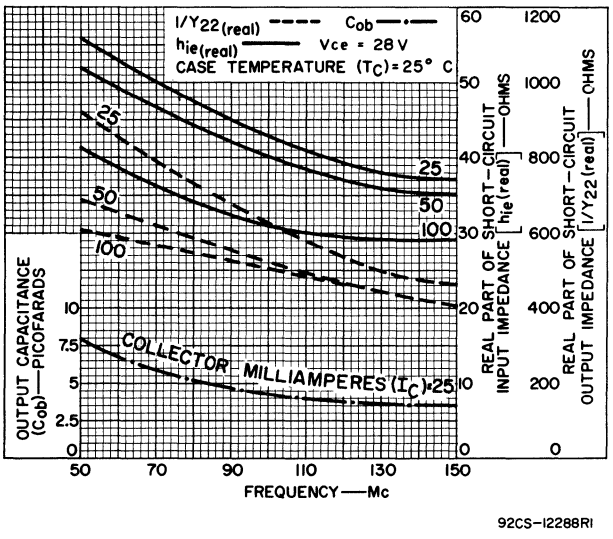
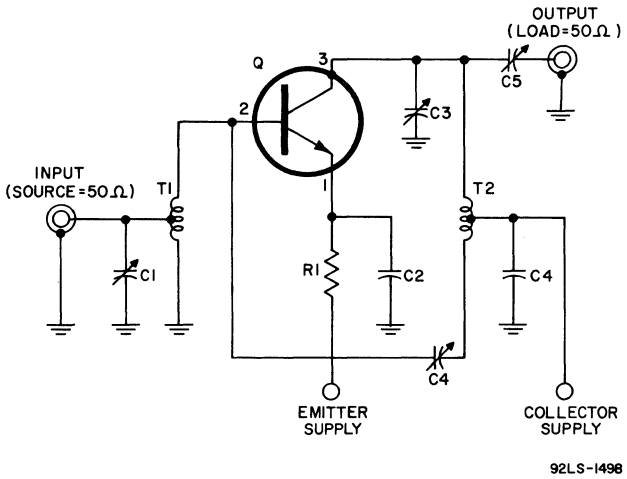


Fig. 11

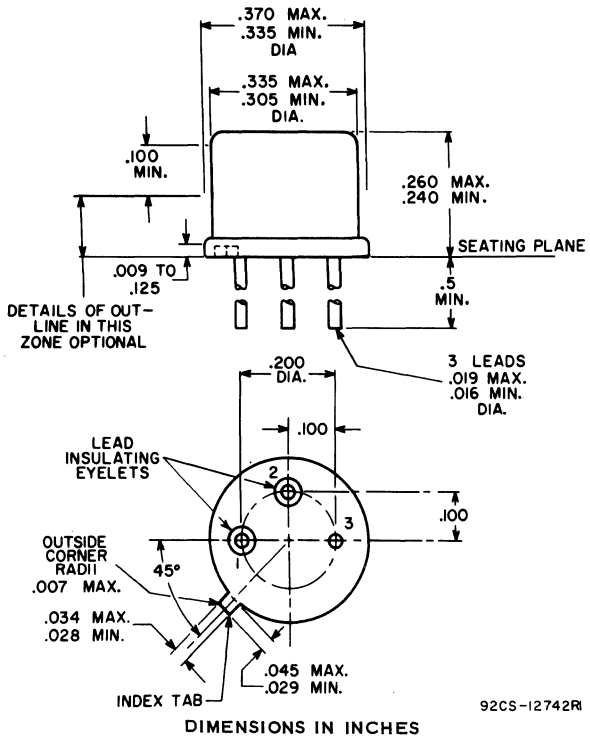
POWER GAIN TEST CIRCUIT



C_1: 3-20 pF variable
C_2, C_6: 0.01 μF
C_3: 3-20 pF variable
C_4: 7-100 pF variable
C_5: 3-20 pF variable
Q: All Types
T_1: 8 turns No.24 wire tapped at 1 turn
T_2: 8 turns No.24 wire tapped at 2.5 turns

Fig. 12

DIMENSIONAL OUTLINE
JEDEC TO-39



DIMENSIONS IN INCHES

TERMINAL CONNECTIONS

Lead No.3 – Emitter

Lead No.2 – Base

Case, Lead No.3 – Collector

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GERMANIUM PNP DRIFT-FIELD TRANSISTORS

For AM Broadcast-Band Receiver Applications in Consumer Equipment



JEDEC TO-1

RCA-2N1524, 2N1526, and 2N1632 are drift-field transistors of the germanium pnp type. They are designed especially for use in entertainment-type battery-operated AM broadcast-band radio receivers.

RCA-2N1524 is intended for use in IF-amplifier stages, and is capable of providing a useful power gain of 30 dB at a frequency of 455 kHz in an unneutralized circuit.

RCA-2N1526 is intended for use in converter (mixer-oscillator) stages, and is capable of providing a useful conversion power gain of 34.5 dB at a signal-input frequency of 1.5 MHz.

RCA-2N1632 is intended for use in RF-amplifier stages, and is capable of providing a useful power gain of 25.5 dB at a frequency of 1.5 MHz.

These transistors also feature exceptional stability, excellent uniformity of characteristics, low feedback capacitance, and very close manufacturing control of small-signal parameters, a feature which makes these devices especially useful in quantity-produced AM broadcast-band radio receivers.

The 2N1524, 2N1526, and 2N1632 utilize hermetically sealed JEDEC TO-1 packages.

- low leakage currents:

  I_{CBO}, I_{EBO} } -16 μA max.

- low feedback capacitance, C_{cb}:

  2N1524, 2N1632 = 2.1 pF typ.

- high unneutralized amplifier gains, MAG:

  2N1524 = 52.4 dB typ. at 455 kHz
  2N1632 = 44.3 dB typ. at 1.5 MHz

- hermetically sealed JEDEC TO-1 metal packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N1524 2N1526	2N1632		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-24	-34	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-0.5	-0.5	max.	V
COLLECTOR CURRENT, I_C	-10	-10	max.	mA
EMITTER CURRENT, I_E	10	10	max.	mA
TRANSISTOR DISSIPATION, P_T:				
At ambient temperatures:				
T_A = 25°C	80	80	max.	mW
T_A = 55°C	50	50	max.	mW
T_A = 71°C	35	35	max.	mW
TEMPERATURE RANGE:				
Operating	-65 to +71			°C
Storage	-65 to +85			°C
LEAD TEMPERATURE (During Soldering):				
At distances not closer than 1/16 inch from seating surface, for 10 seconds max.	255	255	max.	°C

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Printed in U.S.A.
2N1524, 2N1526, 2N1632 12-66
Supersedes issue dated 6-60

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS									UNITS
		DC COLLECTOR-TO-BASE VOLTAGE V_{CB}	DC COLLECTOR-TO-EMITTER VOLTAGE V_{CE}	DC EMITTER-TO-BASE VOLTAGE V_{EB}	DC COLLECTOR CURRENT I_C	DC EMITTER CURRENT I_E	TYPE 2N1524			TYPE 2N1526			TYPE 2N1632			
		V	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-12				0	-	-	-16	-	-	-16	-	-	-16	μA
Emitter-Cutoff Current	I_{EBO}			-0.5	0		-	-	-16	-	-	-16	-	-	-16	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.05	0	-	-	-	-	-	-	-34	-	-	V
Collector-to-Base Breakdown Voltage	BV_{CBV}			-0.5	-0.05		-24	-	-	-24	-	-	-	-	-	V
Small-Signal Forward Current-Transfer Ratio	h_{fe}	f = 1 kHz	-12			1	-	60	-	-	130	-	40	80	170	
Collector-to-Base Feedback Capacitance	C_{cb}		-8.5			1	-	2.1	-	-	-	-	-	2.1	-	pF
Maximum Available Amplifier Gain	MAG*	f = 455 kHz f = 1.5 MHz	-8.5 -8.5			1 1	- -	52.4 -	- -	- -	- -	- -	- -	- 44.3	- -	dB dB
Maximum Usable Amplifier Gain (Unneutralized)	MUG	f = 455 kHz f = 1.5 MHz	-8.5 -8.5			1 1	- -	30 -	- -	- -	- -	- -	- -	- 25.5	- -	dB dB
Maximum Available Conversion Power Gain	MAG_C	f = 1.5 MHz	-8			0.65	-	-	-	-	46.1	-	-	-	-	dB
Maximum Usable Conversion Power Gain	MUG_C	f = 1.5 MHz	-8			0.65	-	-	-	-	34.5	-	-	-	-	dB
Base-to-Emitter Oscillator-Injection Voltage			-8			0.65	-	-	-	-	100	-	-	-	-	mV(rms)
Thermal Resistance (Junction-to-Ambient)	θ_{JA}						-	-	0.4	-	-	0.4	-	-	0.4	°C/mW

* Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power (transformer insertion losses not included).

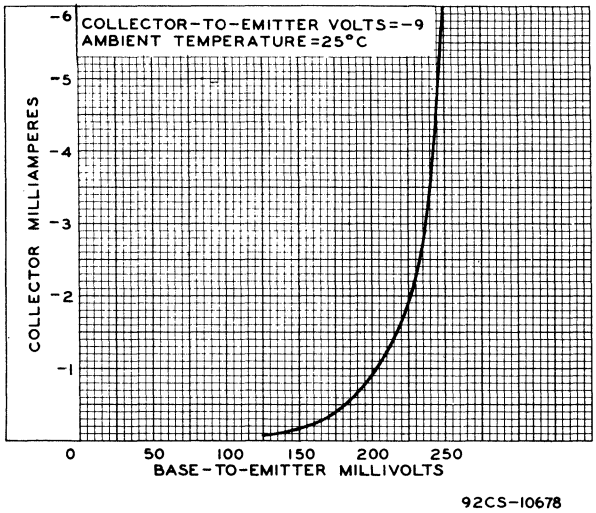


Fig.1 - Typical Transfer Characteristic for Types 2N1524, 2N1526 and 2N1632.

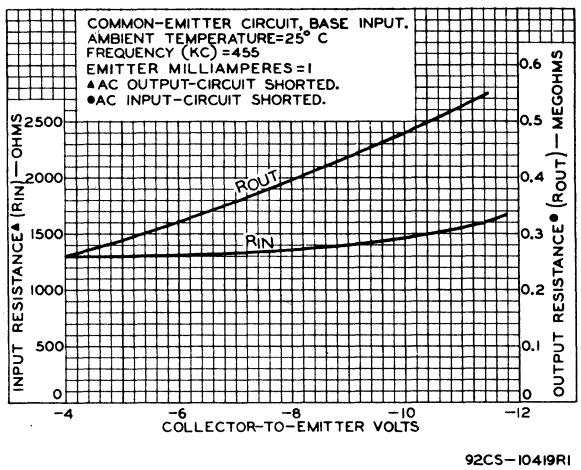


Fig.2 - Typical Performance Characteristics for Type 2N1524.

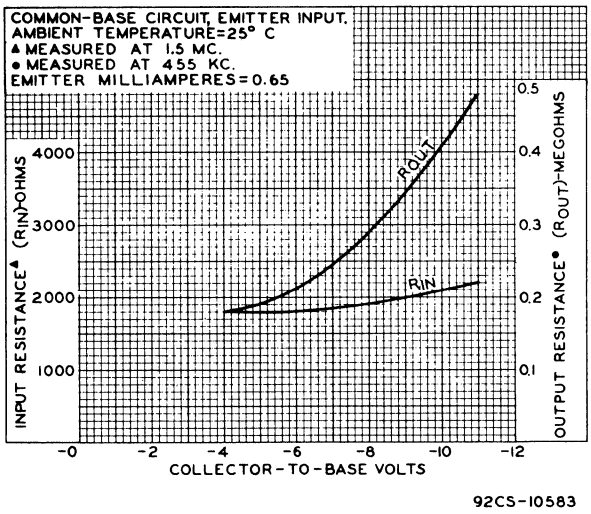


Fig.3 - Typical Performance Characteristics for Type 2N1526.

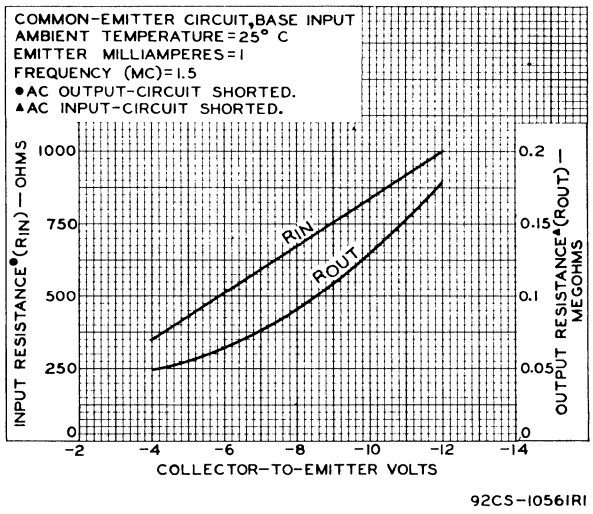


Fig.4 - Typical Performance Characteristics for Type 2N1632.

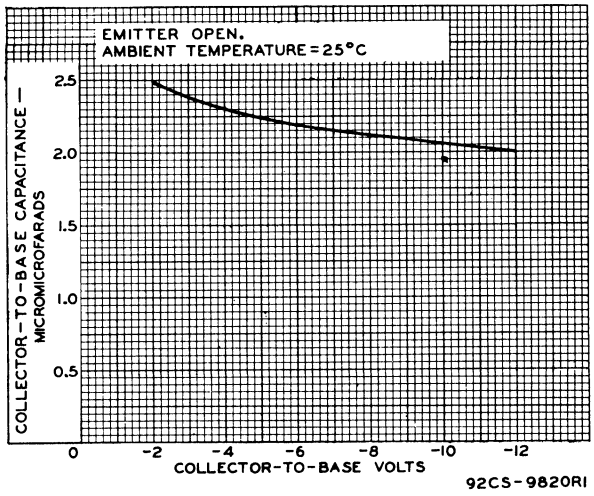


Fig.5 - Typical Characteristic for Types 2N1524, 2N1526 and 2N1632.

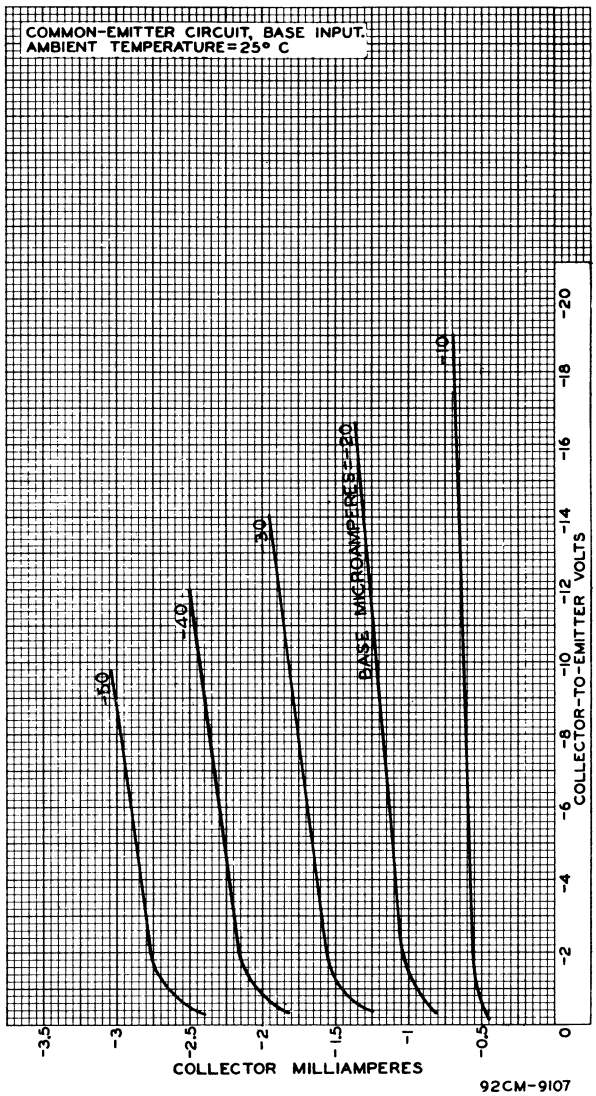


Fig.6 - Typical Collector Characteristics for Type 2N1632.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

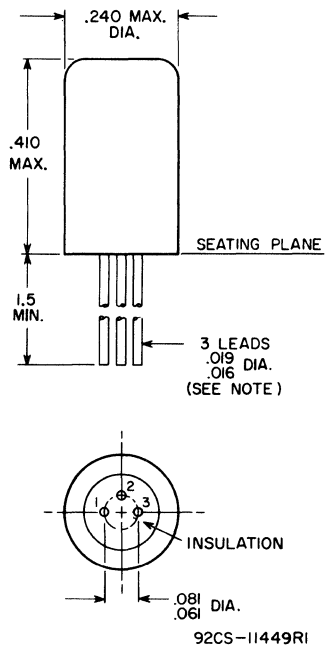
The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variations, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connections to the base, emitter, and collector leads of the device may be soldered directly to the leads provided such connections are made at least 1/16 inch from the seating surface of the transistor, and provided care is taken to conduct excessive heat away from the lead seals during soldering. Failure to observe these precautions will result in cracking of the lead seals and permanent damage to the transistor.

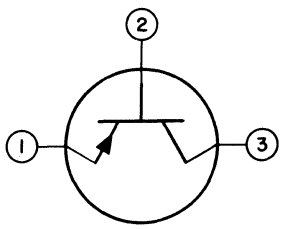
DIMENSIONAL OUTLINE
JEDEC No. TO-1



DIMENSIONS IN INCHES

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR

GERMANIUM N-P-N MEDIUM-SPEED TRANSISTORS

For Computer Switching Service



RCA-2N1605 and 2N1605A are germanium n-p-n alloy-junction transistors which are complements to the p-n-p types 2N404 and 2N404A, respectively. The 2N1605 and 2N1605A, like their p-n-p counterparts, are specifically designed for medium-speed switching applications in data-processing equipment.

- complementary n-p-n versions of p-n-p types 2N404 and 2N404A
- tested in strict accordance with military specification MIL-S-19500B
- rugged four-poster, double-weld construction for reliable performance

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N1605	*2N1605A*	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE With reverse bias, V_{BE} = -1 volt	24	40 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	12	12 max.	volts
COLLECTOR CURRENT, I_C	100	100 max.	ma
EMITTER CURRENT, I_E	100	100 max.	ma
TRANSISTOR DISSIPATION:			
At free-air temperatures up to 25° C.	150	200 max.	mw
At free-air temperatures above 25° C.	See *Figs.1 and 2*		
TEMPERATURE RANGE:			
Storage	-65 to +100	-65 to +100	°C
Operating (Junction)	+100	+100 max.	°C
LEAD TEMPERATURE: 1/16" ± 1/32" from seating surface for 10 seconds max.	235	235 max.	°C

For Electrical Characteristics, see page 2.

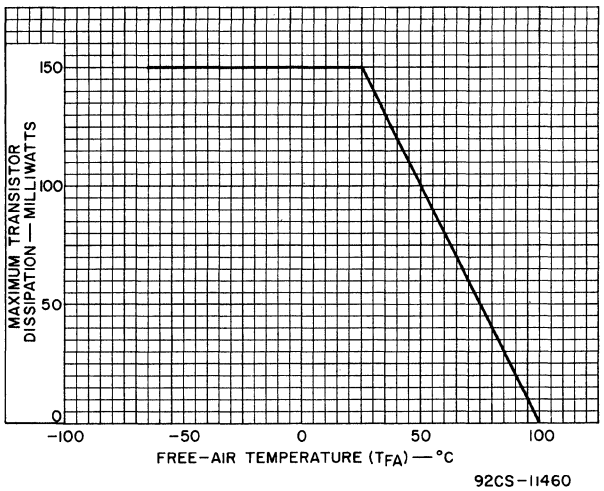


Fig.1 - Rating Chart for Type 2N1605.

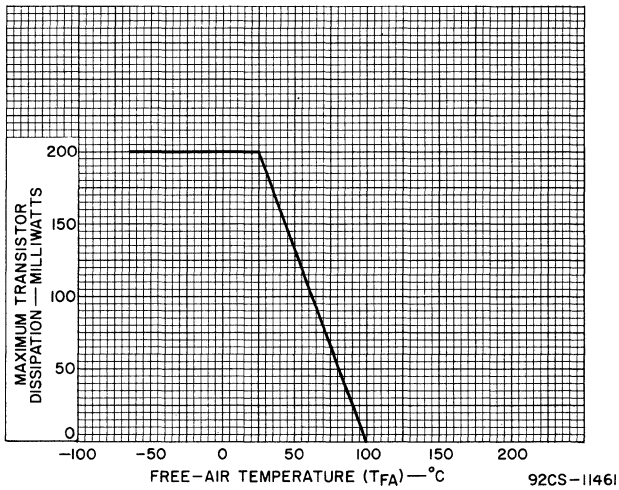


Fig.2 - Rating Chart for Type 2N1605A.

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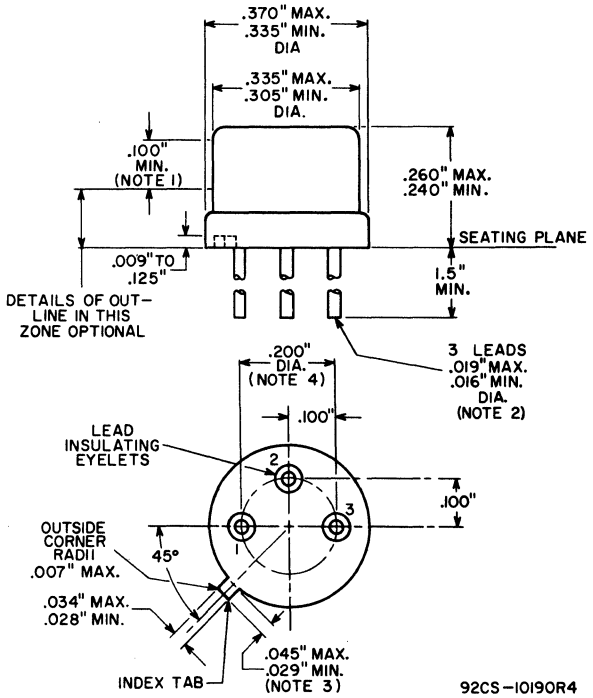
Trademark(s) ® Registered
Marca(s) Registrada(s)

Printed in U.S.A.
2N1605, 2N1605A 6-66
Reprinted from Issue dated 1-62

ELECTRICAL CHARACTERISTICS, *Free-Air Temperature = 25° C Unless Otherwise Specified*

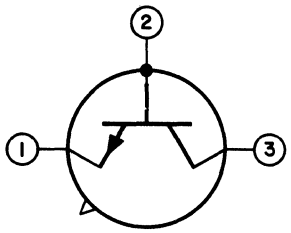
Characteristics	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N1605		Type 2N1605A		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current At free-air temperature of: 25° C 25° C 80° C	I_{CBO}	 12 40 12			 0 0 0			 - - -	 5 - 125	 - - -	 - 10 125	 μa μa μa
Emitter-Cutoff Current	I_{EBO}			2.5			0	-	2.5	-	2.5	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0 0		0.02 0.01	25 -	- -	- 40	- -	volts volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.02		0	12	-	12	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					0.4 1.0	12 24	- -	0.15 0.20	- -	0.15 0.20	volt volt
Base-to-Emitter Voltage	V_{BE}					0.4 1.0	12 24	- -	0.35 0.40	- -	0.35 0.40	volt volt
Emitter Floating Potential With 11-megohm (min.) voltmeter connected between emitter and base	V_{EBF}	 24 40						-	1.0	 - -	 1.0 1.0	volt volt volt
DC Forward-Current Transfer Ratio	h_{FE}		0.15 0.20 0.25				12 24 20	30 24 40	- - -	30 24 40	- - -	
Collector-to-Base Capacitance	C_{ob}	6			1		-	-	20	-	20	pf
Small-Signal, Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}	6			1			4	-	4	-	Mc
Total Stored Charge With collector supply volts (V_{CC}) = 5.25	Q_S					1	10	-	1400	-	1400	pc

DIMENSIONAL OUTLINE (JEDEC No. TO-5)



TERMINAL DIAGRAM

(Bottom View)



Lead 1 – Emitter
Lead 2 – Base, Case
Lead 3 – Collector

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

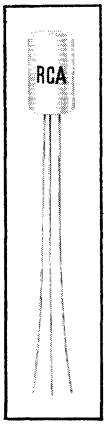
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" – 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

GERMANIUM PNP DRIFT-FIELD TRANSISTORS

For AM Broadcast-Band Receiver Applications in Consumer Equipment



JEDEC TO-1

RCA-2N1637, 2N1638 and 2N1639 are drift-field transistors of the germanium pnp type. They are designed especially for AM broadcast-band applications in automobile radio receivers.

RCA-2N1637 is intended for use in RF-amplifier stages, and is capable of providing a useful power gain of 25.6 dB at a frequency of 1.5 MHz.

RCA-2N1638 is intended for use in IF-amplifier stages, and is capable of providing a useful power gain of 36.6 dB at a frequency of 262.5 kHz.

RCA-2N1639 is intended for use in converter (mixer-oscillator) stages, and is capable of providing a useful conversion power gain of 37 dB at a signal-input frequency of 1.5 MHz.

These transistors also feature exceptional stability, excellent uniformity of characteristics, low feedback capacitances, and very close manufacturing control of small-signal parameters, a feature which makes these devices especially useful in quantity-produced automobile radio receivers.

The 2N1637, 2N1638 and 2N1639 utilize hermetically sealed JEDEC TO-1 metal packages.

FEATURES

- **low leakage current:** I_{CBO} = -12 μA max.
- **low feedback capacitance:** C_{cb} = 2 pF typ.
- **high unneutralized amplifier gains:** MAG { 2N1637 = 47.7 dB typ. at 1.5 MHz; 2N1638 = 61.5 dB typ. at 262.5 kHz }
- **hermetically sealed JEDEC TO-1 metal packages**

Maximum Ratings, *Absolute-Maximum Values:*

	2N1637 2N1638 2N1639	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-34 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-1.5 max.	V
COLLECTOR CURRENT, I_C	-10 max.	mA
EMITTER CURRENT, I_E	10 max.	mA
TRANSISTOR DISSIPATION, P_T:		
At ambient temperatures: T_A = 25°C	80 max.	mW
At ambient temperatures: T_A = 55°C	50 max.	mW
At ambient temperatures: T_A = 71°C	35 max.	mW
TEMPERATURE RANGE:		
Operating	-65 to +71	°C
Storage	-65 to +85	°C
LEAD TEMPERATURE (During Soldering):		
At distances not less than 1/16 inch from seating surface, for 10 seconds max.	255	°C

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N1637, 2N1638, 2N1639 1-67
Supersedes issue dated 6-60

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS					LIMITS									Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	Type 2N1637			Type 2N1638			Type 2N1639			
		V	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-12				0	-	-	-12	-	-	-12	-	-	-12	μA
Emitter-Cutoff Current	I_{EBO}			-1.5	0		-	-	-15	-	-	-	-	-	-15	μA
				-0.5	0		-	-	-	-	-	-12	-	-	-	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.05	0	-34	-	-	-34	-	-	-34	-	-	V
Small-Signal Forward Current-Transfer Ratio	h_{fe}	f = 1 kHz	-12		-1		-	80	-	-	75	-	-	75	-	
Collector-to-Base Feedback Capacitance	C_{cb}		-12		-1		-	2	-	-	2	-	-	2	-	pF
Maximum Available Amplifier Gain	MAG*	f = 1.5 MHz	-11			1	-	47.7	-	-	-	-	-	-	-	dB
		f = 262.5 kHz	-11			2	-	-	-	-	61.5	-	-	-	-	dB
Maximum Usable Amplifier Gain (Unneutralized)	MUG	f = 1.5 MHz	-11			1	-	25.6	-	-	-	-	-	-	-	dB
		f = 262.5 kHz	-11			2	-	-	-	-	36.6	-	-	-	-	dB
Maximum Usable Conversion Power Gain	MUG_c	f = 1.5 MHz	-11			0.25	-	-	-	-	-	-	-	37	-	dB
Base-to-Emitter Oscillator-Injection Voltage (RMS)			-11			0.25	-	-	-	-	-	-	-	100	-	mV(rms)
Thermal Resistance (Junction-to-Ambient)	θ_{JA}						-	-	0.4	-	-	0.4	-	-	0.4	°C/mW

*Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power (transformer insertion losses not included).

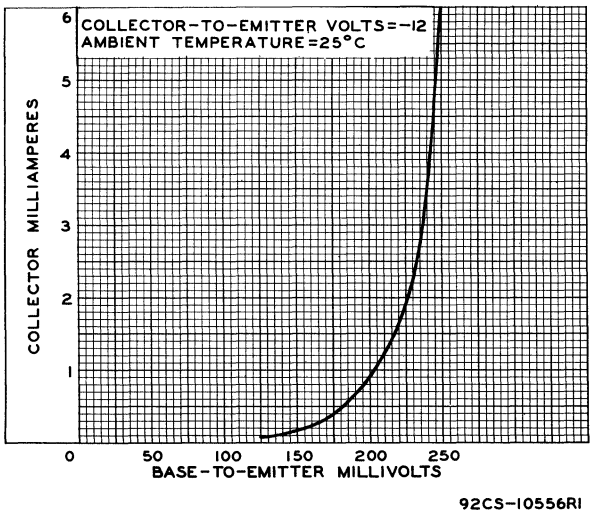


Fig. 1 - Typical Transfer Characteristic for Types 2N1637, 2N1638, and 2N1639.

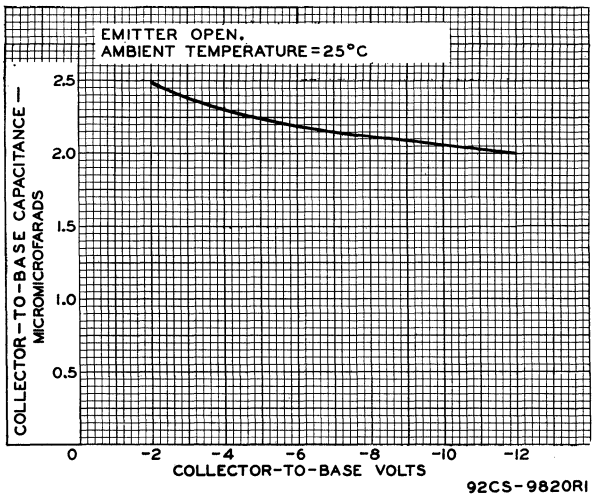


Fig. 2 - Typical Characteristic for Types 2N1637, 2N1638, and 2N1639.

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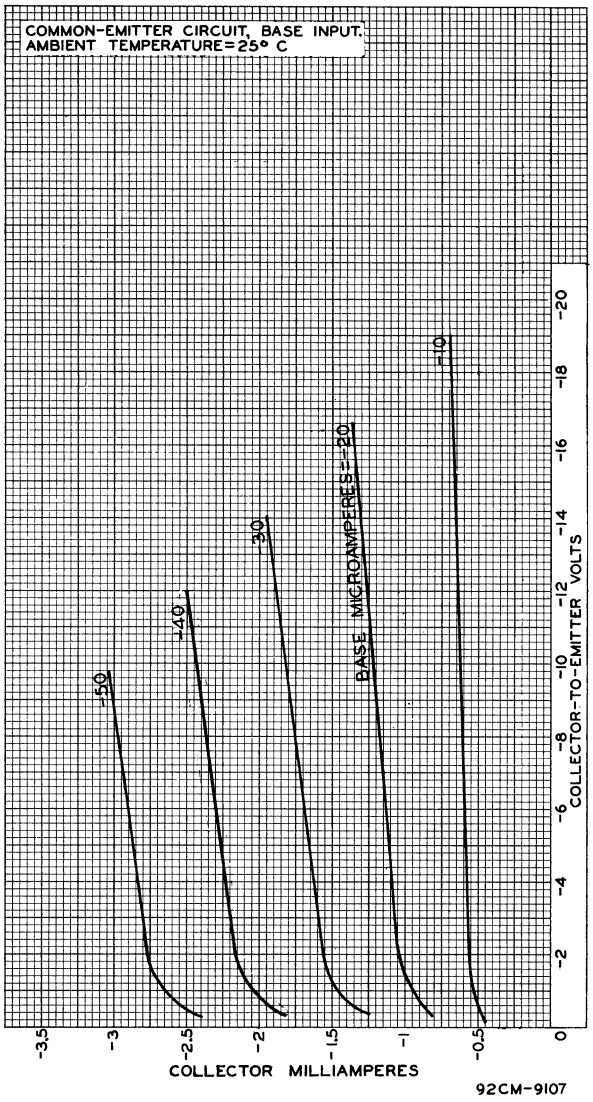


Fig.3 - Typical Collector Characteristics for Types 2N1637, 2N1638, and 2N1639.

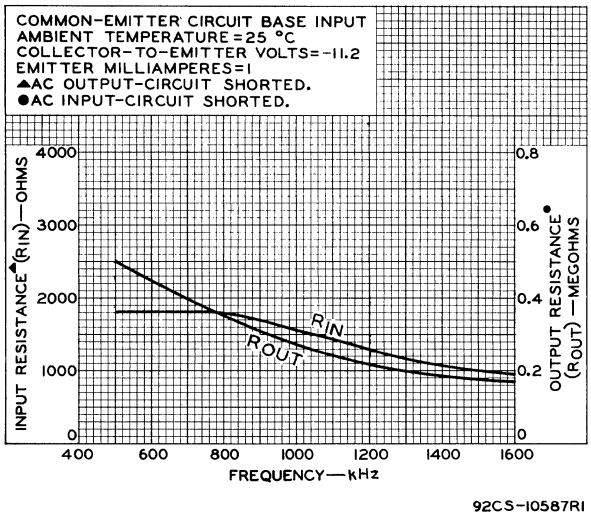


Fig.4 - Typical Performance Characteristics for Type 2N1637.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

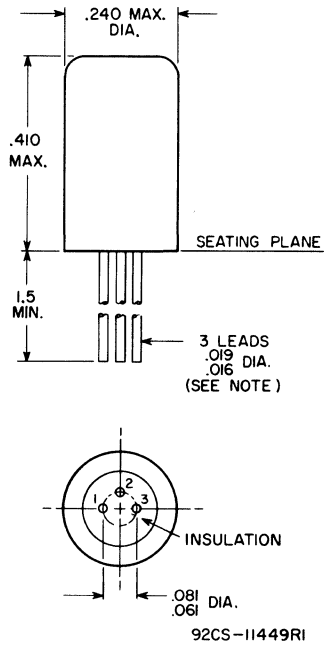
The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variations, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connections to the base, emitter, and collector leads may be soldered directly to the leads provided such connections are made at least 1/16 inch from the seating surface of the transistor, and provided care is taken to conduct excessive heat away from the lead seals during soldering. Failure to observe these precautions will result in cracking of the lead seals and permanent damage to the transistor.

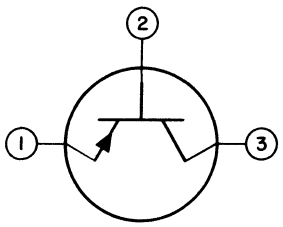
DIMENSIONAL OUTLINE
JEDEC No. TO-1



Dimensions in Inches

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR

SILICON N-P-N POWER TRANSISTORS

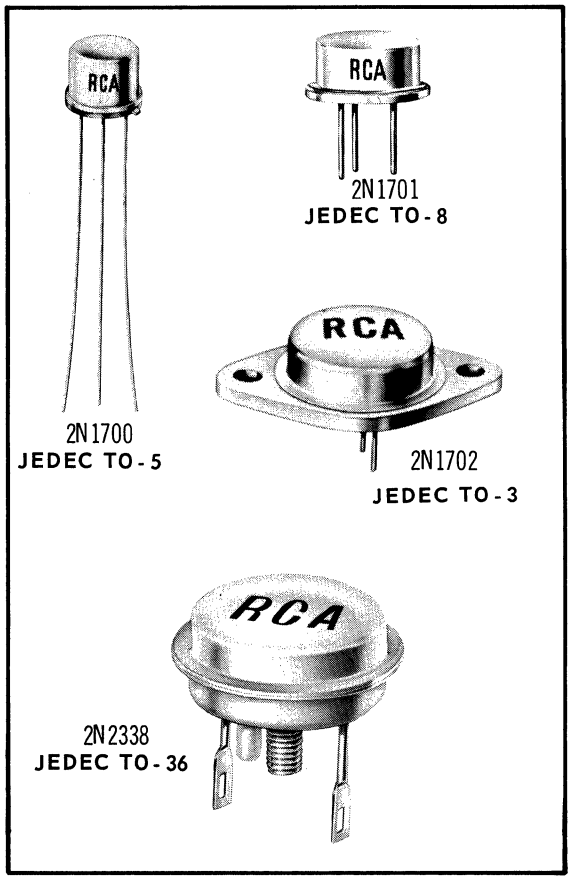
2N1700 2N1701 2N1702 2N2338

File No. 141

RCA 2N1700, 2N1701, 2N1702, and 2N2338 are diffused-junction silicon power transistors of the n-p-n type intended for a wide variety of applications in industrial equipment. They are particularly useful in dc-to-dc converter, inverter, chopper, voltage-and-current regulator, dc and servo amplifier, and realy-actuating circuits of such equipment.

- for operation at high junction temperatures–up to 200° C
- high dissipation ratings–up to 150 watts
- choice of industry-preferred cases

For Industrial Applications



Maximum Ratings, *Absolute-Maximum Values:*

	2N1700	2N1701	2N1702	2N2338	
COLLECTOR-TO-BASE VOLTAGE. .	60	60	60	60	volts
COLLECTOR-TO-EMITTER VOLTAGE:					
With base open (sustaining voltage) . .	40	40	40	40	volts
With emitter-to-base reverse bias (V_{EB} = 1.5 volts). . . .	60	60	60	60	volts
EMITTER-TO-BASE VOLTAGE	6	6	6	6	volts
COLLECTOR CURRENT	1	2.5	5	7.5	amp
BASE CURRENT. . .	0.75	1	2.5	5	amp
TRANSISTOR DISSIPATION: * *(See Rating Charts)*					
At or below 25° C case or mounting-flange temperature . .	5	25	75	150	watts
TEMPERATURE RANGE:					
Storage	-65 to +200				°C
Operating Junction. . .	-65 to +200				°C
LEAD TEMPERATURE: 1/16" ± 1/32" from case for 10 seconds. . .	255	235	-	-	°C

* For Transistor Dissipation in pulse operation refer to RCA Application Note AN-181, "Transistor Dissipation Ratings for Pulse and Switching Service".

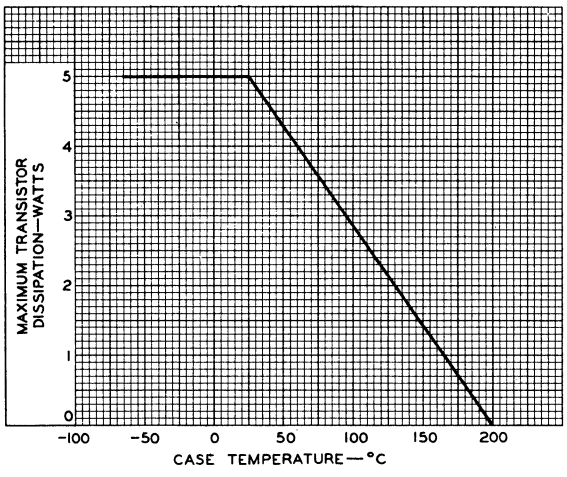


Fig. 1 - Rating Chart for Type 2N1700.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N1700-2N1702, 2N2338 6/66
Reprinted from 2N1700-2N1702, 2N2338 12/60

Typical Characteristics:

At a Case and/or Mounting-Flange Temperature of 25° C

	2N1700	2N1701	2N1702	2N2338	
Small-Signal Forward-Current Transfer Ratio: h_{fe} (I_C = 5 ma, V_{CE} = 4 volts).	40	-	-	-	
Collector-to-Base Capacitance: C_{ob} (V_{CB} = 40 volts)	150	175	200	400	pf
Thermal Time Constant: τ_1. .	10	10	12	30	msec
Alpha-Cutoff Frequency: $f_{\alpha b}$ (V_{CB} = 28 volts, I_C = 5 ma)	1.2	1	1	-	Mc
Small-Signal Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency: f_{hfe} (V_{CE} = 4 volts, I_C = 5 amp) . . .	-	-	-	20	Kc

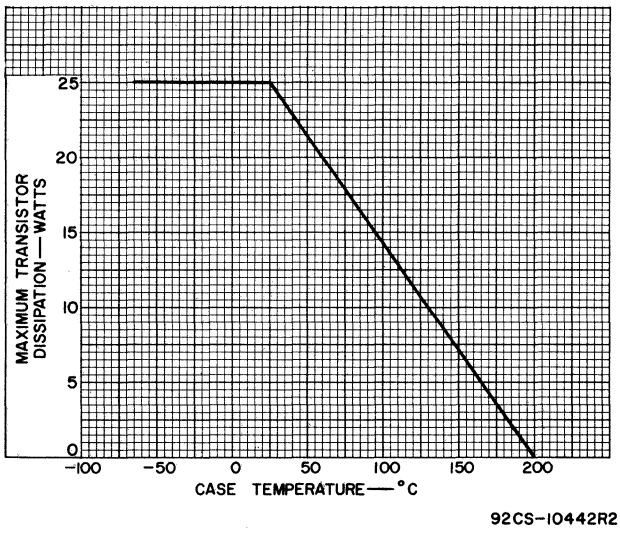


Fig. 2 - Rating Chart for Type 2N1701.

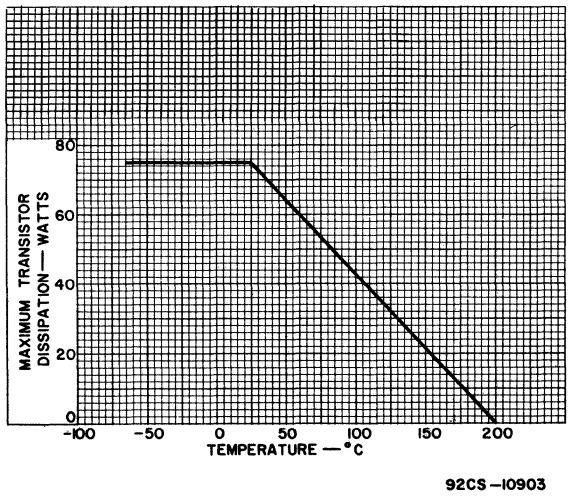


Fig. 3 - Rating Chart for Type 2N1702.

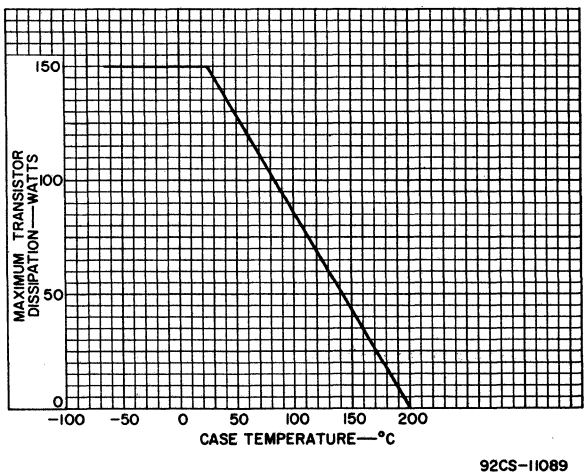


Fig. 4 - Rating Chart for Type 2N2338.

ELECTRICAL CHARACTERISTICS

At case or mounting-flange temperature of 25° C, unless otherwise specified.

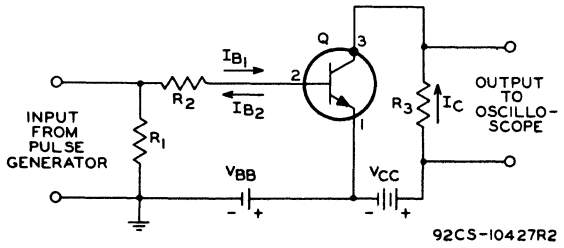
Characteristic	Symbol	TEST CONDITIONS					LIMITS								Units
		DC Collector-to-Base Voltage (V_{CB})	DC Collector-to-Emitter Voltage (V_{CE})	DC Emitter-to-Base Voltage (V_{EB})	DC Base Current (I_B)	DC Collector Current (I_C)	Type 2N1700		Type 2N1701		Type 2N1702		Type 2N2338		
		volts	volts	volts	ma	ma	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With I_E = 0 and at a temperature of;	I_{CBO}														
25° C		30						75		100		200		200	μa
150° C		30						1000		1500		2000		3000	μa
Emitter-Cutoff Current	I_{EBO}			6		0		25		50		100		100	μa
Collector-to-Emitter Voltage with reverse bias between emitter and base	V_{CEX}			1.5		0.5	60								volts
				1.5		0.75			60						volts
				1.5		1					60				volts
				1.5		2							60		volts
Collector-to-Emitter Sustaining Voltage with base open	$V_{CEO(sus)}$				0	50	40								volts
					0	100			40		40				volts
					0	200							40		volts
DC Forward-Current Transfer Ratio	h_{FE}		4			100	20	80							
			4			300			20	80					
			4			800					15	60			
			4			3000							15	60	
DC Collector-to-Emitter Saturation Resistance	R_S				10	100		10							ohms
					30	300				5					ohms
					80	800						4			ohms
					300	3000								0.5	ohm
Base-to-Emitter Voltage	V_{BE}		4			100		2							volts
			4			300				3					volts
			4			800						4			volts
			4			3000								3	volts
Thermal Resistance: Junction-to-case or mounting flange	θ_{J-C}							35		7		2.33		1.17	°C/w
Junction-to-free air	θ_{J-FA}							200		100					°C/w

Typical Operation of Type 2N1700 in the Power-Switching Circuit of Fig. 6:

At a Case Temperature of 25° C

Common-Emitter Circuit, Base Input

DC Collector Supply Voltage (V_{CC})	12	volts
DC Base Bias Voltage (V_{BB})	-8.5	volts
Generator Resistance	50	ohms
DC Collector Current ("On" condition)	200	ma
"Turn-On" Base Current (I_{B_1})	20	ma
"Turn-Off" Base Current (I_{B_2})	-8.5	ma
Switching Time:		
Delay time (t_d)	0.2	μsec
Rise time (t_r)	1	μsec
Storage time (t_s)	0.6	μsec
Fall time (t_f)	1	μsec



R_1 = 50 ohms, 1 watt
R_2 = 700 ohms, 1 watt
R_3 = 59 ohms, 2 watts
Q = Type 2N1700
V_{BB} = 8.5 volts
V_{CC} = 12 volts

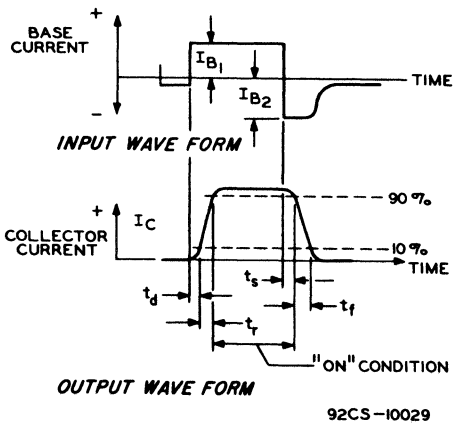


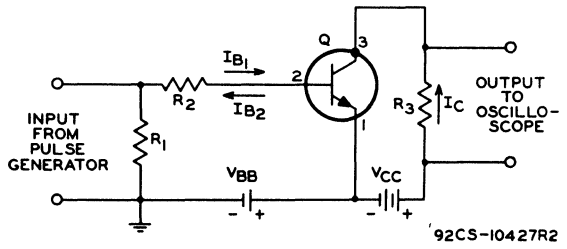
Fig. 5 - Typical Power-Switching Circuit for Type 2N1700.

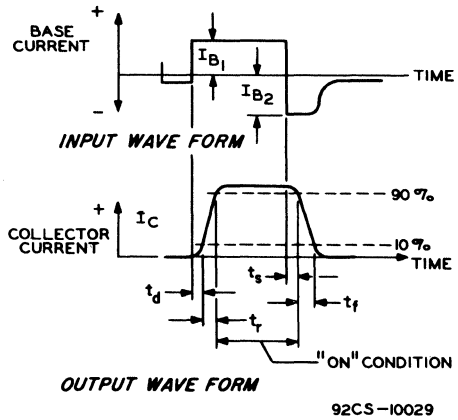
Typical Operation of Type 2N1701 in the Power-Switching Circuit of Fig. 6:

At a Case Temperature[C] of 25° C

Common-Emitter Circuit, Base Input

DC Collector Supply Voltage (V_{CC})	12	volts
DC Base Bias Voltage (V_{BB})	-8.5	volts
Generator Resistance	50	ohms
DC Collector Current ("On" condition)	750	ma
"Turn-On" Base Current (I_{B_1})	65	ma
"Turn-Off" Base Current (I_{B_2})	-35	ma
Switching Time:		
Delay time (t_d)	0.2	μsec
Rise time (t_r)	1	μsec
Storage time (t_s)	0.8	μsec
Fall time (t_f)	1.1	μsec





Q = Type 2N1701
V_{BB} = 8.5 volts
V_{CC} = 12 volts
R_1 = 50 ohms, 1 watt
R_2 = 220 ohms, 1 watt
R_3 = 15.9 ohms, 2 watts

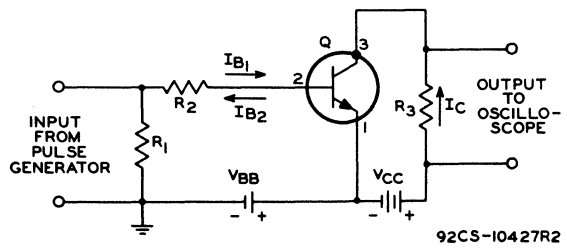
Fig. 6 - Typical Power-Switching Circuit for Type 2N1701.

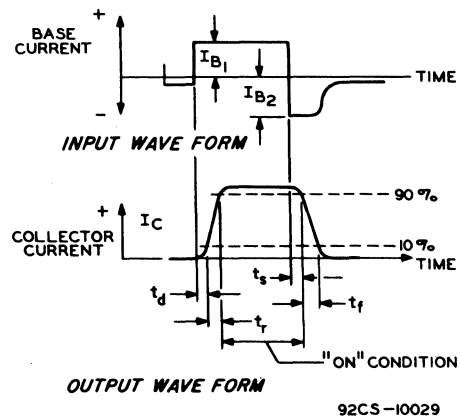
Typical Operation of Types 2N1702 and 2N1703 in the Power-Switching Circuit of Fig. 7:

At a Mounting-Flange and/or Case Temperature of 25° C

Common-Emitter Circuit, Base Input

DC Collector Supply Voltage (V_{CC})	12	volts
DC Base Bias Voltage (V_{BB})	-8.5	volts
Generator Resistance	50	ohms
DC Collector Current ("On" condition)	1.5	amp
"Turn-On" Base Current (I_{B_1})	300	ma
"Turn-Off" Base Current (I_{B_2})	-150	ma
Switching Time:		
Delay time (t_d)	0.2	μsec
Rise time (t_r)	1	μsec
Storage time (t_s)	1	μsec
Fall time (t_f)	1.2	μsec

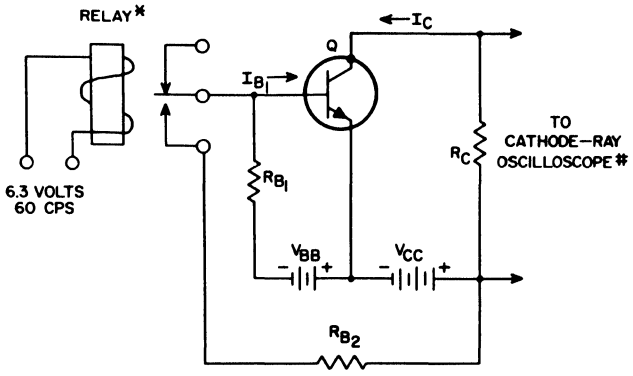




Q = Type 2N1702
V_{BB} = 8.5 volts
V_{CC} = 12 volts
R_1 = 50 ohms, 1 watt
R_2 = 30 ohms, 1 watt
R_3 = 7.8 ohms, 2 watts

[C] Measured at center of seating surface.

Fig. 7 - Typical Power-Switching Circuit for Type 2N1702.



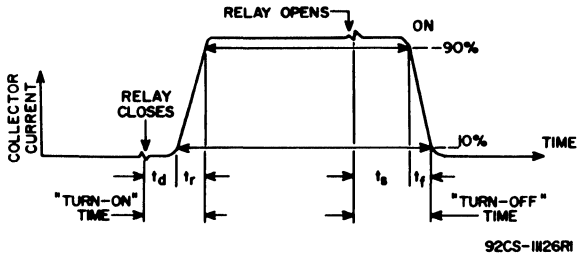
*C.P. CLARE TYPE HGP-1028 OR EQUIVALENT

#TEKTRONIX TYPE 545 OR EQUIVALENT

Q = Type 2N2338

92CS-11125RI

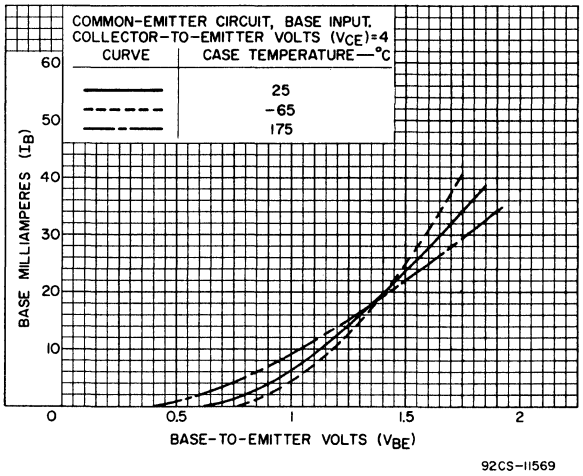
DC Collector Supply Voltage (V_{CC})	24	volts
DC Base Bias Voltage (V_{BB})	6	volts
DC Collector Current ("On" condition)	10	amp



92CS-11126RI

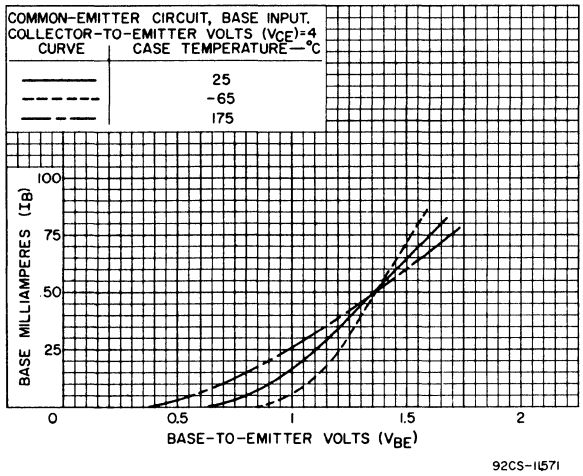
"Turn-On" Base Current (I_{B_1})	2	amp
Base Circuit Resistance (R_{B_1})	10	ohms
Base Circuit Resistance (R_{B_2})	10	ohms
Collector Circuit Resistance (R_C)	2	ohms
Switching Time:		
"On" Time		
[Delay time (t_d) + Rise time (t_r)]	4	μsec
"Off" Time		
[Storage time (t_s) + Fall time (t_f)]	7	μsec

Fig. 8 - Pulse-Response Test Circuit for Type 2N2338.



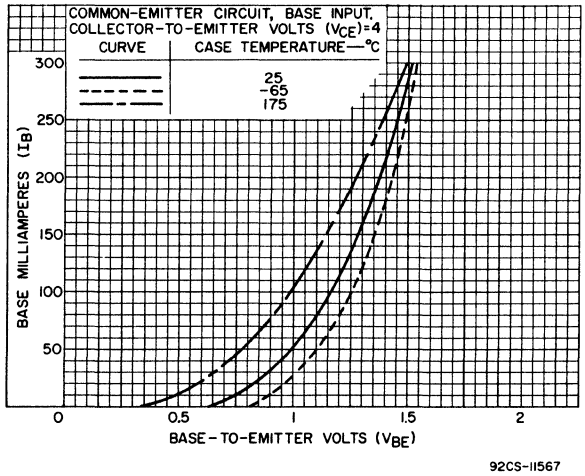
92CS-11569

Fig. 9 - Typical Input Characteristics for Type 2N1700.



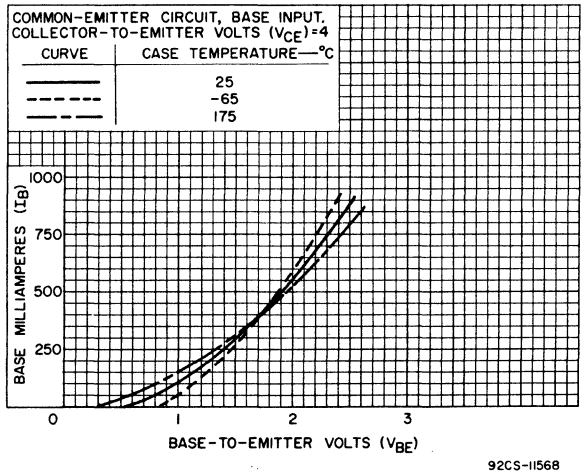
92CS-11571

Fig. 10 - Typical Input Characteristics for Type 2N1701.



92CS-11567

Fig. 11 - Typical Input Characteristics for Type 2N1702.



92CS-11568

Fig. 12 - Typical Input Characteristics for Type 2N2338.

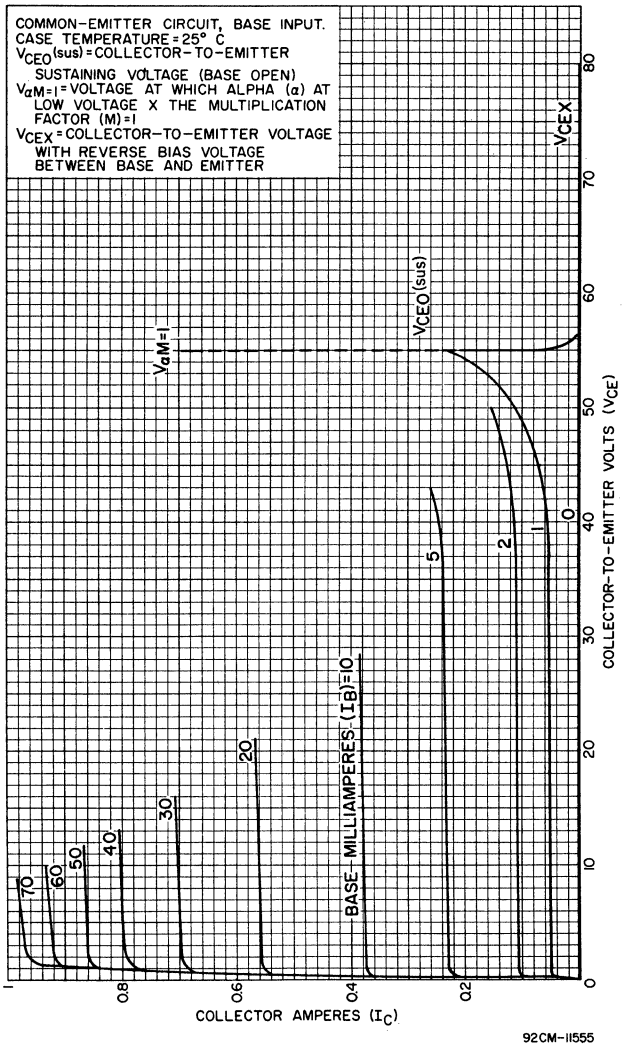


Fig. 13 - Typical Collector Characteristics for Type 2N1700.

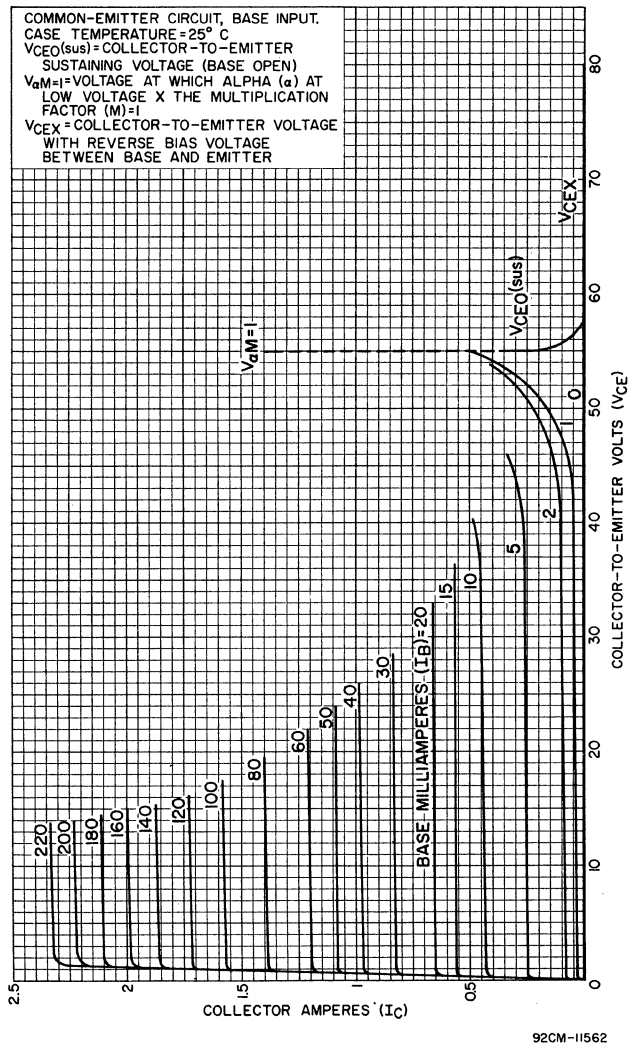


Fig. 14 - Typical Collector Characteristics for Type 2N1701.

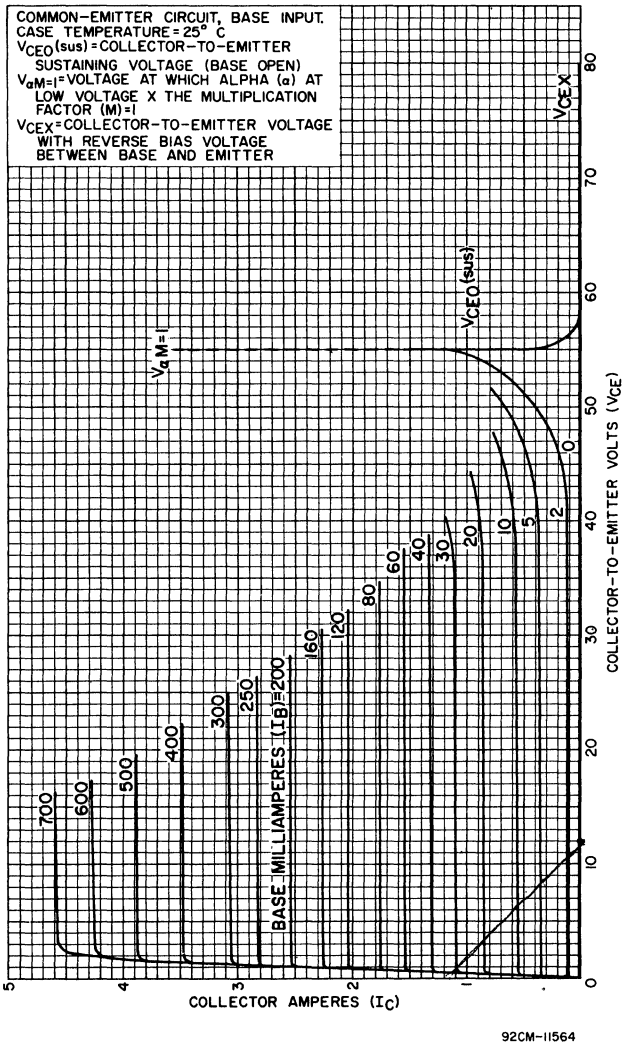


Fig. 15 - Typical Collector Characteristics for Type 2N1702.

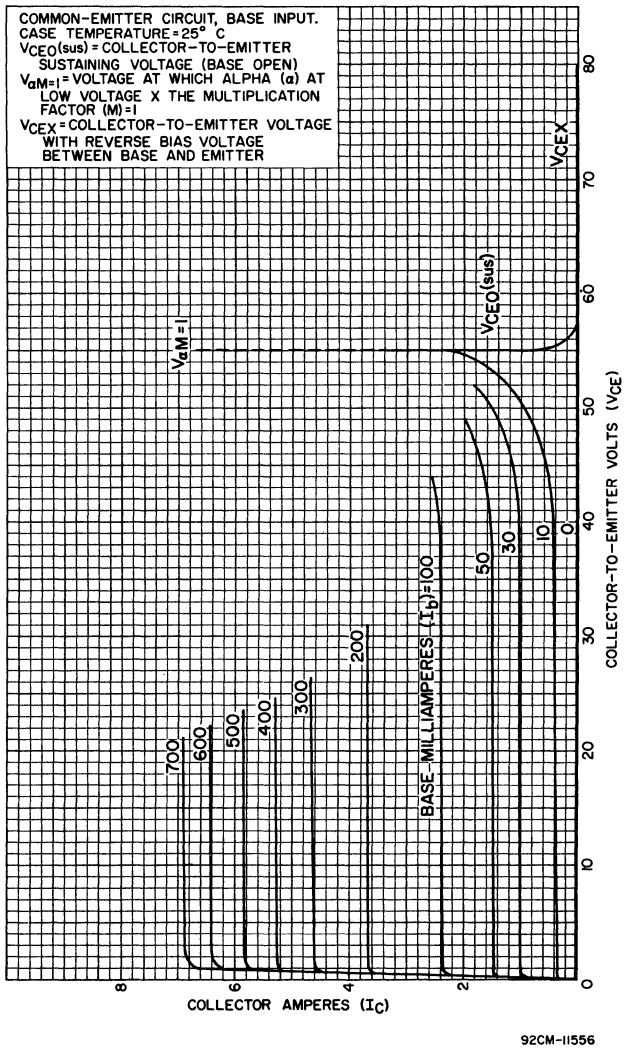


Fig. 16 - Typical Collector Characteristics for Type 2N2338.

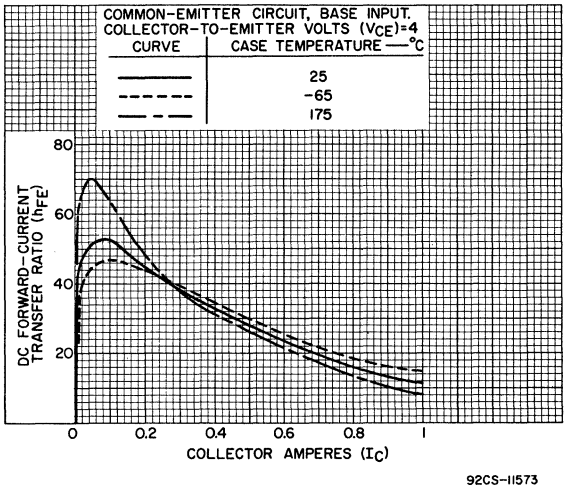


Fig. 17 - Typical Operation Characteristics for Type 2N1700.

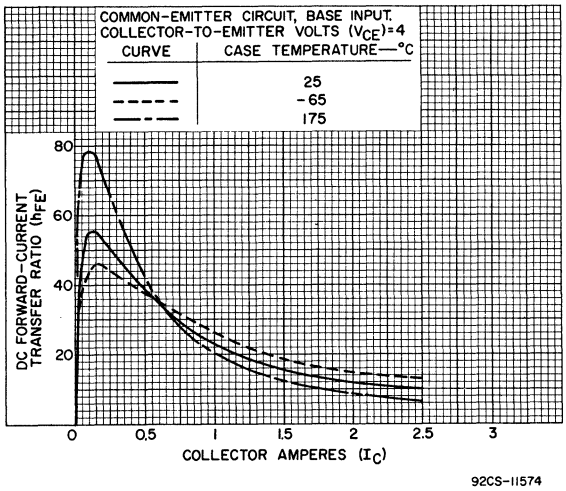


Fig. 18 - Typical Operation Characteristics for Type 2N1701.

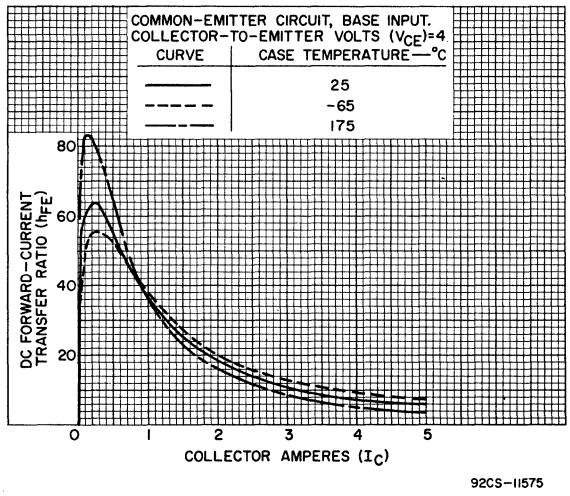


Fig. 19 - Typical Operation Characteristics for Type 2N1702.

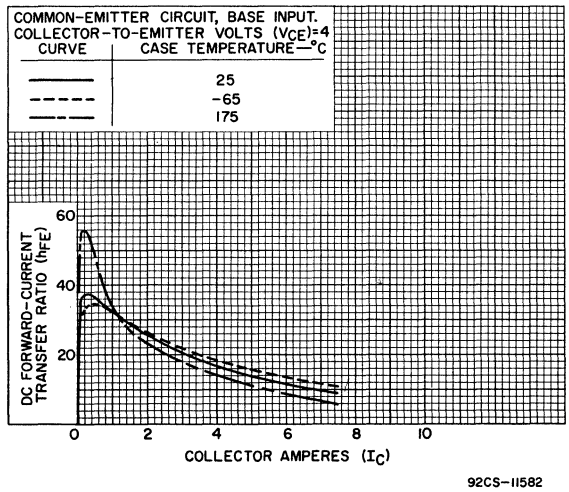


Fig. 20 - Typical Operation Characteristics for Type 2N2338.

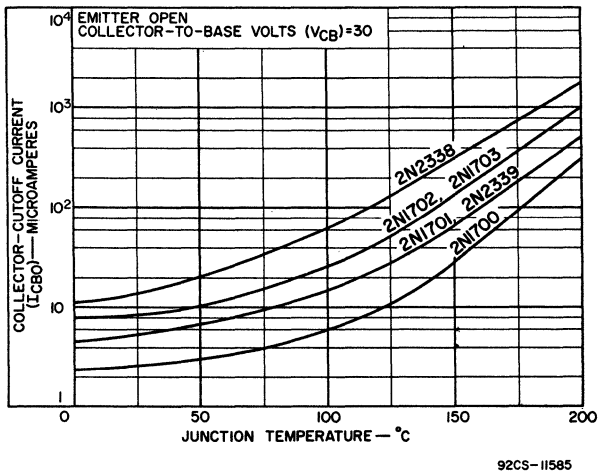
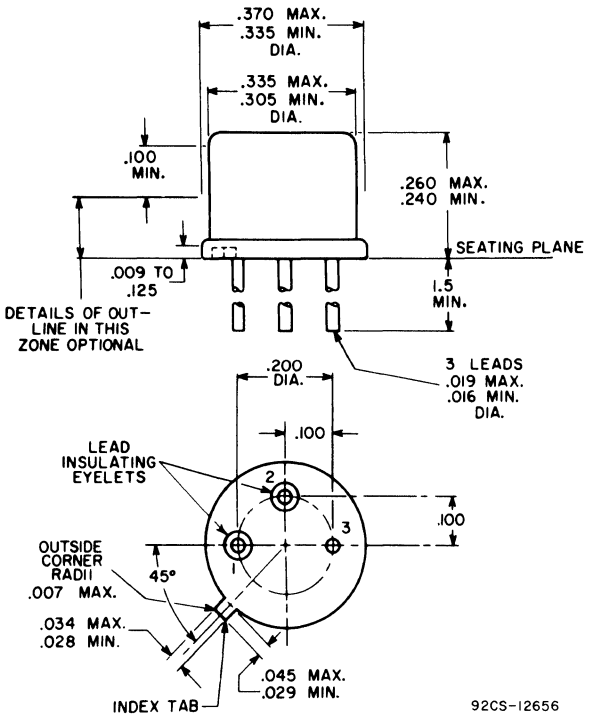
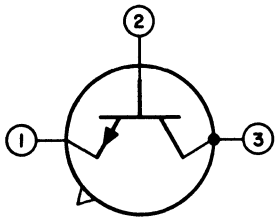


Fig. 21 - Typical Operation Characteristics for Types 2N1700, 2N1701, 2N1702 and 2N2338.

DIMENSIONAL OUTLINE
for Type 2N1700
JEDEC No. TO-5



TERMINAL DIAGRAM (Bottom View)
for Type 2N1700

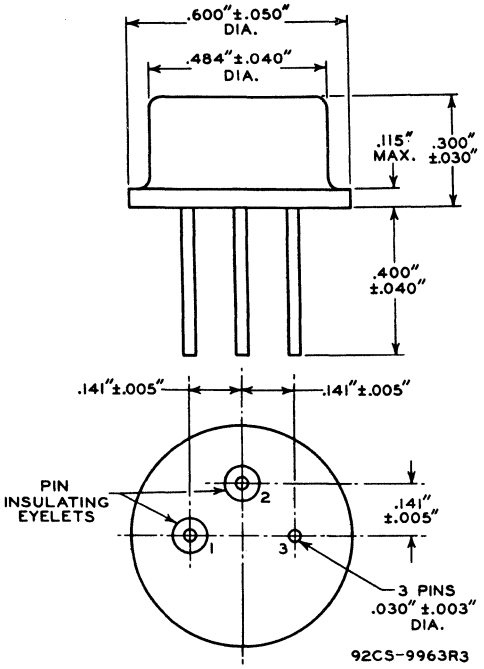


LEAD 1 – EMITTER LEAD 3 – COLLECTOR, CASE

LEAD 2 – BASE

DIMENSIONAL OUTLINE for Type 2N1701

JEDEC No. TO-8



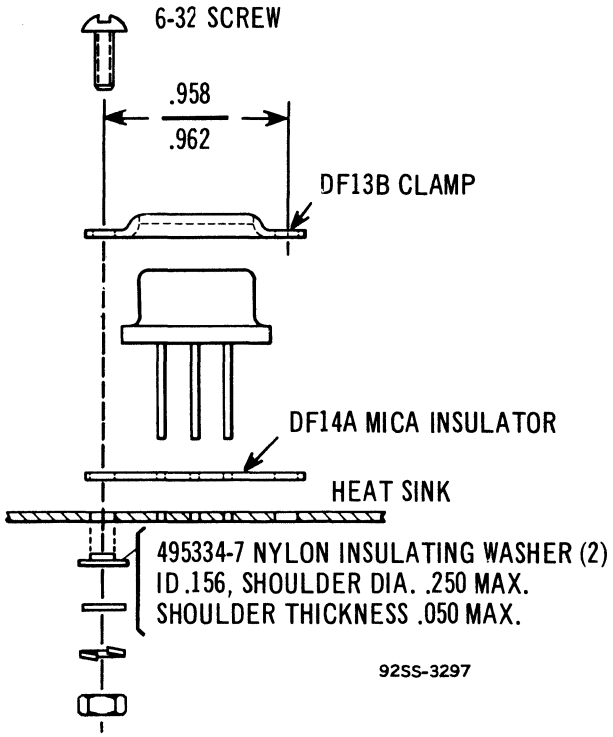
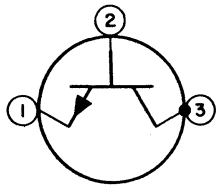


Fig. 22 - Suggested Mounting Arrangement for Type 2N1701.

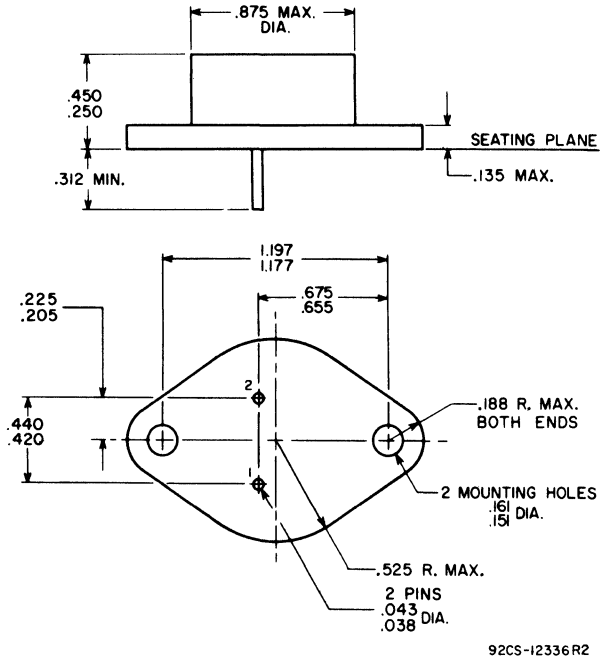
TERMINAL DIAGRAM (Bottom View) for Type 2N1701

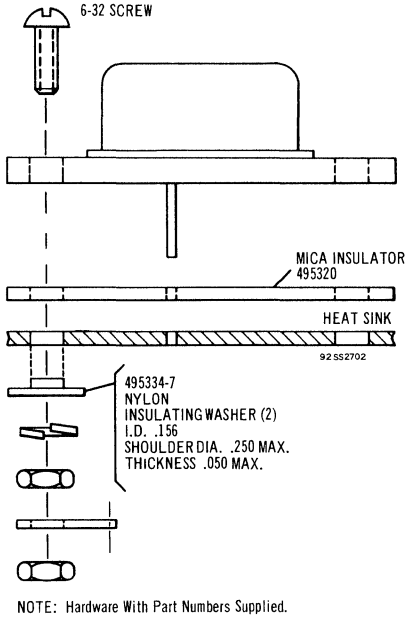


LEAD 1 – EMITTER LEAD 3 – COLLECTOR, CASE

LEAD 2 – BASE

DIMENSIONAL OUTLINE for Type 2N1702

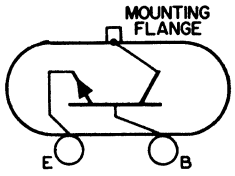




NOTE: Hardware With Part Numbers Supplied.

Fig. 23 - Suggested Mounting Arrangement for Type 2N1702.

TERMINAL DIAGRAM (Bottom View) for Type 2N1702

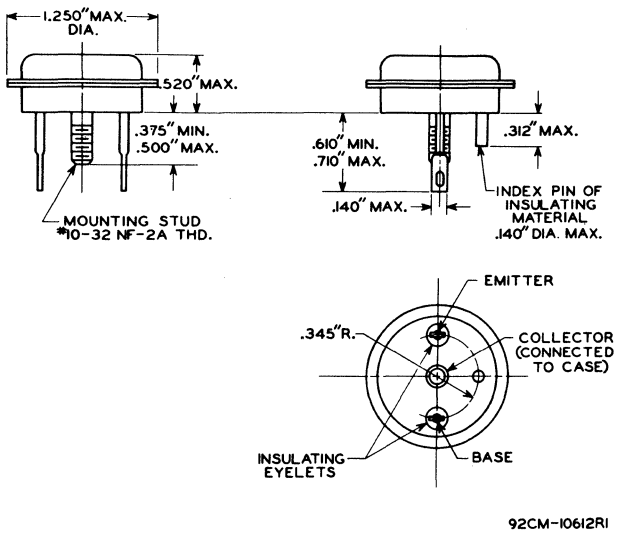


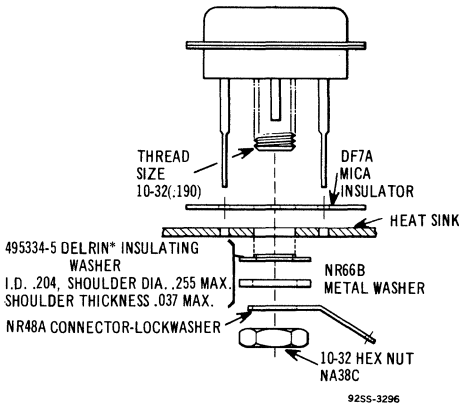
E – EMITTER

B – BASE

MOUNTING FLANGE – COLLECTOR, CASE

DIMENSIONAL OUTLINE
for Type 2N2338
JEDEC No. TO-36

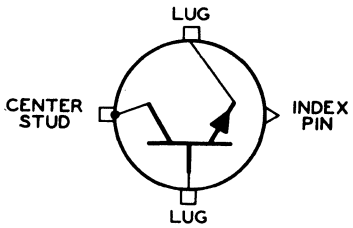




*REGISTERED TRADEMARK OF E.I. DUPONT DE NEMOURS & CO.

Fig. 24 - Suggested Mounting Arrangement for Type 2N2338.

TERMINAL DIAGRAM (Bottom View)
for Type 2N2338



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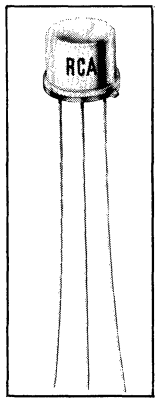
SILICON N-P-N PLANAR TRANSISTOR

2N1711

File No. 26

RCA-2N1711 is a triple-diffused-junction planar transistor of the silicon n-p-n type intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. It features exceptionally low noise and low leakage characteristics, high pulse beta (h_{FE}), high breakdown voltage ratings, low saturation voltages, high sustaining voltages, and low output capacitance.

For Small-Signal and Medium-Power Applications



JEDEC TO-5

- minimum gain-bandwidth product = 70 Mc, useful in applications from dc to 25 Mc
- operation at high junction temperatures—up to 200° C
- planar construction—insures low noise and low leakage characteristics
- low saturation voltages:
  $V_{CE}(sat)$ = 0.5 volt typical at I_C = 150 ma
  $V_{BE}(sat)$ = 1.1 volts typical at I_C = 150 ma
- low output capacitance

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	75 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER} With external $R_{BE} \leq$ 10 ohms	50 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	7 max.	volts
COLLECTOR CURRENT, I_C	1 max.	amp
TRANSISTOR DISSIPATION:		
At case temperatures up to 25° C.	3 max.	watts
above 25° C.	See *Fig. 1*	
At free-air temperatures up to 25° C.	0.8 max.	watt
above 25° C.	See *Fig. 1*	
TEMPERATURE RANGE:		
Storage	-65 to +300	°C
Operating (Junction)	-65 to +200	°C

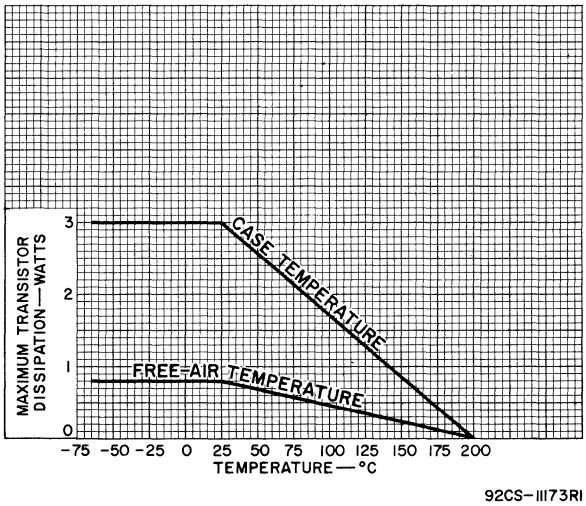


Fig. 1 - Rating Chart for Type 2N1711.

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Printed in U.S.A.
2N1711 6/66
Reprinted from 2N1711 4/62

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	TEST CONDITIONS								LIMITS		Units
		Case Temperature °C	Frequency kc	DC Collector-to-Base Voltage (volts)	DC Collector-to-Emitter Voltage (volts)	DC Emitter-to-Base Voltage (volts)	DC Collector Current (ma)	DC Emitter Current (ma)	DC Base Current (ma)	Min.	Max.	
				V_{CB}	V_{CE}	V_{EB}	I_C	I_E	I_B			
Collector-Cutoff Current	I_{CBO}	25 150		60 60				0 0		- -	0.01 10	μa μa
Emitter-Cutoff Current	I_{EBO}	25				5	0			-	0.005	μa
DC-Pulse Forward-Current Transfer Ratio [a]	h_{FE}	25 25 25			10 10 10		10 150 500			75 100 40	- 300 -	
DC Forward-Current Transfer Ratio	h_{FE}	25 25 -55			10 10 10		0.01 0.1 10			20 35 35	- - -	
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0.1	0		75	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.1		7	-	volts
Collector-to-Emitter Reach-Through Voltage	V_{RT}	25				1.5 [b]	0.1			75	-	volts
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance = 10 ohms	$V_{CER}(sus)$	25					100 (pulsed)			50	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25					150		15	-	1.5	volts
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25					150		15	-	1.3	volts
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25 25 25	1 1 20 Mc		5 10 10		1 5 50			50 70 3.5	200 300 -	
Noise Figure: Generator resistance (R_G) = 510 ohms, circuit bandwidth (BW) = 1 cycle	NF	25	1	10			0.3			-	8	db
Output Capacitance	C_{ob}	25		10				0		-	25	pf
Input Capacitance	C_{ib}	25				0.5	0			-	80	pf
Input Resistance	h_{ib}	25 25	1 1	5 10			1 5			24 4	34 8	ohms ohms
Voltage-Feedback Ratio	h_{rb}	25 25	1 1	5 10			1 5			- -	5×10^{-4} 5×10^{-4}	
Output Conductance	h_{ob}	25 25	1 1	5 10			1 5			0.1 0.1	0.5 1	μmho μmho
Thermal Resistance: Junction-to-case	θ_{J-C}	-								-	58.3	°C/watt
Junction-to-free air	θ_{J-FA}	-								-	219	°C/watt

[a] Pulse duration, 300 μsec; duty factor, 1.8%.

[b] V_{FBF} = Emitter-to-base floating potential.

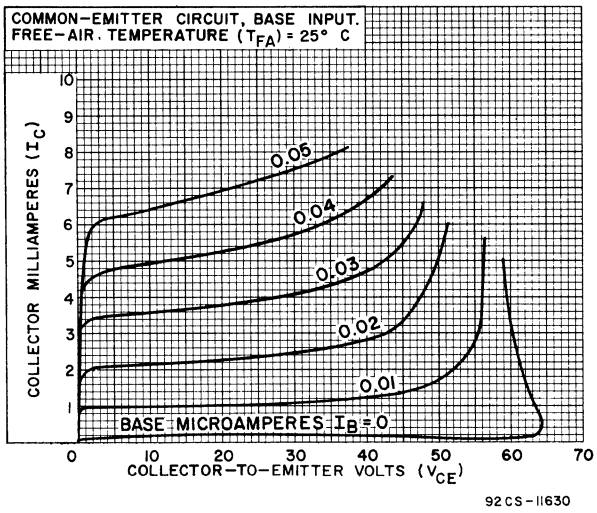


Fig. 2 - Typical Collector Characteristics at 25° C for Type 2N1711.

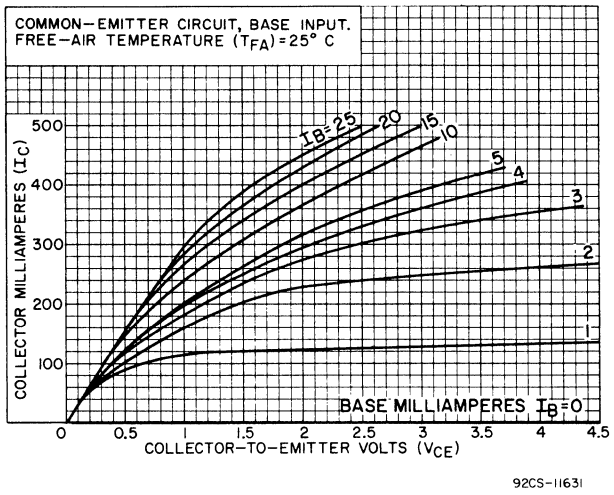


Fig. 5 - Typical Collector Characteristics at 25° C for Type 2N1711.

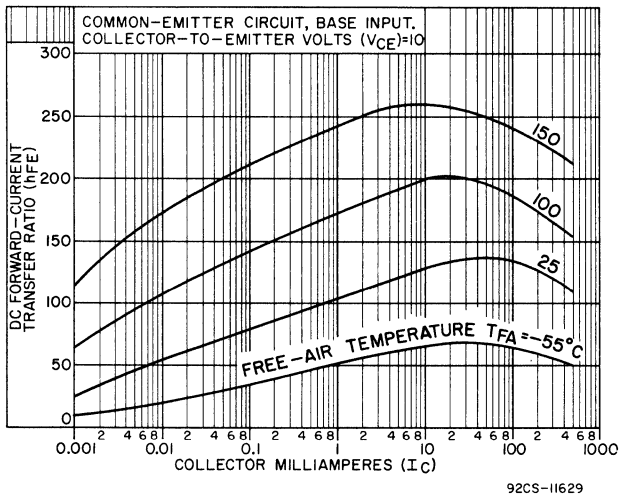


Fig. 3 - Typical DC - Forward - Current Transfer - Ratio Characteristics for Type 2N1711.

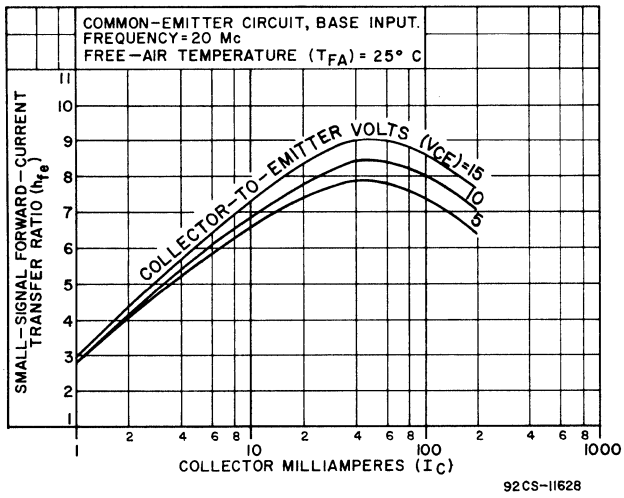


Fig. 6 - Typical Small - Signal Forward-Current Transfer - Ratio Characteristics for Type 2N1711.

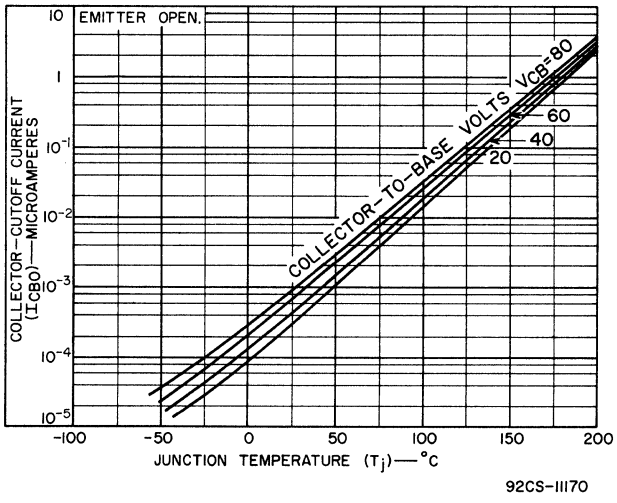


Fig. 4 - Typical Collector - Cutoff - Current Characteristics for Type 2N1711.

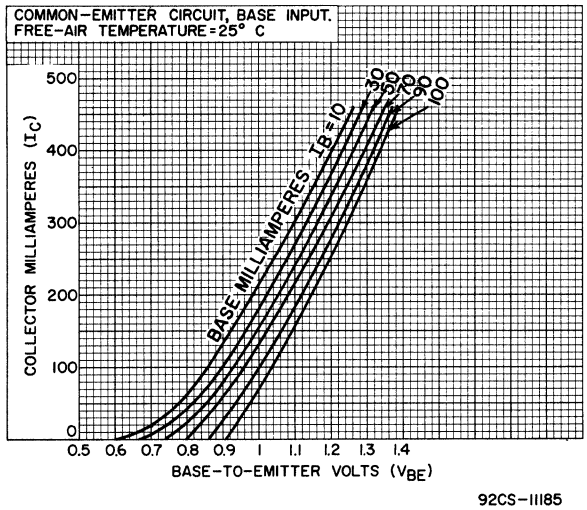


Fig. 7 - Typical Transfer Characteristics for Type 2N1711.

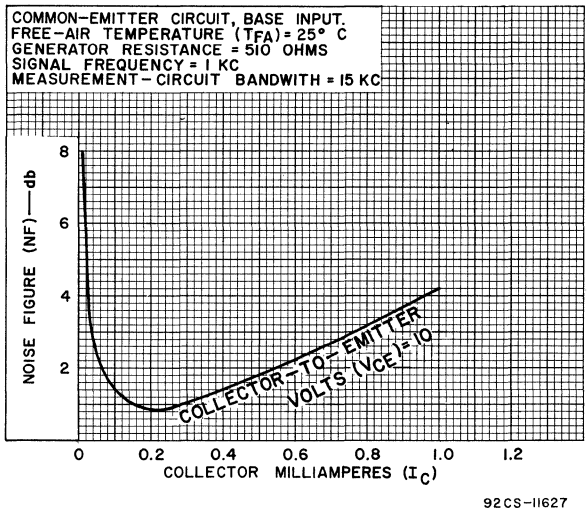
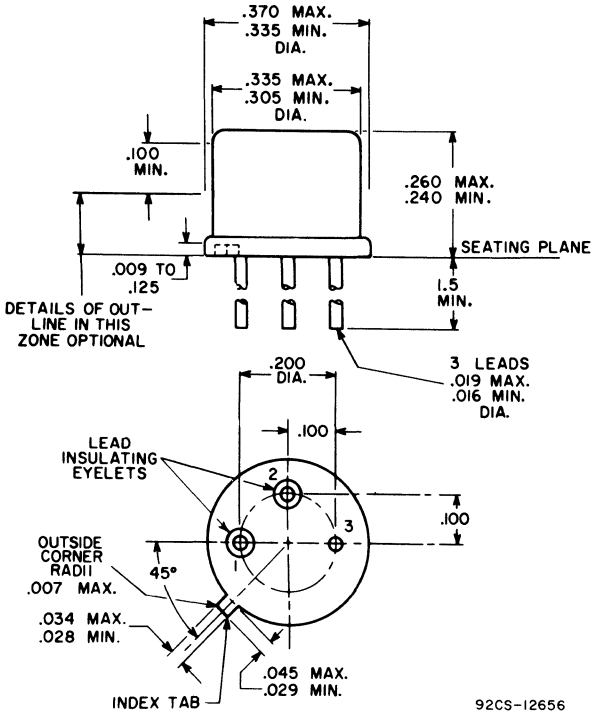
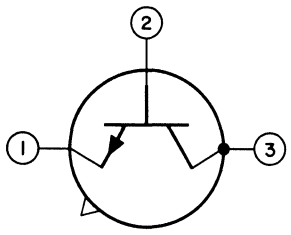


Fig. 8 - Typical AF-Noise-Figure Characteristic for Type 2N1711.

DIMENSIONAL OUTLINE
JEDEC No. TO-5



TERMINAL DIAGRAM



LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR, CASE

SILICON CONTROLLED-RECTIFIERS

2N1842A-2N1850A

File No. 28

RCA—2N1842A-2N1850A controlled-rectifiers are all-diffused, three-junction silicon devices for use in power-control and power-switching applications requiring blocking-voltage capabilities to 500 volts and forward-current capability of 10 amperes (average value) or 16 amperes (rms value).

All-Diffused Types for Power-Control and Power-Switching Applications

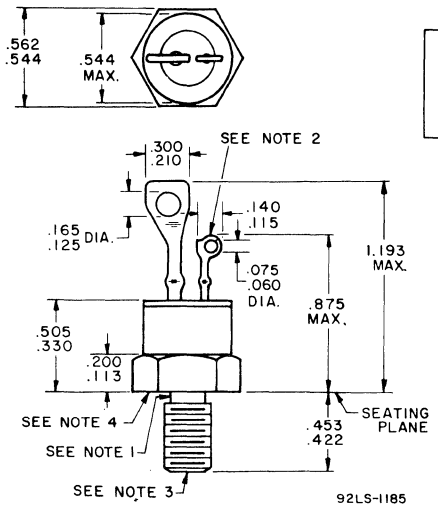


JEDEC TO-48

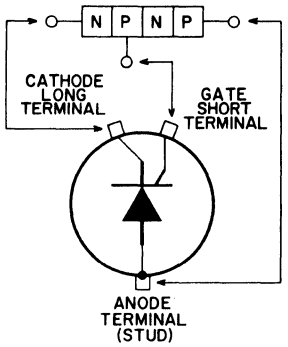
FEATURES—

- all-diffused construction—assures exceptional uniformity and stability of characteristics
- multi-diffusion process—permits precise control of individual junction parameters
- direct-soldered internal construction—assures exceptional resistance to fatigue
- shorted emitter gate-cathode construction
- each unit aged at maximum ratings to assure dependable performance
- symmetrical gate-cathode construction—provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- designed to meet stringent military environmental and mechanical specifications
- exceptionally rugged terminals
- hermetic seals
- low leakage currents, both forward and reverse
- welded construction
- low forward voltage drop at high current levels
- low thermal resistance
- exceptionally high stud-torque capability through use of high-strength copper-alloy stud

DIMENSIONAL OUTLINE
JEDEC TO-48



TERMINAL DIAGRAM



NOTE 1: COMPLETE THREADS TO EXTEND TO WITHIN 2 1/2 THREADS OF HEAD. DIA. OF UNTHREADED PORTION 0.249" MAXIMUM, 0.220" MINIMUM.

NOTE 2: ANGULAR ORIENTATION OF THESE TERMINALS IS UNDEFINED. SQUARE OR RADIUS ON END OF TERMINAL IS OPTIONAL.

NOTE 3: 1/4-28 UNF-2A. MAXIMUM PITCH DIA. OF PLATED THREADS SHALL BE BASIC PITCH DIA. 0.2268", MINIMUM PITCH DIA. 0.2225". REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.

NOTE 4: A CHAMFER (OR UNDERCUT) ON ONE OR BOTH ENDS OF HEXAGONAL PORTION IS OPTIONAL.

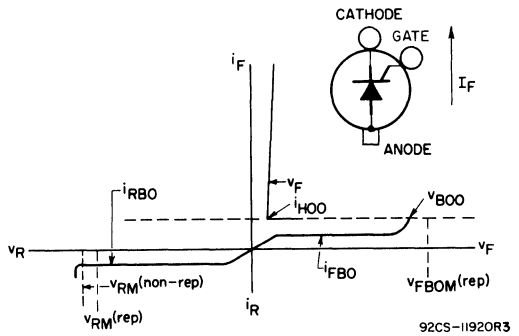
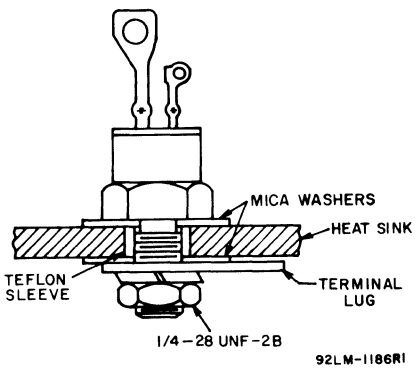


Fig. 1 - Typical E-I Characteristic of Silicon Controlled-Rectifier.



Suggested Mounting Arrangement for Insulating Types 2N1842A-2N1850A from Heat Sink. Components Shown (Except Heat Sink) are Furnished with Each Device.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N1842A-2N1850A 5/66
Reprinted from 2N1842A-2N1850A 4/63

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 cps, and with Resistive or Inductive Load

RATINGS	SYMBOLS	* REF.	CONTROLLED-RECTIFIER TYPE 2N1842A	2N1843A	2N1844A	2N1845A	2N1846A	2N1847A	2N1848A	2N1849A	2N1850A	UNITS
TRANSIENT PEAK REVERSE VOLTAGE (NON-REPETITIVE)	V_{RM} (non-rep)	1	35	75	150	225	300	350	400	500	600	volts
PEAK REVERSE VOLTAGE (REPETITIVE)	V_{RM} (rep)	2	25	50	100	150	200	250	300	400	500	volts
PEAK FORWARD BLOCKING VOLTAGE (REPETITIVE)	V_{FBOM} (rep)	3	← 600 →									volts
AVERAGE FORWARD CURRENT:	I_{FAV}	4										
For a case temperature# of +80° C and a conduction angle of 180°			← 10 →									amp
For other case temperatures and conduction angles			← See *Fig. 2* →									
PEAK SURGE CURRENT:	i_{FM}(surge)	5										
For one cycle of applied voltage			← 125 →									amp
For more than one cycle of applied voltage			← See *Fig. 3* →									
PEAK GATE POWER	P_{GM}	6	← 5 →									watts
AVERAGE GATE POWER	P_{GAV}	7	← 0.5 →									watt
PEAK FORWARD GATE CURRENT	i_{GKM}	8	← 2 →									amp
PEAK FORWARD GATE VOLTAGE:	V_{KGM}	9										
Forward			← 10 →									volts
Reverse			← 5 →									volts
TEMPERATURE:												
Storage	T_{stg}	-	← -65 to +125 →									°C
Operating (Case)#	T_C	-	← -65 to +125 →									°C
Operating (Free-air)	T_{FA}	-	← See *Fig. 4* →									

#Measured at the center of any of the six major faces on the perimeter of the hexagonal flange.

Electrical and Thermal Characteristics at Maximum Electrical Ratings (unless otherwise specified), and at Indicated Case Temperature, T_C

CHARACTERISTICS	SYMBOLS	* REF.	T_C °C	CONTROLLED-RECTIFIER TYPE 2N1842A	2N1843A	2N1844A	2N1845A	2N1846A	2N1847A	2N1848A	2N1849A	2N1850A	UNITS
Minimum Forward Breakover Voltage	V_{BOO}	10	+125	25	50	100	150	200	250	300	400	500	volts
Maximum Average Forward Blocking Current	I_{FBOAV}	11	+125	22.5	19	12.5	6.5	6	5.5	5	4	3	ma
Maximum Average Reverse Blocking Current	I_{RBOAV}	12	+125	22.5	19	12.5	6.5	6	5.5	5	4	3	ma
Maximum Average Forward Voltage Drop	V_{FAV}	13	+80	← 1.2 →									volts
Maximum DC Gate Trigger Current	I_{GT}	14	+125	← 45 →									ma
DC Gate-Trigger Voltage:	V_{GT}	15											
Maximum			-40	← 3.5 →									volts
			-65	← 3.7 →									volts
Minimum			+125	← 0.25 →									volt
			+100	← 0.3 →									volt
Holding Current (Typical)	i_{HOO}	16	+125	← 8 →									ma
Maximum Thermal Resistance, Junction-to-Case	θ_{JC}	17	-	← 2 →									°C/watt

* Numerical References are to Table of Terms, Symbols, and Definitions on page 4.

Measured at the center of any of the six major faces on the perimeter of the hexagonal flange.

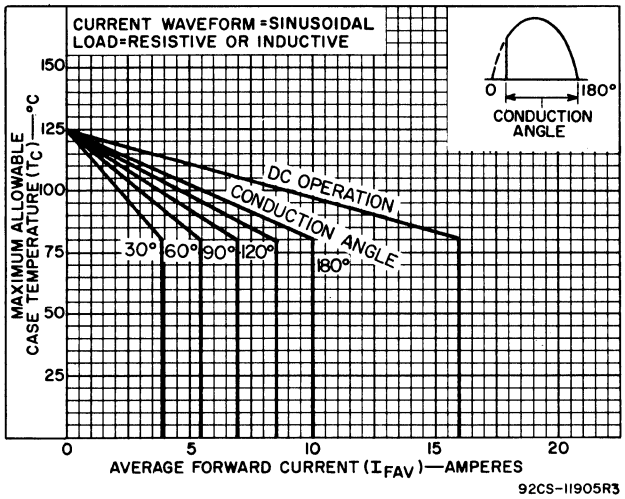


Fig. 2 - Rating Chart for Types 2N1842A through 2N1850A.

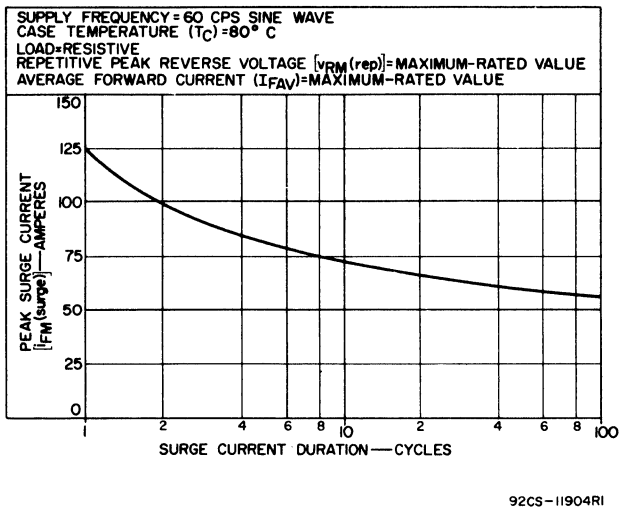


Fig. 3 - Surge Current Rating Chart for Types 2N1842A through 2N1850A.

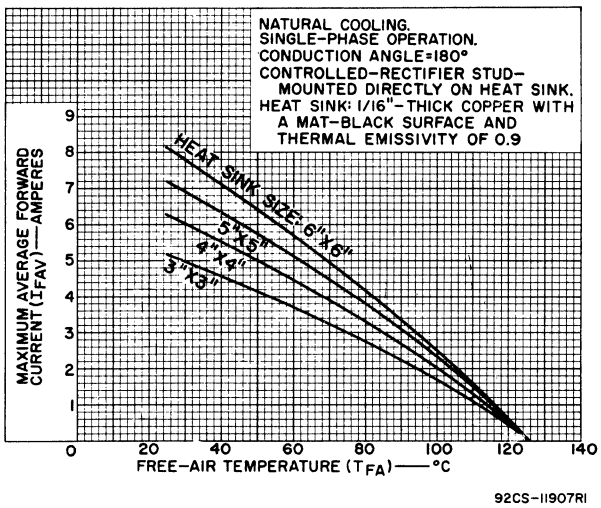


Fig. 4 - Operation Guidance Chart for Types 2N1842A through 2N1850A.

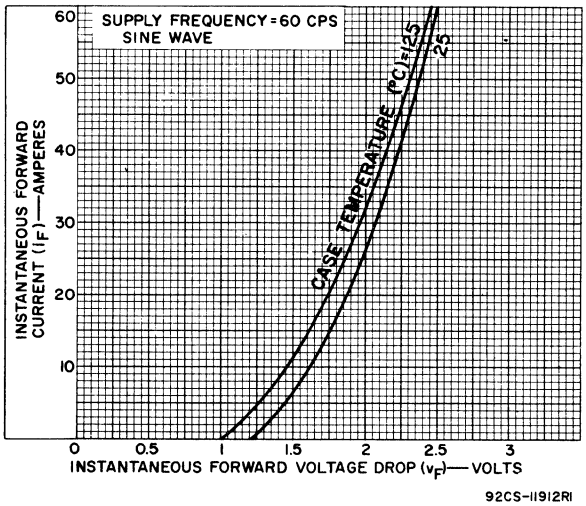


Fig. 5 - Maximum Forward Characteristics for Types 2N1842A through 2N1850A.

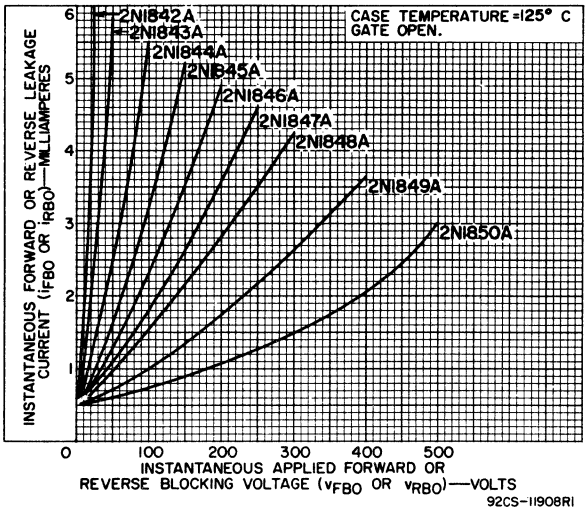


Fig. 6 - Typical Forward and Reverse Leakage Characteristics for Types 2N1842A through 2N1850A.

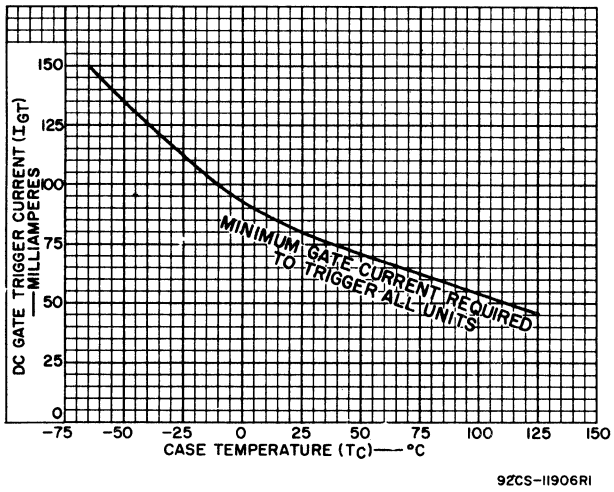


Fig. 7 - Gate Trigger-Current Characteristic for Types 2N1842A through 2N1850A.

CONTROLLED-RECTIFIER TERMS, SYMBOLS, AND DEFINITIONS (as used in this bulletin)

1. **Transient Peak Reverse Voltage (Non-repetitive)** - v_{RM}(non-rep) - The maximum value of negative (reverse-blocking) voltage which may be applied to the anode for not more than 5 milliseconds when the gate is open.
2. **Peak Reverse Voltage (Repetitive)** - $v_{RM(rep)}$ - The maximum instantaneous value of negative (reverse-blocking) voltage which may be applied repetitively to the anode when the gate is open.
3. **Peak Forward Blocking Voltage** - $v_{FBOM(rep)}$ - The maximum instantaneous value of positive (forward-blocking) voltage which may be applied repetitively to the anode when the gate is open.
4. **Average Forward Current** - I_{FAV} - The average (dc) value of the current flowing from anode to cathode in the device.
5. **Peak Surge Current** - $i_{FM(surge)}$ - The maximum instantaneous value of forward current which may be superimposed on the average forward current during one forward half-cycle when the device is operating within its specified maximum voltage, average-forward-current, gate-power, and temperature ratings in a single-phase circuit with 60-cps supply and resistive load. The peak surge current may be repeated after sufficient time has elapsed for the device to return to pre-surge thermal equilibrium conditions.
6. **Peak Gate Power** - p_{GM} - The maximum instantaneous power dissipated between gate and cathode.
7. **Average Gate Power** - P_{GAV} - The average power dissipated between gate and cathode.
8. **Peak Forward Gate Current** - i_{GKM} - The maximum instantaneous value of the current which may flow between gate and cathode.
9. **Peak Gate Voltage** - v_{GKM} or v_{KGM} - The maximum instantaneous value of voltage which may be applied between gate and cathode when the anode is open.
10. **Forward Breakover Voltage** - v_{BO} - The value of positive anode voltage at which a controlled rectifier switches into the conducting state when the gate is open.
11. **Maximum Average Forward Blocking Current** - I_{FBOAV} - The maximum full-cycle average value of forward blocking current through a controlled rectifier when the gate is open.
12. **Maximum Average Reverse Blocking Current** - I_{RBOAV} - The maximum full-cycle average value of reverse blocking current through a controlled rectifier when the gate is open.
13. **Maximum Average Forward Voltage Drop** - V_{FAV} - The average value over one complete cycle of the forward voltage drop across a controlled rectifier operating at its maximum-average-forward-current rating in a single-phase circuit with 60-cps supply and resistive load.
14. **Maximum DC Gate Current** - I_{GT} - The gate current required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.
15. **Gate-Trigger Voltage** - V_{GT} - The gate-to-cathode voltage required to trigger a controlled-rectifier at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.
16. **Holding Current** - i_{HOO} - The instantaneous value of forward current i_F below which a controlled rectifier with its gate open returns to its forward blocking state.
17. **Thermal Resistance, Junction-to-case** - θ_{JC} - The thermal resistance in °C per watt, between the junction and any of the six major surfaces on the perimeter of the hexagonal flange.
18. **Instantaneous Forward Current** - i_F - The instantaneous value of the current flowing from anode to cathode in the device.
19. **Instantaneous Forward Voltage Drop** - v_F - The instantaneous voltage drop across a controlled rectifier at a given instantaneous forward current i_F.
20. **Instantaneous Forward Blocking Voltage** - v_{FBOM} - Instantaneous forward blocking voltage of a controlled rectifier when the gate is open.
21. **Instantaneous Reverse Blocking Voltage** - v_{RBOM} - Instantaneous reverse blocking voltage of a controlled rectifier when the gate is open.
22. **Instantaneous Reverse Leakage Current** - i_{RBO} - Instantaneous reverse leakage current with the gate open.
23. **Instantaneous Forward Leakage Current** - i_{FBO} - Instantaneous forward leakage current with the gate open.

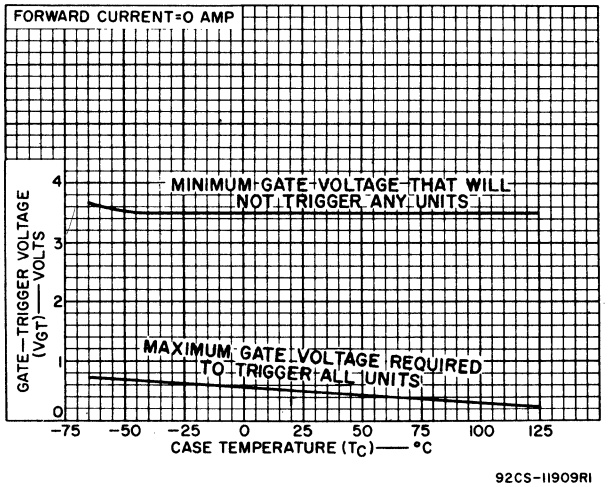


Fig. 8 - Gate Trigger-Voltage Characteristics for Types 2N1842A through 2N1850A.

OPERATING CONSIDERATIONS

Because these controlled rectifiers may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent personnel from coming in contact with the rectifier.

The recommended torque is 26 to 36 inch-pounds applied to 1/4-28 UNF-2B hex nut assembled on thread.

The applied torque during installation should not exceed 50 inch-pounds.

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HIGH-SPEED P-N-P MESA TRANSISTORS

FOR SWITCHING SERVICE IN ELECTRONIC DATA-PROCESSING SYSTEMS



JEDEC TO-5

RCA-2N1853 and 2N1854 are germanium p-n-p diffused-junction Mesa transistors specifically designed for high-speed saturated-switching applications in military and commercial data-processing equipment.

The 2N1853 and 2N1854 feature high switching speeds, high minimum beta (h_{FE}), and high steady-state and transient dissipation capabilities. They utilize the JEDEC TO-5 transistor package, and are very ruggedly constructed to assure dependable performance in critical military and industrial applications involving severe environmental and mechanical conditions.

- **Military versions available:**

  USN 2N1853 designed to meet MIL-S-19500/171A (Navy) dated Oct. 13, 1961

  USN 2N1854 designed to meet MIL-S-19500/172A (Navy) dated Oct. 18, 1961

- high transient dissipation capability
- high steady-state dissipation capability
- high gain-bandwidth product
- high minimum beta
- low total stored charge in saturating circuits
- operating at pulse-repetition rates up to 10 Mc

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N1853	2N1854		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-18	-18	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-6	-6	max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-2▲	-2▲	max.	volts
COLLECTOR CURRENT, I_C	-100	-100	max.	ma
TRANSISTOR DISSIPATION:				
At free-air temperatures up to 25° C.	150♦	150♦	max.	mw
At free-air temperatures above 25° C.	See *Fig. 1*			
EMITTER-TO-BASE DISSIPATION UNDER BREAKDOWN CONDITIONS WITH REVERSE BIAS:				
At free-air temperatures up to 25° C.	25	25	max.	mw
At free-air temperatures above 25° C.	See *Fig. 1*			
FREE-AIR TEMPERATURE RANGE:				
Storage & operating	-55 to +85			°C
LEAD TEMPERATURE:				
1/16" ± 1/32" from seating surface for 10 seconds max	235	235	max.	°C

▲ This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter-to-base dissipation is limited to 25 milliwatts at 25° C. For free-air temperatures above 25° C, reduce the dissipation as shown in Fig. 1.

♦ For higher dissipation values in switching applications under transient operating conditions, the maximum dissipation can be computed by utilization of the method described in RCA Application Note "Transistor Dissipation Ratings for Pulse and Switching Service" (AN-181).

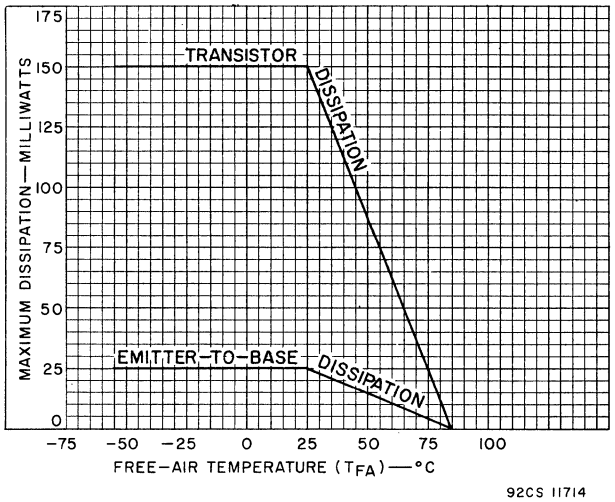


Fig. 1 - Rating Chart for Types 2N1853 and 2N1854.

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N1853, 2N1854 6-66
Reprinted from Issue dated 6-62

ELECTRICAL CHARACTERISTICS

At a free-air temperature, T_{FA} of 25° C, unless otherwise specified

Characteristics	Symbols	TEST CONDITIONS						LIMITS				Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N1853		Type 2N1854		
		Volts	Volts	Volts	Ma	Ma	Ma	Min.	Max.	Min.	Max.	
Collector-Cutoff Current:	I_{CBO}											
At T_{FA} = 25° C		-15				0		-	-4.2	-	-4.2	μa
At T_{FA} = 60° C		-18				0		-	-35	-	-	μa
At T_{FA} = 65° C		-15				0		-	-	-	-40	μa
Emitter-Cutoff Current	I_{EBO}			-2	0			-	-100	-	-100	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				-0.025	0		-18	-	-18	-	volts
Collector-to-Emitter Breakdown Voltage:	BV_{CEV}											
With reverse bias between base and emitter				-0.15	-0.025			-18	-	-	-	volts
				-0.2	-0.025			-	-	-18	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0	-0.1		-2	-	-2	-	volts
Collector-to-Emitter Latching Voltage (See Fig.2 for measurement circuit)	V_{CERL}		V_{CC} = -18 volts	R_{BE} = 1000 ohms	R_L = 178 ohms			-	-	-17	-	volts
Base-to-Emitter Voltage	V_{BE}				-6		-0.2	-	-0.4	-	-	volt
					-20		-0.5	-	-	-	-0.8	volt
Collector-to-Emitter Saturation Voltage:	$V_{CE(sat)}$											
At T_{FA} = 25° C					-6		-0.2	-	-0.2	-	-	volt
At T_{FA} = 25° C					-20		-0.66	-	-	-	-0.25	volt
At T_{FA} = 25° C					-20		-0.5	-	-	-	-0.3	volt
At T_{FA} = 55° C					-80		-2.7	-	-	-	-0.7	volt
DC Forward-Current Transfer Ratio	h_{FE}		-1				-0.2	30	400	-	-	
			-0.4		-6			30	-	-	-	
			-0.5		-20			-	-	40	-	
			-0.75		-100			-	-	25	-	
			-1		-50			-	-	-	400	
Turn-On Time (See Fig.3 for measurement circuit)	t_{on}							-	0.8	-	-	μsec
Turn-Off Time (See Fig.4 for measurement circuit)	t_{off}							-	0.9	-	-	μsec
Storage Time (See Fig.4 for measurement circuit)	t_s							-	0.8	-	-	μsec
Charge Storage Time (See Fig.5 for measurement circuit)	t_{Qs}				-20		I_{B1} = -1.5 ma	-	-	-	60	nsec
					-80		I_{B1} = -4.5 ma	-	-	-	80	nsec
Gain-Bandwidth Product (h_{fe} = 5)	f_T		-1		-10			-	-	40	-	Mc
Output Capacitance (measured at f = 140 kc)	C_{ob}	-10				0		-	-	-	12	pf

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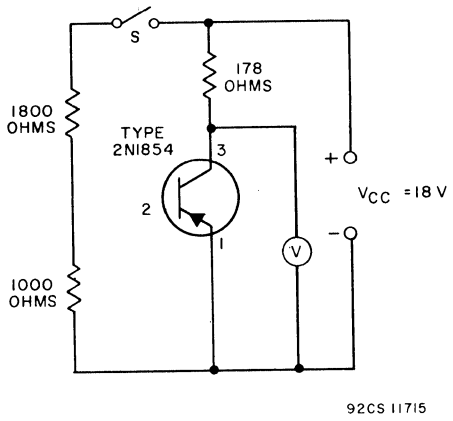
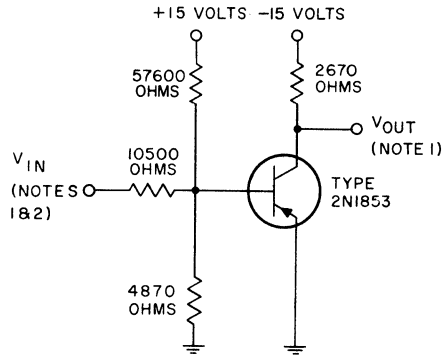
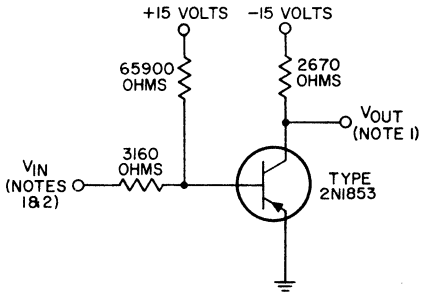


Fig. 2 - Test Circuit for Collector-to-Emitter Latching Voltage, V_{CERL}. The transistor is inserted in the test circuit with Switch S open. The switch is then closed and immediately reopened. The resulting Collector-to-Emitter voltage is the "Latching" voltage, V_{CERL}.



NOTE 1: INPUT AND OUTPUT WAVEFORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANOSECONDS, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

NOTE 2: INPUT VOLTAGE (V_{IN}) OBTAINED FROM A MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 100 OHMS.



NOTE 1: INPUT AND OUTPUT WAVEFORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANOSECONDS, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

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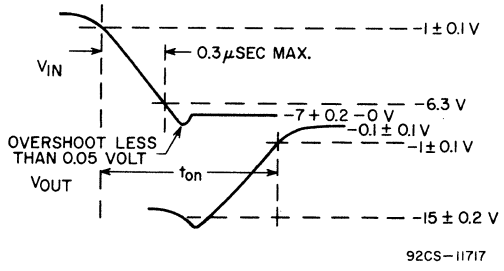


Fig. 3 - Circuit Used to Measure Turn-On Time (t_{on}) for Type 2N1853.

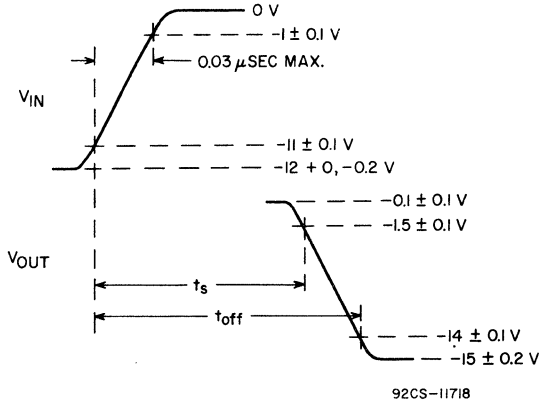
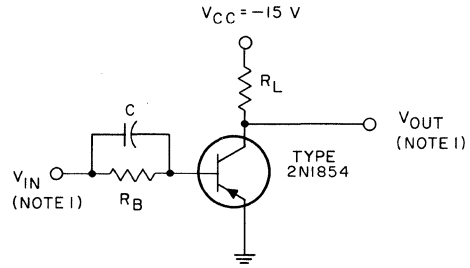


Fig. 4 - Circuit Used to Measure Storage Time (t_s) and Turn-Off Time (t_{off}) for Type 2N1853.



TEST CONDITIONS

I_C (ma)	I_{B_1} (ma)	R_B (ohms)	C (pf)	R_L (ohms)
−20	−1.5	3300	150	750
−80	−4.5	1100	510	189

NOTE 1: INPUT AND OUTPUT WAVEFORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANOSECONDS, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

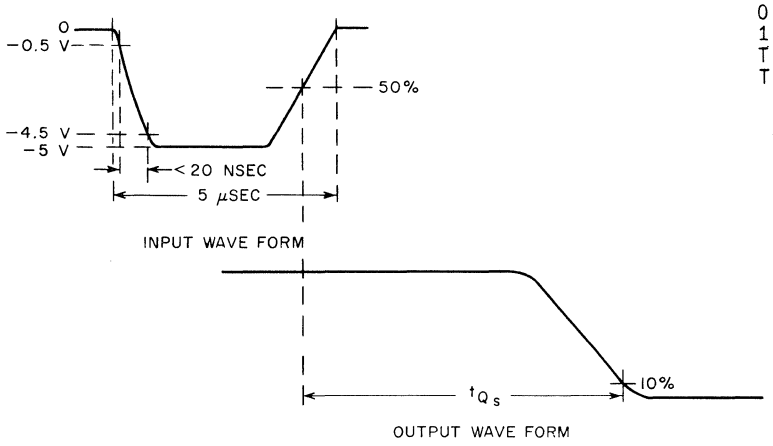
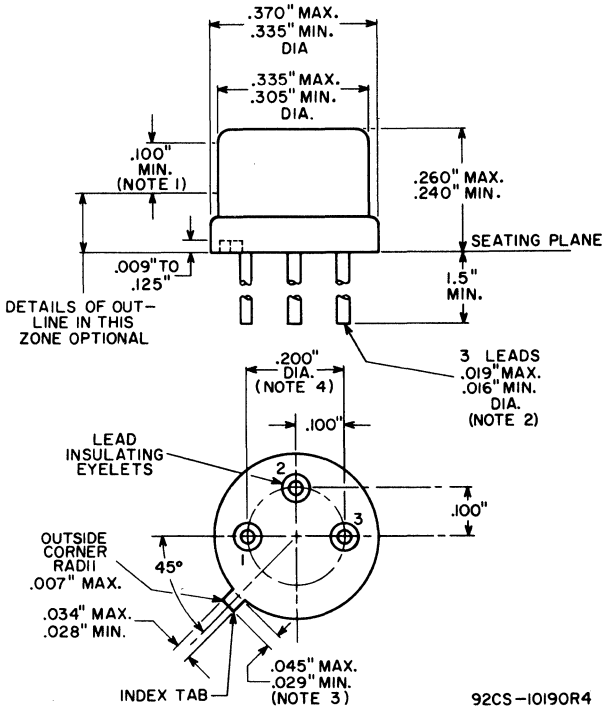


Fig. 5 - Test Circuit for Charge Storage Time, t_{Q_s}.

DIMENSIONAL OUTLINE FOR TYPES 2N1853 and 2N1854

JEDEC No. TO-5



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

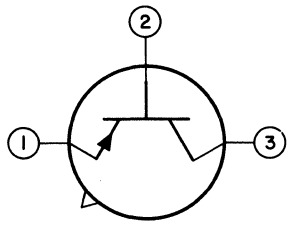
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5" A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE 0.054" + 0.001" − 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHSLL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

TERMINAL DIAGRAM
(Bottom View)

Lead 2 – Base

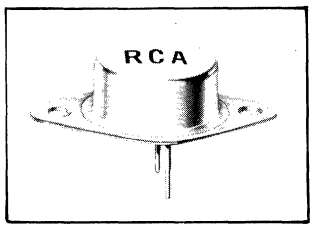


Lead 1 – Emitter

Lead 3 – Collector

GERMANIUM P-N-P DRIFT-FIELD POWER TRANSISTORS

For Industrial and Commercial Applications



JEDEC TO-3

RCA-2N1905 and 2N1906 are diffused-collector graded-base power transistors of the germanium p-n-p type intended for a wide variety of applications in industrial and consumer-type equipment. These transistors utilize a combination of diffusion and alloying techniques to provide a built-in accelerating field in the base region. This accelerating field makes possible a wide frequency response and a linearity of characteristics over the entire collector-current range not available in conventional power transistors. RCA-2N1905 and 2N1906 are particularly useful as high-power, high-speed switches in dc-to-dc converters, inverters, and computers for data-processing equipment, as ultrasonic oscillators, and as large-signal, wide-band linear amplifiers.

The 2N1906 differs from the 2N1905 in having a higher collector-to-base-voltage rating, controlled switching characteristics, and controlled saturation voltage and beta at high current levels.

FEATURES

- 30-watt dissipation at T_{MF} = 55°C
- high min. beta: 50 for 2N1905; 75 for 2N1906
- extremely short rise and fall times at high values of I_C – less than 1 μs
- high typical gain-bandwidth product –
  2N1905, f_T = 4 MHz
  2N1906, f_T = 5 MHz
- low base resistance for high power sensitivity
- linear current-transfer characteristic (h_{FE}) over wide collector-current range

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N1905	2N1906	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-100	-130	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-50	-60	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-1.5*	-1.5*	V
COLLECTOR CURRENT, I_C	-6	-6	A
BASE CURRENT, I_B	-1	-1	A
TRANSISTOR DISSIPATION, P_T:			
For Mounting-Flange Temperatures▲ up to 55°C	30	30	W
For other Mounting Flange Temperatures▲	See Rating Chart (Fig.1)		
TEMPERATURE RANGE:			
Storage	-65 to +100		°C
Operating (Junction)	-65 to +100		°C
LEAD TEMPERATURE:			
≥ 1/16" from Case for 10 Seconds max.	255	255	°C

* This value may be exceeded provided that the power dissipated in the Emitter under breakdown conditions is limited to 5 watts.

▲ Measured at center of seating surface.

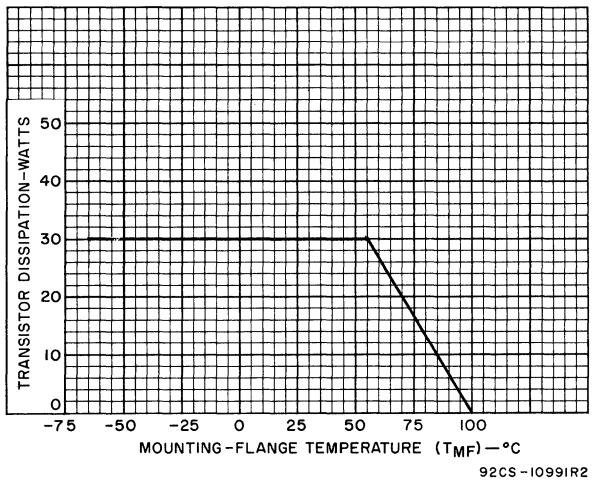


Fig.1 - Rating Chart for 2N1905 and 2N1906.

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Printed in U.S.A.
2N1905, 2N1906 10-66
Supersedes 2N1905, 2N1906 Issue dated 3-61

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

At Mounting-Flange Temperature (T_{MF}) = 25°C, Measured at Center of Seating Surface

Characteristics Common-Emitter Circuit, Base Input Unless Otherwise Specified	Symbols	TEST CONDITIONS					LIMITS						Units
		DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Base Current I_B	DC Emitter Current I_E	Type 2N1905			Type 2N1906			
		V	V	A	A	A	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			-0.01		0	-100	-	-	-130	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			-0.1	0		-50	-	-	-60	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0		0.005	-1.5	-	-	-1.5	-	-	V
Collector Cutoff Current	I_{CBO}	V_{CB}=-40				0	-	-	-1	-	-	-1	mA
Collector Cutoff Saturation Current	I_{CBO}(sat)	V_{CB}=-0.5				0	-	-	-100	-	-	-100	μA
Emitter Cutoff Current	I_{EBO}		-0.5	0			-	-1	-	-	-1	-	mA
Static-Forward-Current Transfer Ratio	h_{FE}	-2 -2		-1 -5			50 30	90 -	150 -	75 75	125 -	250 -	
Base-to-Emitter Voltage	V_{BE}	-2 -2		-1 -5			- -	-0.38 -	-0.5 -	- -	- -0.6	-0.5 -0.9	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			-5	-0.25		-	-	-1	-	-	-0.5	V
Gain-Bandwidth Product	f_T	-5		-0.5			2	4	-	3	5	-	MHz
Thermal Resistance (Junction-to-Case)	θ_{J-C}						-	-	1.5	-	-	1.5	°C/W

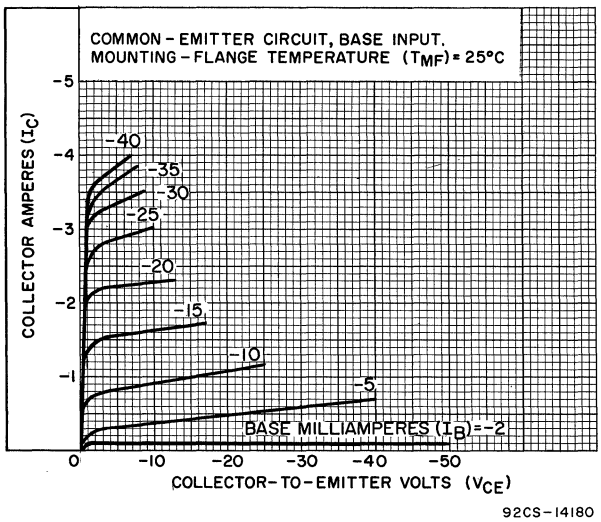


Fig.2 - Typical Collector Characteristics for Type 2N1905.

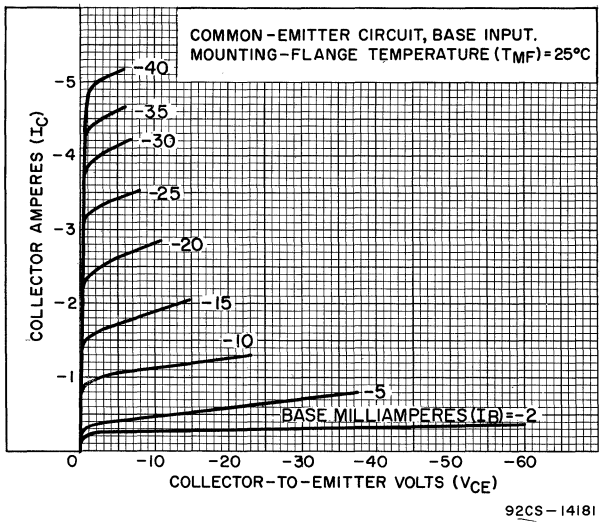


Fig.3 - Typical Collector Characteristics for Type 2N1906.

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OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

These transistors utilize the Loranger Mfg. Corp., Socket No.2149 or equivalent. Electrical connection can also be made to the base and emitter pins by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seals, otherwise the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that a fibre washer be used between the bolt and the chassis as shown in Fig.10.

It is important that the mounting flange which serves as the collector be securely fastened to a heat sink. Depending on the application, the chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply.

It is to be noted that the metal shells of these transistors operate at the collector voltage. Consideration, therefore, should be given to the possibility of shock hazard if the metal shells of these transistors are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

The 2N1905 or the 2N1906 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

To prevent damage to the transistors by thermal runaway an external resistance may be placed in the emitter or collector circuit. The minimum value of this resistance may be obtained from the following equation:

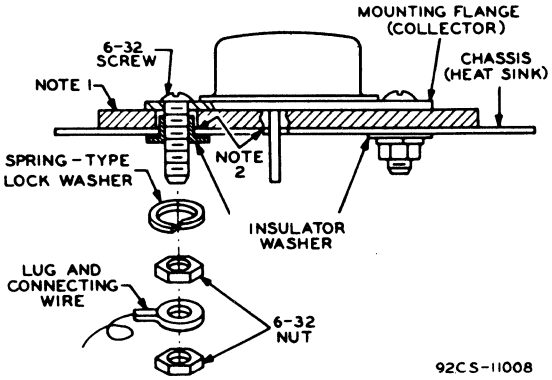
$$R_{min} = \frac{E^2}{4\left(P_o + \frac{25}{K}\right)}$$

where:

E = DC Collector Supply Voltage (volts)

P_o = Collector-to-Emitter Voltage x Collector Current at desired operating point (watts)

K = Thermal Resistance - Transistor and Heat Sink (^oC/watt)



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

Mounting hardware items for RCA-2N1905 and 2N1906 are available from RCA Distributors under the following RCA Part Numbers:

ITEM	RCA PART NO.
Mica Insulator	495320
Nylon Insulating Washer (2)	495334-7

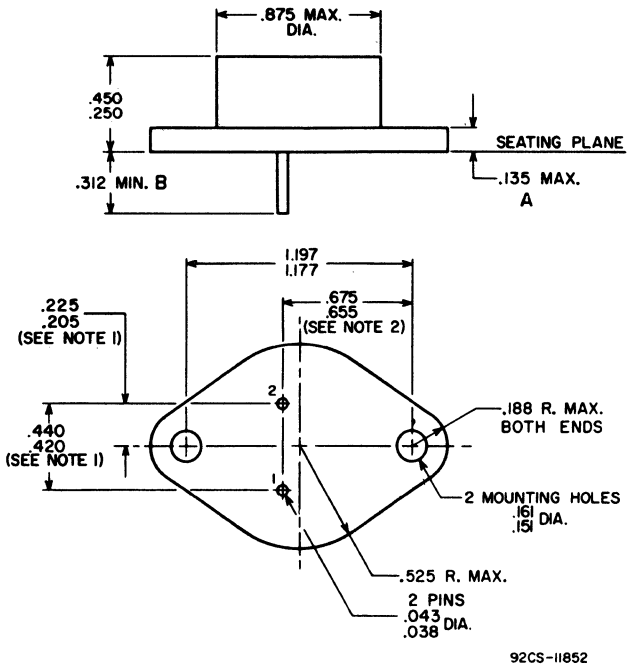
Mica insulators are also available from Reliance Mica Co., 341-351 39th St., Brooklyn, N.Y. 10032, United Mineral & Chemical Corp., 16 Hudson St., N.Y., N.Y. 10014, and other suppliers of similar components.

Insulating shoulder washers are also available from Contour Plastics, Minneapolis, Minn. and other suppliers of similar components.

Sockets for RCA-2N1905 and 2N1906 and other semiconductor devices utilizing the JEDEC TO-3 package are made by several manufacturers, and are generally available from electronic parts distributors.

Fig.10 - Suggested Mounting Arrangement for Types 2N1905 and 2N1906.

DIMENSIONAL OUTLINE
For Types 2N1905 and 2N1906
JEDEC No. TO-3



DIMENSIONS IN INCHES

NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

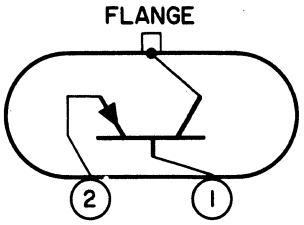
NOTE 2: TWO LEADS.

For RCA-2N1905 and 2N1906

Mounting-Flange Thickness (A) = 0.050" max.

Pin Length (B) = { 0.440" min. / 0.480" max.

TERMINAL CONNECTIONS



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

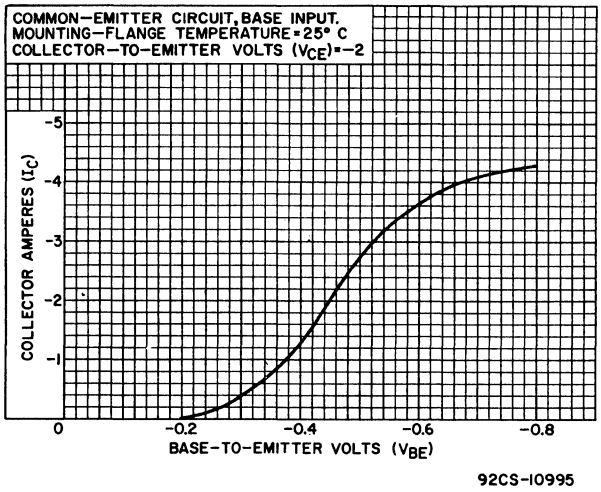


Fig.4 - Typical Characteristic for Type 2N1905.

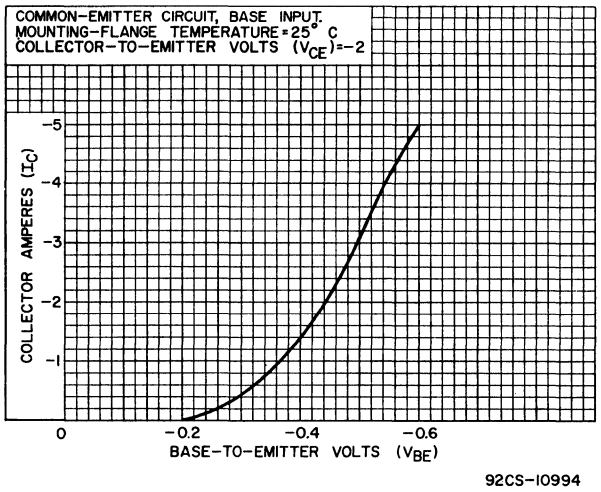


Fig.5 - Typical Characteristic for Type 2N1906.

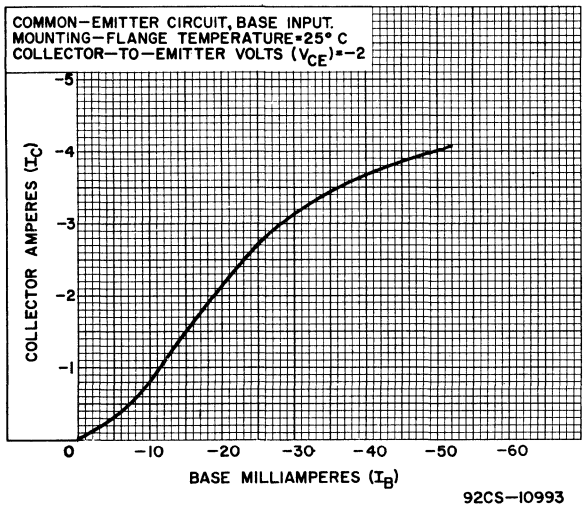


Fig.6 - Typical Current-Transfer Characteristic for Type 2N1905.

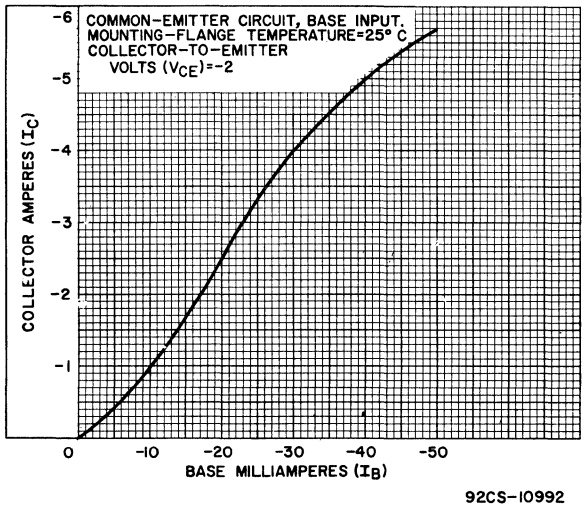


Fig.7 - Typical Current-Transfer Characteristic for Type 2N1906.

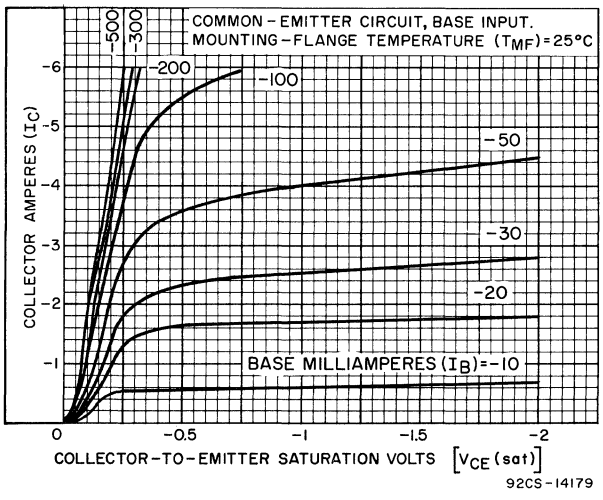


Fig.8 - Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N1905.

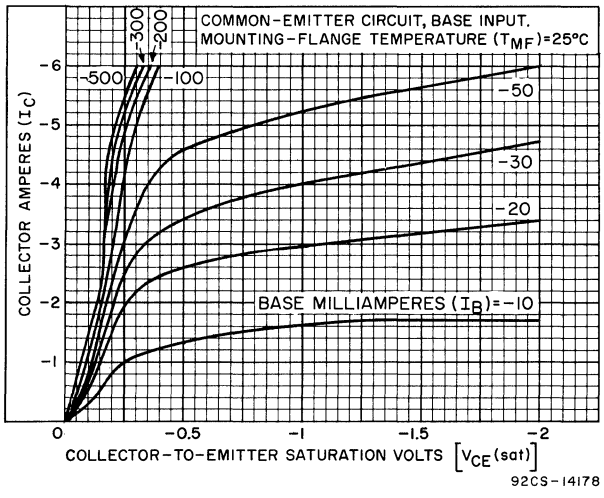


Fig.9 - Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N1906.


RCA

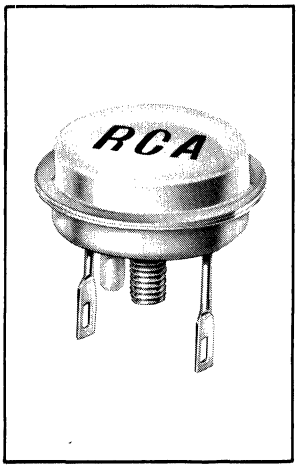
SILICON N-P-N TRANSISTORS

2N2015
2N2016

File No. 12

RCA 2N2015 and 2N2016 are diffused-junction power transistors of the silicon n-p-n type having very high power-dissipation capabilities (150 watts). The 2N2015 and 2N2016 are particularly useful in power-switching circuits such as those employed in dc-to-dc converters, inverters, choppers, and relay-control equipment. They are also extremely useful in oscillator, regulator, and pulse-amplifier circuits, and as class A and class B push-pull amplifiers for af and servo applications.

High-Power Types for Military and Industrial Applications



JEDEC TO-36

- for operation at high junction temperatures – up to 200° C
- very high dissipation rating – 150 watts
- very low thermal resistance, junction-to-case – 1.17° C/Watt
- very low saturation resistance – 0.25 ohm max. at I_C = 5 amp, I_B = 0.5 amp
- JEDEC TO-36 single-ended stud-type package with cold-weld hermetic seals

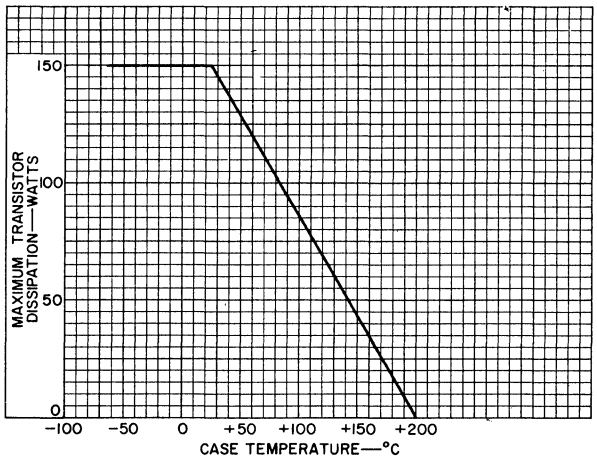
Maximum Ratings, *Absolute-Maximum Values:*

	2N2015	2N2016		
COLLECTOR-TO-BASE VOLTAGE.	100	130	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (Sustaining voltage) .	50	65	max.	volts
EMITTER-TO-BASE VOLTAGE. .	10	10	max.	volts
COLLECTOR CURRENT.	10	10	max.	amp
EMITTER CURRENT.	-13	-13	max.	amp
BASE CURRENT	6	6	max.	amp
TRANSISTOR DISSIPATION:*				
At case temperatures up to 25° C.	150	150	max.	watts
At other case temperatures	See *Fig.1*			
TEMPERATURE RANGE:				
Operating and Storage. .	-65 to +200			°C
LEAD TEMPERATURE, 1/16" ± 1/32" from case, for immersion in molten solder for 10 sec. max..	235	235	max.	°C

Typical Characteristics of 2N2015 and 2N2016 at a Case Temperature[C] of 25° C:

Collector-to-Base Capacitance, C_{ob}: (V_{CB} = 40 volts)	400 μμf
Thermal Time Constant, τ_1.	30 msec
Forward Current-Transfer-Ratio Cutoff Frequency, $f_{\alpha e}$.	25 Kc

* For transistor dissipation in pulse operation refer to RCA Application Note AN-181, "Transistor Dissipation Ratings for Pulse and Switching Service".



92CS-11089

Fig. 1 - Rating Chart for Types 2N2015 and 2N2016.

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

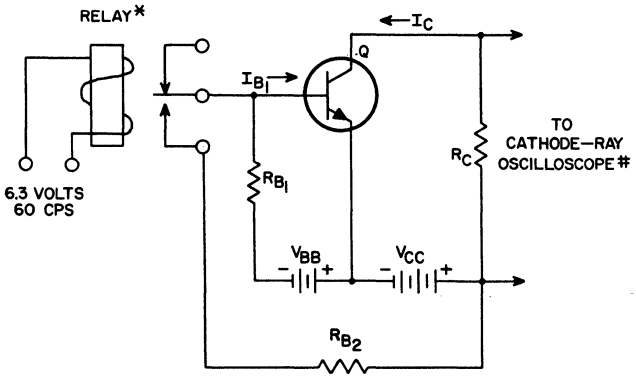
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Printed in U.S.A.
2N2015-2N2016 6/66
Reprinted from 2N2015-2N2016 5/61

ELECTRICAL CHARACTERISTICS

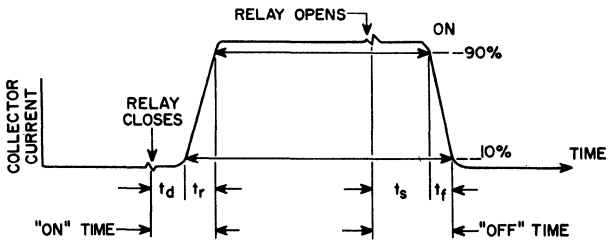
Case temperature = 25° C unless otherwise specified.

Characteristic	Symbol	TEST CONDITIONS					LIMITS				Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Base Current I_B	Type 2N2015		Type 2N2016		
		Volts	Volts	Volts	Amperes	Amperes	Min.	Max.	Min.	Max.	
Collector-Cutoff Current ($I_E=0$) at case temperature of:	I_{CBO}										
25° C		30					-	50	-	50	μA
150° C		30					-	2	-	2	mA
Emitter-Cutoff Current	I_{EBO}			10			-	50	-	50	μA
DC Forward-Current Transfer Ratio	h_{FE}		4		5		15	50	15	50	
			4		10		7.5	-	7.5	-	
Collector-to-Emitter Saturation Resistance	R_s				5	0.5	-	0.25	-	0.25	ohm
Base-to-Emitter Voltage	V_{BE}		4		5		-	2.2	-	2.2	volts
Collector-to-Emitter Voltage: Sustaining voltage with base open	V_{CEO} (sus)				0.2	0	-	50	-	65	volts
With reverse bias between emitter and base	V_{CEX}			1.5	2 mA		-	100	-	130	volts
Thermal Resistance Junction-to-case	R_T						-	1.17	-	1.17	°C/W



*C.P. CLARE TYPE HGP-1028 OR EQUIVALENT

#TEKTRONIX TYPE 545 OR EQUIVALENT



"ON" TIME, DELAY TIME (t_d) + RISE TIME (t_r).....4μsec

"OFF" TIME, STORAGE TIME (t_s) + FALL TIME (t_f).....7μsec

Collector Supply Voltage (V_{CC})	24	volts
DC Base Bias Voltage (V_{BB})	6	volts
"On" DC Collector Current	10	amperes
"Turn-On" Base Current (I_{B_1})	2	amperes
Base Resistance (R_{B_1})	10	ohms
Base Resistance (R_{B_2})	10	ohms
Collector Resistance (R_C)	2	ohms
Switching Time:		
"On" Time [Delay time (t_d) + Rise time (t_r)]	4	μsec
"Off" Time [Storage time (t_s) + Fall time (t_f)]	7	μsec

Fig. 2 - Pulse-Response Test Circuit for Types 2N2015 and 2N2016.

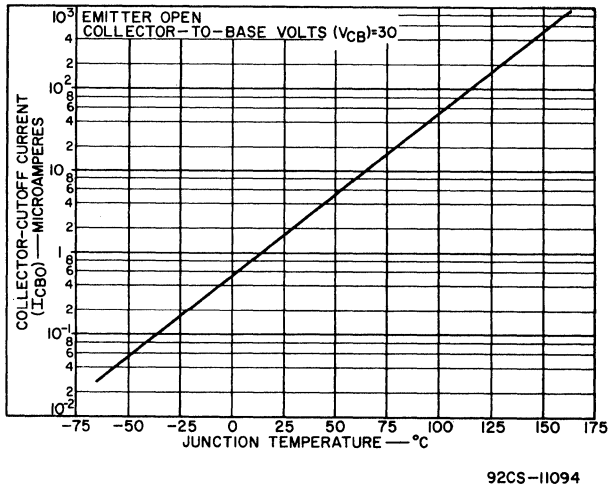


Fig. 3 - Typical Operation Characteristic for Types 2N2015 and 2N2016.

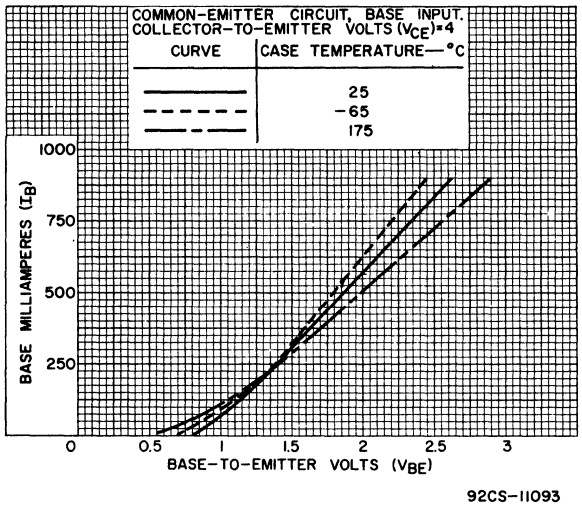


Fig. 5 - Typical Input Characteristics for Types 2N2015 and 2N2016.

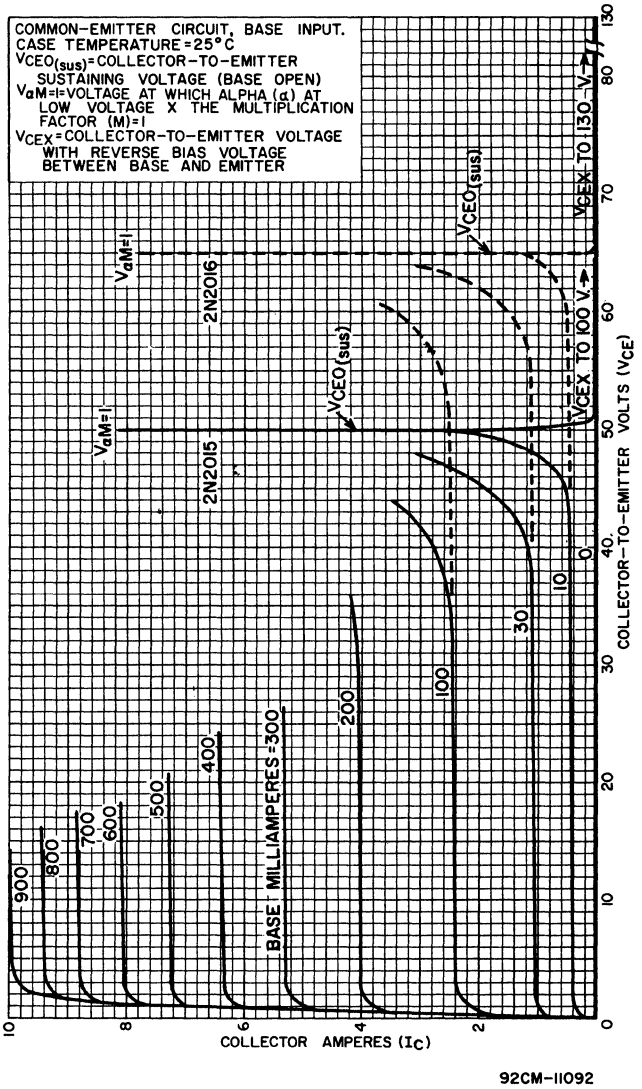


Fig. 4 - Typical Collector Characteristics for Types 2N2015 and 2N2016.

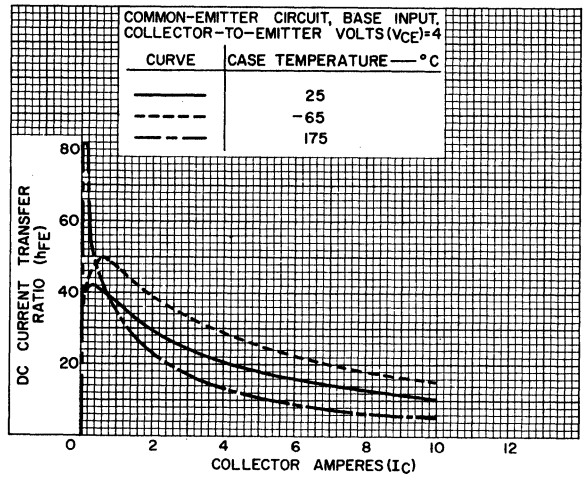


Fig. 6 - Typical Operation Characteristics for Types 2N2015 and 2N2016.

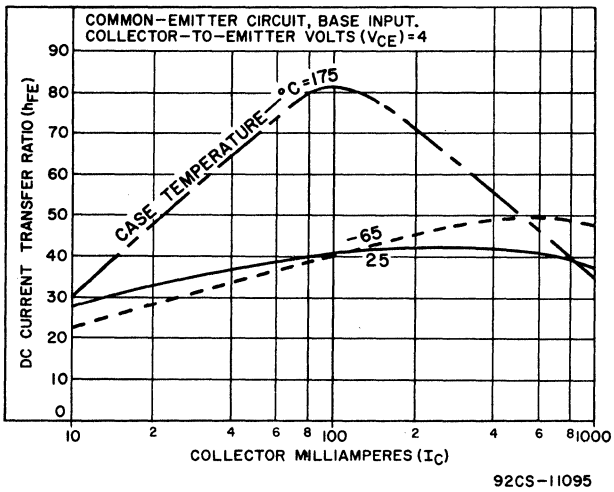
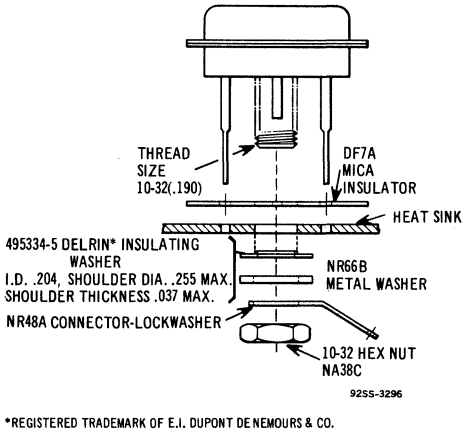


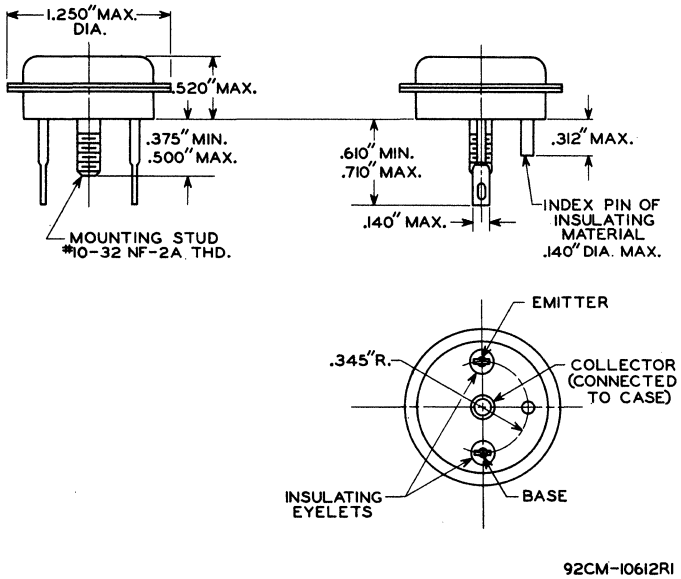
Fig. 7 - Typical Operation Characteristics for Types 2N2015 and 2N2016.



*REGISTERED TRADEMARK OF E.I. DUPONT DE NEMOURS & CO.

Fig. 8 – Suggested Mounting Arrangement for Types 2N2015 and 2N2016.

DIMENSIONAL OUTLINE for Types 2N2015 and 2N2016 JEDEC No. TO-36



SILICON N-P-N PLANAR TRANSISTORS

2N2102
2N1613

File No. 106

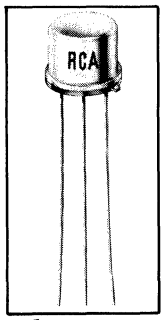
RCA-2N2102 is a triple-diffused, silicon n-p-n planar transistor intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. It features exceptionally low noise, low leakage characteristics, high switching speed, and high pulse beta.

RCA-2N2102 is a direct replacement for the 2N1613 family of transistors. In addition, because of its triple-diffused-junction design, the 2N2102 has higher breakdown voltage ratings, higher dissipation ratings, lower saturation voltages, higher sustaining voltages, and lower output capacitance.

Maximum Ratings, *Absolute-Maximum Values:*

	2N2102	2N1613	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	75 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With external $R_{BE} \leq 10$ ohms, V_{CER}	80	50 max.	volts
With base open, V_{CEO}	65	- max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7 max.	volts
COLLECTOR CURRENT, I_C	1	1 max.	amp
TRANSISTOR DISSIPATION, P_T			
At case temperatures up to 25° C	5	3 max.	watts
At free-air temperatures up to 25° C	1	0.8 max.	watt
At temperatures above 25° C	See *Figures 1 and 2.*		
TEMPERATURE RANGE:			
Operating (Junction)	-65 to 200		°C
LEAD TEMPERATURE:			
1/16" ± 1/32" from case for 10 sec. max.	300	265 max.	°C

For Small-Signal and Medium-Power Applications



JEDEC TO-5

- For operation at high junction temperatures — up to 200° C
- Planar construction — Insures low noise and low leakage characteristics
- Low output capacitance

RCA-2N2102 Features:

- Minimum gain-bandwidth product (f_T) — 120 Mc; useful in applications from dc to 20 Mc
- High breakdown voltage (BV_{CBO}) — 120 volts min. at I_C = 0.1 ma
- Low saturation voltages — $V_{CE(sat)}$ = 0.5 volt max. at I_C = 150 ma; $V_{BE(sat)}$ = 1.1 volts max. at I_C = 150 ma
- Beta (h_{FE}) controlled over 5 decades of I_C
- High pulse h_{FE} at high I_C — 10 min. at I_C = 1 ampere

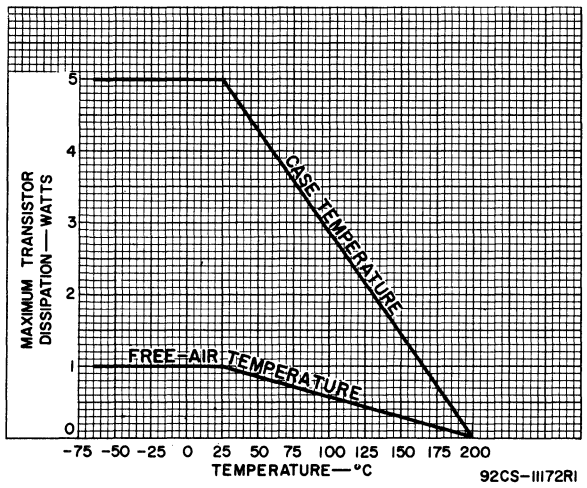


Fig. 1 RATING CHART FOR TYPE 2N2102

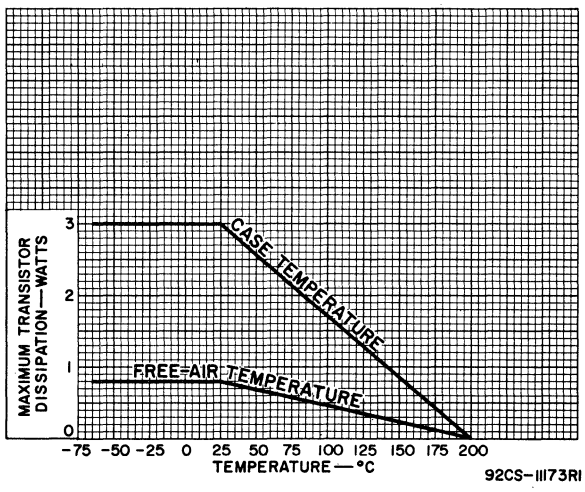


Fig. 2 RATING CHART FOR TYPE 2N1613

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Printed in U.S.A.
2N2102, 2N1613 6/66
Reprinted from 2N2012, 2N1613 11/65

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25° C, Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Emitter Volts	DC Current (Milliamperes)			Type 2N2102		Type 2N1613		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: (At T_C = 25° C) (AT T_C = 150° C)	I_{CBO}	60 60			0 0			- -	0.002 2	- -	0.01 10	μa μa
Emitter-Cutoff Current	I_{EBO}			5			0	-	0.005	-	0.01	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	120	-	75	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	7	-	7	-	volts
Collector-to-Emitter Sustaining Voltage: With external R_{BE} = 10 ohms	$V_{CER(sus)}$						100●	80	-	50	-	volts
With base open	$V_{CEO(sus)}$					0	100●	65	-	-	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					15	150●	-	0.5	-	1.5	volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$					15	150●	-	1.1	-	1.3	volts
DC Forward-Current Transfer Ratio:	h_{FE}		10 10 10 10 10 10				0.01 0.1 10● 150● 500● 1000●	10 20 35 40 25 10	- - - 120 - -	- 20 35 40 20 -	- - - 120 - -	
(At T_C = -55° C)	h_{FE}		10				10●	20	-	20	-	
Small-Signal Forward-Current Transfer Ratio: At f = 1 kc 1 kc 20 Mc	h_{fe}		5 10 10				1 5 50	40 45 6	125 190 -	30 35 3	100 150 -	
Input Resistance (At f = 1 kc)	h_{ib}	5 10					1 5	24 4	34 8	24 4	34 8	ohms ohms
Small-Signal Reverse Voltage Transfer (Feedback) Ratio (At f = 1 kc)	h_{rb}	5 10					1 5	- -	3×10^{-4} 3×10^{-4}	- -	3×10^{-4} 3×10^{-4}	
Output Conductance (At f = 1 kc)	h_{ob}	5 10					1 5	0.1 0.1	0.5 1	0.1 0.1	0.5 1	μmho μmho
Output Capacitance	C_{ob}	10			0			-	15	-	25	pf
Input Capacitance	C_{ib}			0.5			0	-	80	-	80	pf
Noise Figure: Circuit Bandwidth (BW) = 1 cps Reference signal freq. = 1 kc Generator resistance (R_G) = 510 ohms	NF		10				0.3	-	6	-	12	db
Thermal Resistance: Junction-to-case Junction-to-free air	$\theta_{J\text{-}C}$ $\theta_{J\text{-}FA}$							- -	35 175	- -	58.3 219	°C/watt °C/watt

● Pulsed. Pulse duration = 300 μsec; duty factor = 1.8%.

TYPICAL OPERATION CHARACTERISTICS FOR TYPES 2N2102 & 2N1613

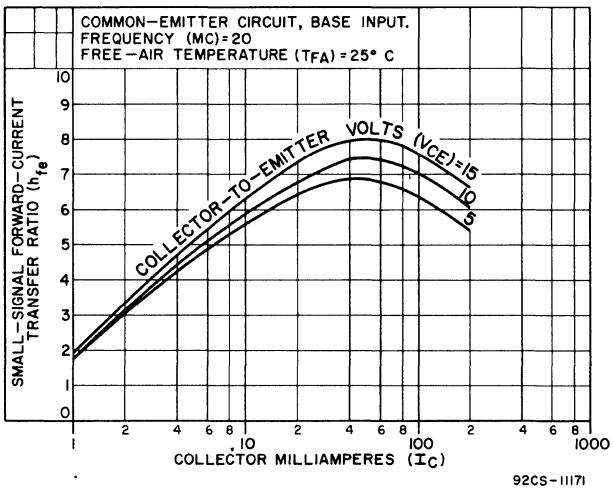


Fig.7

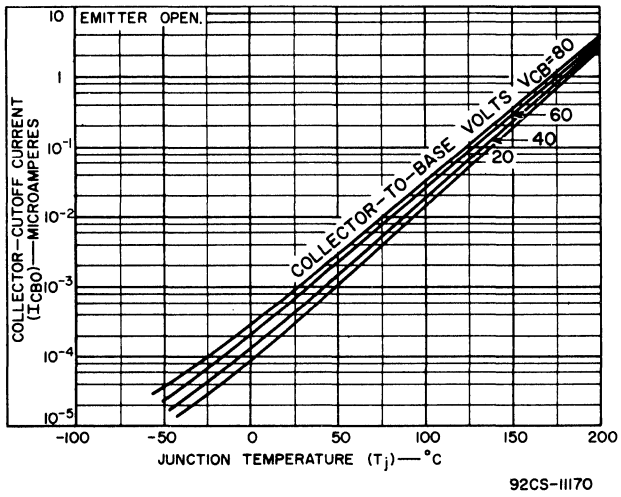


Fig.8

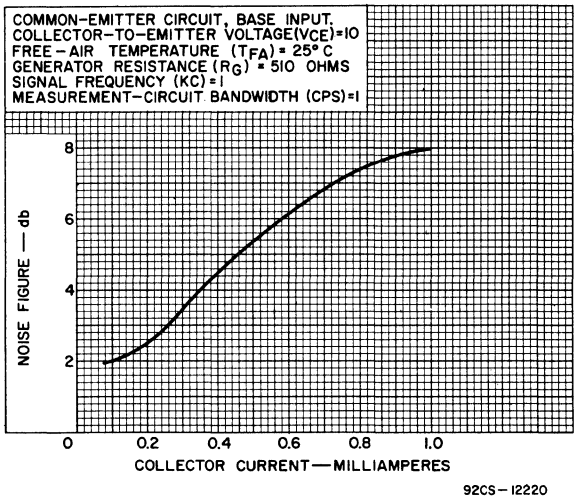


Fig.9

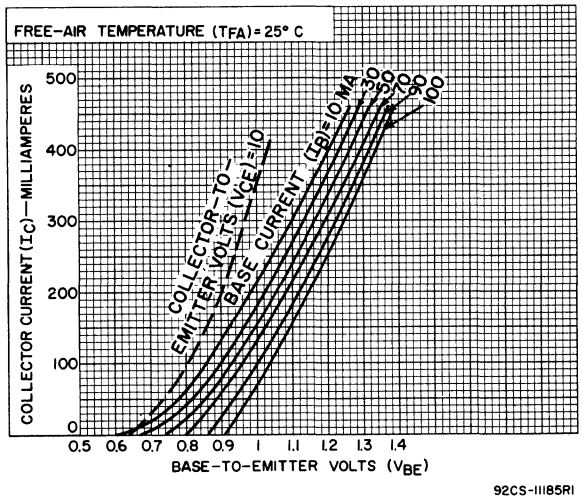


Fig.10

TYPICAL OPERATION CHARACTERISTICS FOR TYPES 2N2102 & 2N1613

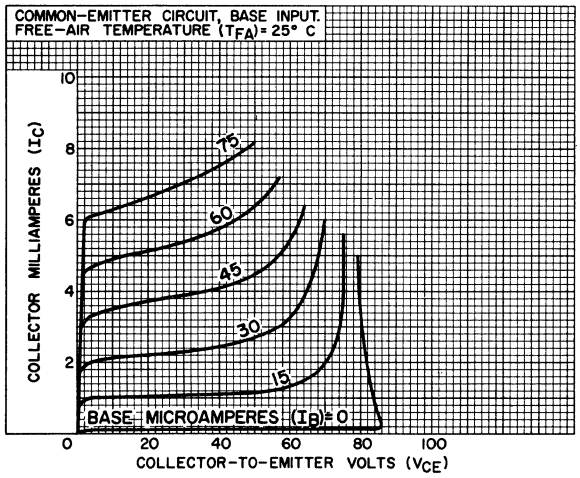


Fig.11

TYPICAL SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N1613

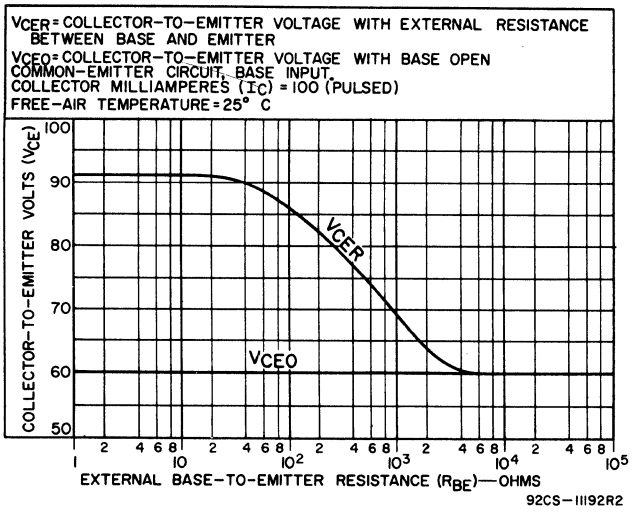


Fig.12

TYPICAL SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N2102

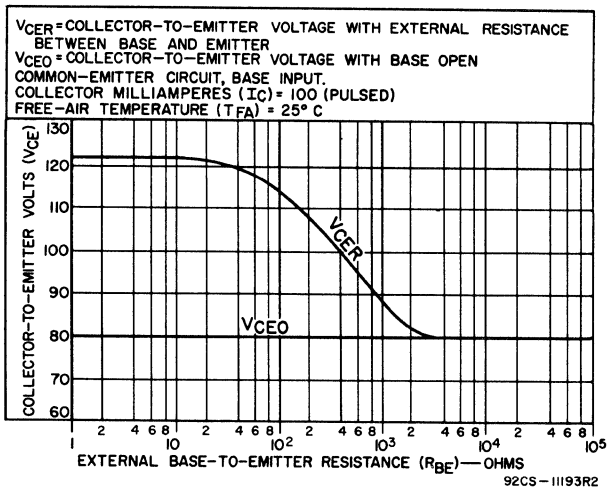


Fig.13

TYPICAL OPERATION CHARACTERISTICS FOR TYPES 2N2102 & 2N1613

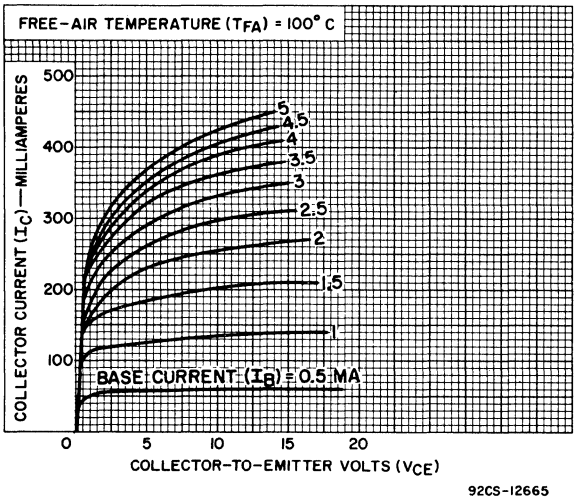


Fig.3

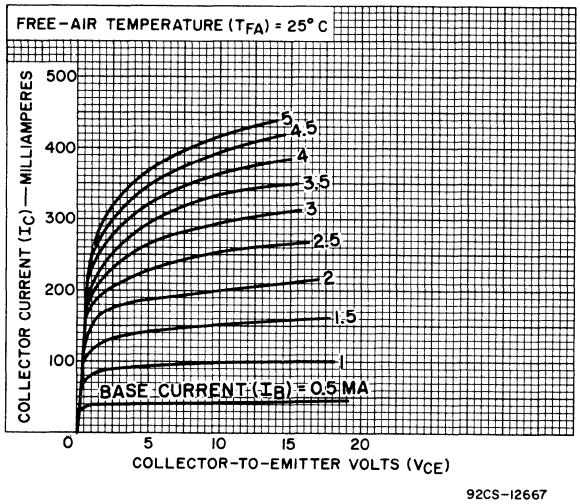


Fig.4

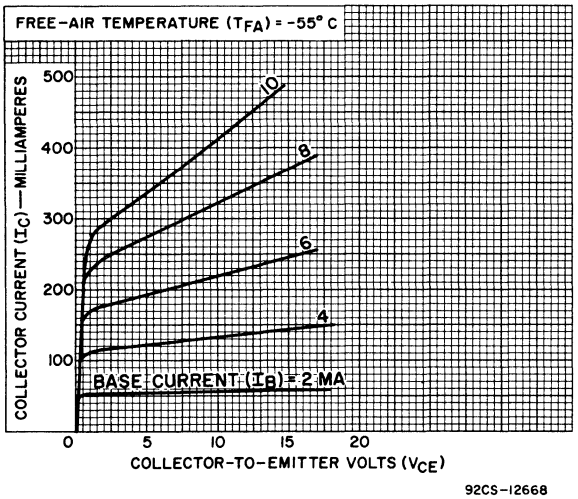


Fig.5

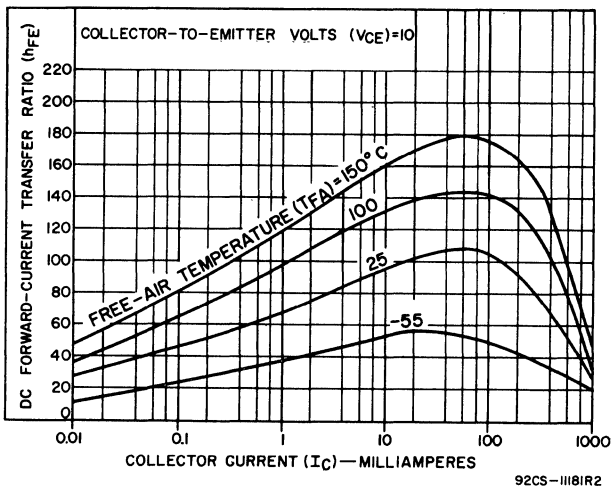
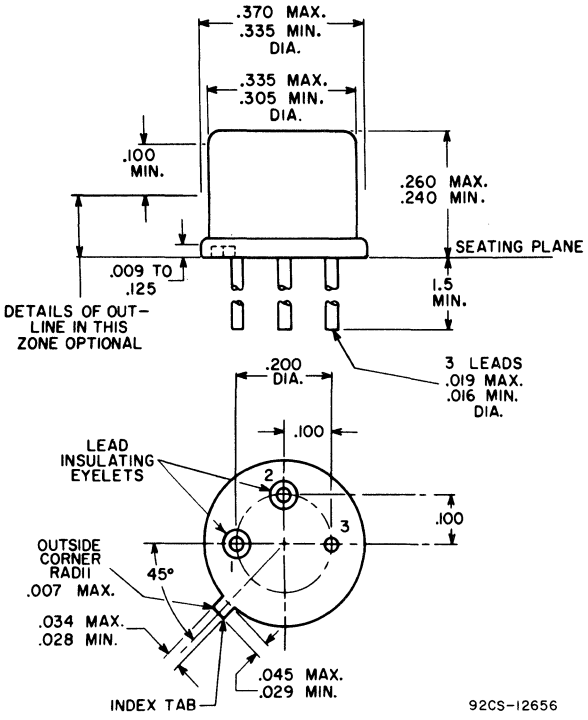


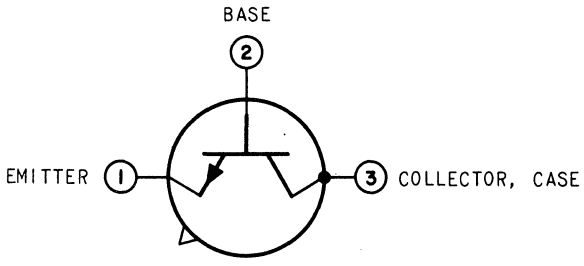
Fig.6

DIMENSIONAL OUTLINE FOR TYPES 2N2102 & 2N1613

JEDEC TO-5



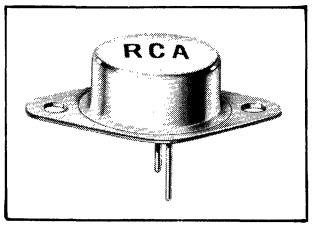
TERMINAL DIAGRAM FOR TYPES 2N2102 & 2N1613



(Bottom View)

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GERMANIUM P-N-P DRIFT-FIELD POWER TRANSISTORS



For High-Fidelity Audio-Frequency-Amplifier Applications

- **High Power Sensitivity Over Entire AF Spectrum:**
  - **high minimum betas at high currents –**

$$h_{FE} = \begin{cases} \text{100 min. for 2N2147} \\ \text{60 min. for 2N2148} \end{cases} \text{at } I_C = 1\text{ A}$$

$$h_{FE} = \begin{cases} \text{75 min. for 2N2147} \\ \text{40 min. for 2N2148} \end{cases} \text{at } I_C = 4\text{ A}$$

  - **high gain-bandwidth product provides full gain to 20 kHz –** $f_T = \begin{cases} \text{4 MHz typ. for 2N2147} \\ \text{3 MHz typ. for 2N2148} \end{cases}$
  - **low base resistance minimizes driving-voltage requirements**
- **100% pulse tested for freedom from second breakdown**
- **completely welded, hermetically sealed TO-3 package**

RCA-2N2147 and 2N2148 are diffused-collector–graded-base power transistors of the germanium p-n-p type intended for use in high-fidelity amplifiers and other af amplifiers where wide frequency range and low distortion are required. These transistors utilize a combination of diffusion and alloying techniques to provide a built-in accelerating field in the base region. This accelerating field makes possible a wide frequency response and a linearity of characteristics not available in conventional power transistors.

RCA-2N2147 and 2N2148 are intended primarily for use in class B amplifier service, and have specially controlled breakdown-voltage and collector-saturation-current characteristics to provide dependable performance in this type of service. In a "single-ended push-pull" class B amplifier circuit of the type shown in Fig.1, using a 4-Ω speaker, a pair of 2N2147 transistors can deliver 25 watts rms power output with less than 5% total harmonic distortion, and provide a power gain of 33 dB; a pair of 2N2148 transistors can deliver 15 watts rms power output with less than 5% total harmonic distortion, and provide a power gain of 31 dB.

RCA-2N2148 is also extremely useful as a class A power amplifier in driver stages of high-power, high-quality af amplifiers, and in output stages of moderate-power amplifiers. In class A amplifier service a 2N2148 can deliver up to 5 watts output and provide a power gain of 36 dB.

AF-POWER-AMPLIFIER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N2147	2N2148		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-75	-60	max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-50	-40	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-1.5[a]	-1.5[a]	max.	V
COLLECTOR CURRENT, I_C	-5	-5	max.	A
BASE CURRENT, I_B	-1	-1	max.	A
EMITTER CURRENT, I_E	+5	+5	max.	A
TRANSISTOR DISSIPATION, P_T:				
Average:				
For mounting-flange temperatures[b] up to 81° C.	12.5	12.5	max.	W
Derate linearly:	0.66 W/°C			
Peak: Determined by operating conditions – See *Figs.4 and 5.*				

TEMPERATURE RANGE:			
Storage	-65° C to +100° C		
Operating (Junction)	-65° C to +100° C		
PIN TEMPERATURE (During soldering):			
At distances of not less than 1/16" from seating surface for 10 seconds max.	255	255 max.	°C

[a] This rating may be exceeded provided the combined dissipation in the emitter and the collector does not exceed the maximum dissipation rating for the device, and provided the driver stage (transformer-coupled) is capable of providing the emitter-to-base current drawn by the transistors under the emitter-to-base voltage conditions (reverse-bias) shown.

[b] Measured at center of seating surface.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N2147, 2N2148 6-66
Supersedes issue dated 9-63

Electrical Characteristics, at a Mounting-Flange Temperature (T_{MF}) of 25° C

Characteristics: Common-Emitter Circuit, Base Input Unless Otherwise Specified	Symbols	TEST CONDITIONS						LIMITS						Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Base Current I_B	DC Emitter Current I_E	Type 2N2147			Type 2N2148			
		volts	volts	volts	mA	mA	mA	Min.	Typical	Max.	Min.	Typical	Max.	
Collector-to-Base Breakdown Voltage*	BV_{CBO}				-10		0	-75	–	–	-60	–	–	V
Collector-to-Emitter Sustaining Voltage	V_{CEO} (sus)				-100	0		-50	–	–	-40	–	–	V
Collector-to-Emitter Saturation Voltage	V_{CE} (sat)				-5000	-250		–	–	-0.6	–	–	-0.75	V
Collector Cutoff Current	I_{CBO}	-40					0	–	–	-1	–	–	-1	mA
Collector Cutoff Saturation Current	I_{CBO} (sat)	-0.5					0	–	–	-70	–	–	-100	μA
EmitterCutoff Current	I_{EBO}			-1.5	0			–	–	-2.5	–	–	-10	mA
Static Forward-Current-Transfer Ratio	h_{FE}		-2 -2		-1000 -4000			100 75	150 –	300 –	60 40	100 –	– –	
Gain-Bandwidth Product	f_T		-5		-500			3	4	–	2	3	–	MHz
Thermal Resistance (Junction-to-Case)	θ_{JC}			–				–	–	1.5	–	–	1.5	°C/W
Base-to-Emitter Voltage	V_{BE}		-10 -2		-50 -1000			-0.2 –	-0.23 –	-0.27 -0.5	-0.21 –	-0.24 –	-0.28 -0.5	V

* Pulse Test: Pulse Duration = 300 μs; Duty Factor = 0.01

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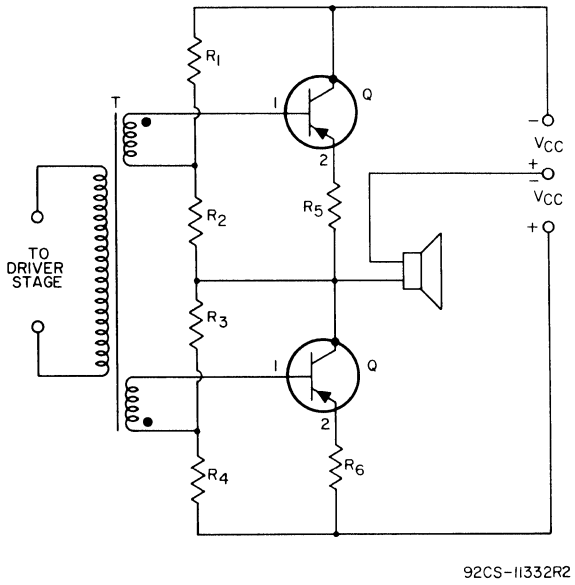
Typical Operation of Types 2N2147 and 2N2148 in "Single-Ended Push-Pull" Class B AF-Amplifier Circuit Shown in Fig. 1:

For a Mounting-Flange Temperature of 25° C

	2N2147	2N2148	
DC Collector Supply Voltages (V_{CC})[c]	22	16.5	V
Zero-Signal DC Collector Current	-0.035	-0.035	A
Zero-Signal Base-Bias Voltage	-0.24	-0.26	V
Peak Collector Current	-3.5	-2.7	A
Maximum-Signal DC Collector Current	-1.1	-0.85	A
Input Impedance of Stage (per base)	75	65	Ω
Load-Impedance (Speaker Voice-Coil)	4	4	Ω
Power Gain	33	31	dB
Maximum-Signal Power Output	25	15	W
Total Harmonic Distortion at Maximum-Signal Power Output	5	5	%
Maximum Collector Dissipation (per transistor) under worst-case conditions	12.5	7.5	W
EIA Music Power Output Rating[d]	45	25	W

[c] The data shown are for a dc collector supply having 10 per cent regulation.

[d] EIA Standard No.RS234, Section 2.1.2.1.



92CS-11332R2

Q: Transistor Types 2N2147, 2N2148

	2N2147	2N2148	
R_1, R_3	330	270	Ω ± 10%, 2 W
R_2, R_4	3.9	3.9	Ω ± 10%, 0.5 W
R_5, R_6	0.47	0.47	Ω ± 10%, 0.5 W
Speaker: Voice-Coil Impedance	4	4	Ω

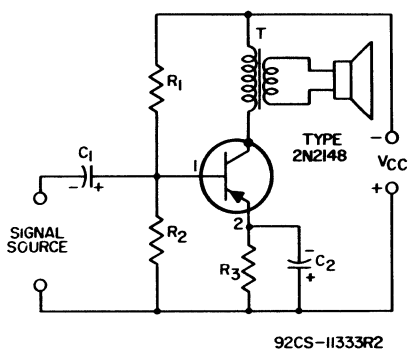
T: Driver Transformer. Primary-winding impedance, current-carrying capacity, and dc resistance determined by large-signal characteristics of driver stage; secondary windings bifilar wound, impedance of each winding = 100 Ω

Fig. 1 - "Single-Ended-Push-Pull" Class-B AF Amplifier Stage using RCA Types 2N2147 or 2N2148.

Typical Operation of Type 2N2148 in Class A AF-Amplifier Circuit Shown in Fig. 2

For a Mounting-Flange Temperature of 25° C

DC Collector Supply Voltage (V_{CC})	16	V
DC Collector-Emitter Voltage	-13.2	V
DC Collector Current	0.9	A
Peak Collector Current	1.8	A
Input Impedance	10	Ω
Collector Load Impedance	15	Ω
Maximum-Signal Power Output	5	W
Total Harmonic Distortion at 5 watts Output	5	%
Power Gain	36	dB
Maximum Collector Dissipation	12	W



92CS-11333R2

Fig. 2 - Class-A AF-Amplifier Stage using RCA Type 2N2148 Transistor.

C_1: Value determined by signal-source impedance

C_2: 5000 μF, electrolytic, 3 V

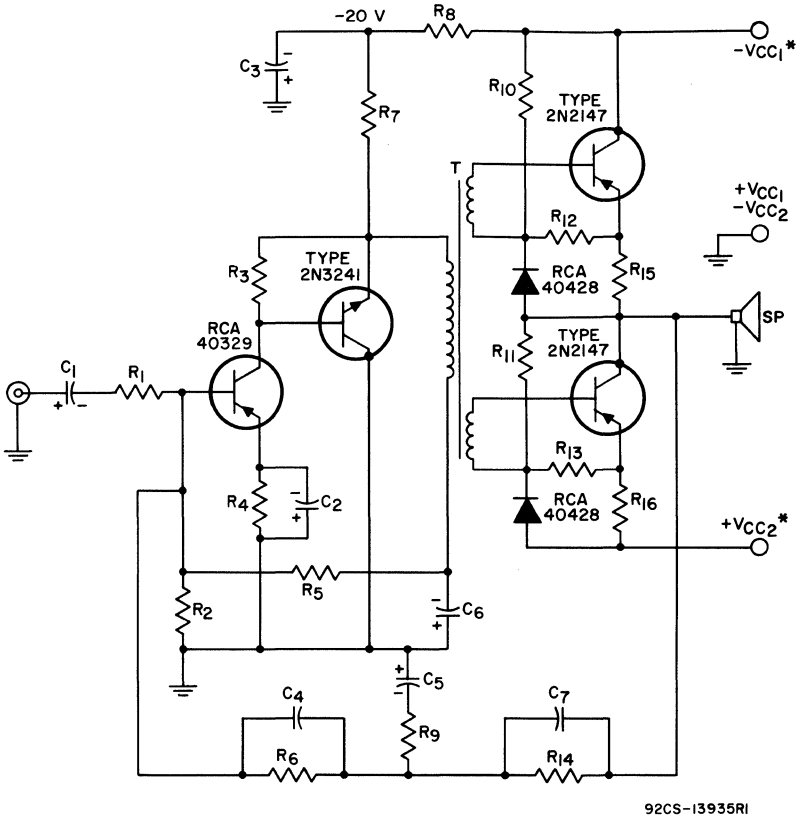
R_1: 120 Ω ± 10%, 2W

R_2: 22 Ω ± 10%, 0.5 W

R_3: 2.2 Ω ± 10%, 2 W

T: Output Transformer for matching impedance of speaker voice coil to 15-Ω collector load impedance for 2N2148; primary-winding current = 1 A; primary-winding dc resistance = 1 Ω max.

V_{CC}: 16 V



C_1 = 5 μF, 3 V, electrolytic
C_2 = 200 μF, 3 V, electrolytic
C_3 = 2500 μF, 35 V, electrolytic
C_4,C_7 = 39 pF, mica
C_5 = 10 μF, 3 V, electrolytic
C_6 = 250 μF, 15 V, electrolytic
R_1 = 1500 Ω, 0.5 W
R_2 = 22 KΩ, 0.5 W
R_3 = 270 Ω, 0.5 W
R_4,R_9 = 1 KΩ, 0.5 W
R_5 = 56 KΩ, 0.5 W
R_6 = 22 KΩ, 0.5 W
R_7 = 330 Ω, 1 W
R_8 = Selected to provide 20 V across C_3 under zero-signal conditions
R_{10},R_{11} = 270 Ω, 2 W
R_{12},R_{13} = 22 Ω, 5 W
R_{14},= 33 KΩ, 0.5 W
R_{15},R_{16} = 0.47 Ω, 0.5 W
SP = Speaker or speaker system: Impedance = 4 Ω
T = Driver Transformer:
Turns ratio, primary to each secondary: 3:1
Primary impedance: 400 Ω
Primary dc: 0 mA
* V_{CC_1}, V_{CC_2}: Zero-signal value = 22 V (I = 150 mA)
Maximum-signal value = 20 V (I = 1 A)

Performance Specifications for 4 Ω Speaker Load:

Continuous (Sine-Wave) Power Output = 25 W
EIA Music Power Output# = 40 W
Total Harmonic Distortion at 25 W output, f = 1 kHz = 0.5%
Sensitivity = 50 mV rms input for 25 W output at 1 kHz
Frequency Response = 1 dB down at 20 Hz and 20 kHz
3 dB down at 15 Hz and 35 kHz
Input Resistance = 1500 Ω
Hum and Noise = 80 dB below 25 W, input open or shorted

EIA Standard No.RS 234, Section 2.1.2.1

Fig.3 - Circuit of 25-Watt High-Quality Power Amplifier Using RCA-2N2147, 2N3241, and 40329 Transistors, and RCA-40428 Compensating Diode.

TECHNICAL BULLETINS FOR RCA-2N3241 40329, AND 40428 ARE AVAILABLE ON REQUEST FROM COMMERCIAL ENGINEERING, RCA ELECTRONIC COMPONENTS AND DEVICES, 415 SO. 5TH ST., HARRISON, N.J. 07029.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

In the design of amplifier circuits using the 2N2147 and 2N2148, it is extremely important to assure that the operating characteristic for either type does not, under any foreseeable combination of operating conditions, extend outside the safe operating region shown in Fig.4 or Fig.5. EVEN MOMENTARY EXCURSION OF THE TRANSISTOR OPERATING CHARACTERISTIC OUTSIDE THIS REGION, OR MOMENTARY OPERATION OF THE TRANSISTOR ABOVE ANY OF ITS MAXIMUM RATINGS CAN RESULT IN PERMANENT DAMAGE TO THE TRANSISTOR.

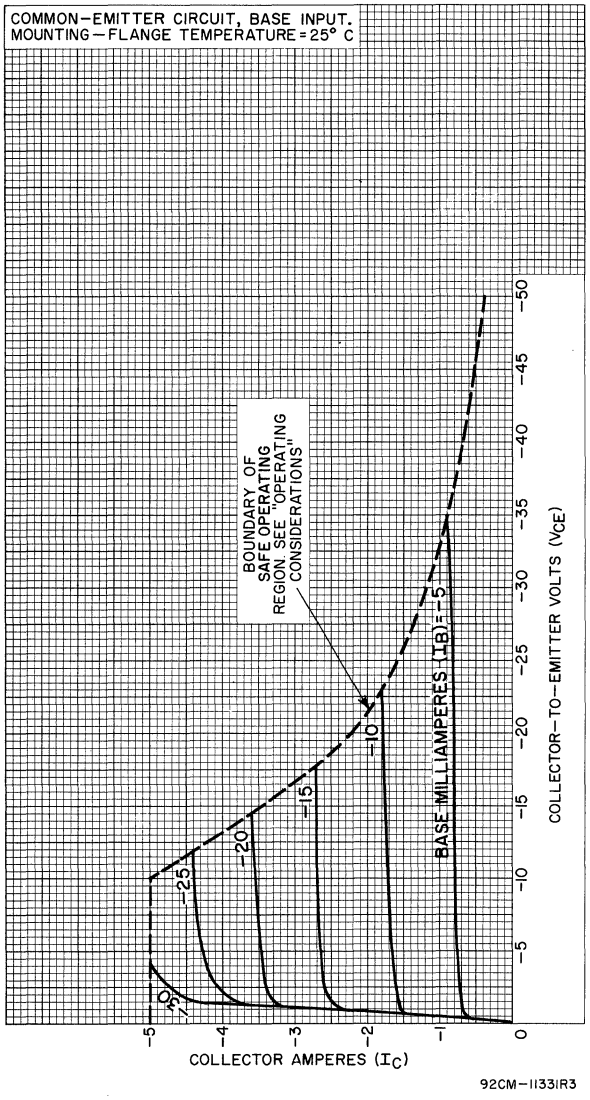


Fig.4 - Typical Collector Characteristics for Type 2N2147.

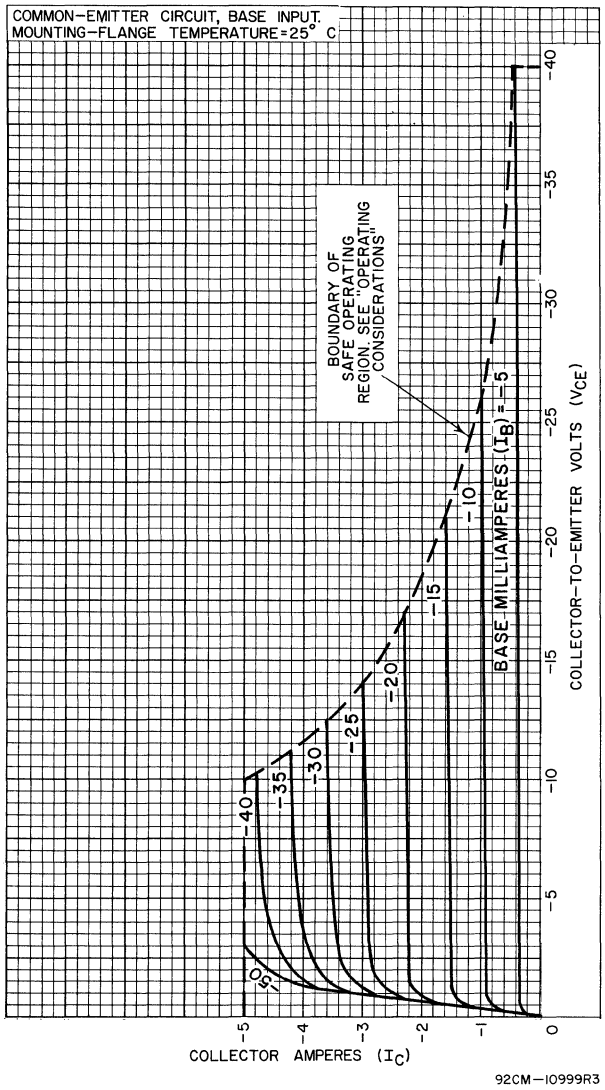


Fig.5 - Typical Collector Characteristics for Type 2N2148.

To assure that the 2N2147 and 2N2148 are operated at all times within the safe regions shown in Figs.4 and 5, the circuit designer should take into account the possible effects of the following factors:

(1) phase shift due to circuit capacitances and/or speaker resonance

(2) parasitic oscillations, such as "ringing" caused by excessive or improperly neutralized feedback

(3) high line voltage

(4) variations in speaker impedance

(5) overdriving of transistors

(6) non-sinusoidal signal waveforms

Any of these factors, or combination, can change the character and value of the transistor load sufficiently to cause operation outside the safe operating region shown in Fig.4 and Fig.5.

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

The 2N2147 and 2N2148 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

These transistors can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

It is essential that the mounting flange which serves as the collector terminal be securely fastened to a heat sink, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE TRANSISTOR.

The mounting-flange temperature of the 2N2147 or 2N2148 will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the transistor-mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use either an anodized aluminum insulator having high thermal conductivity, or a 0.002" thick mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that a insulating washer be used between each bolt and the chassis as shown in Fig.13

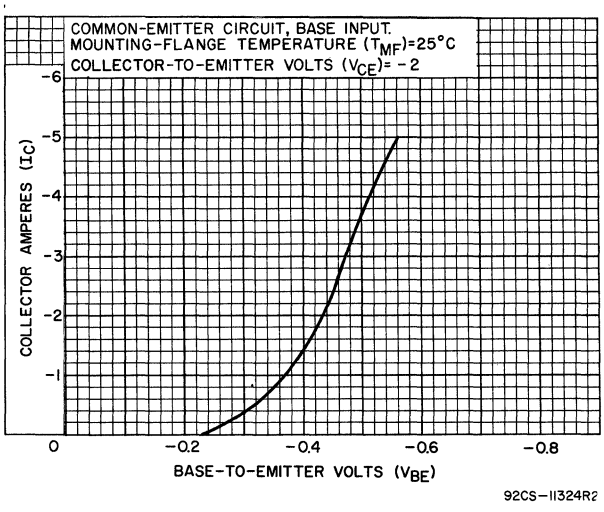


Fig.6 - Typical Transfer Characteristic for Type 2N2147.

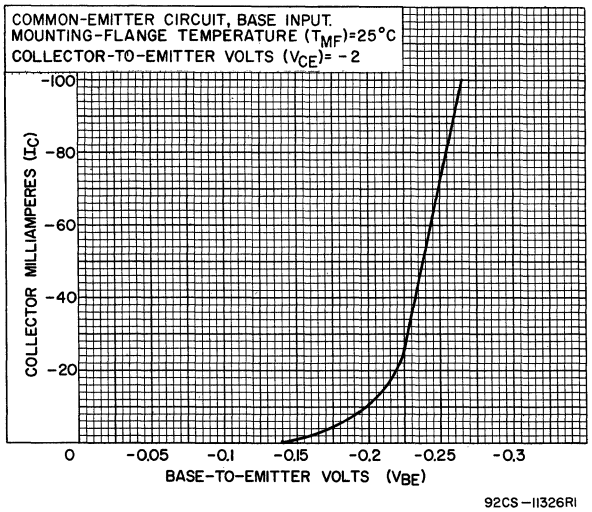


Fig.7 - Typical Transfer Characteristic for Type 2N2147.

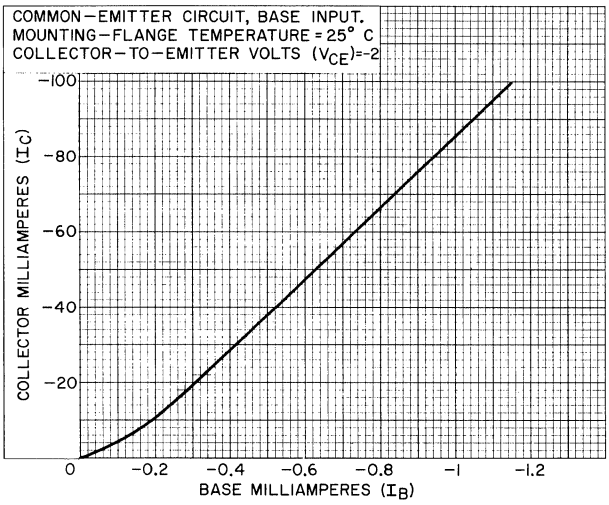


Fig.8 - Typical Current-Transfer Characteristic for Type 2N2147.

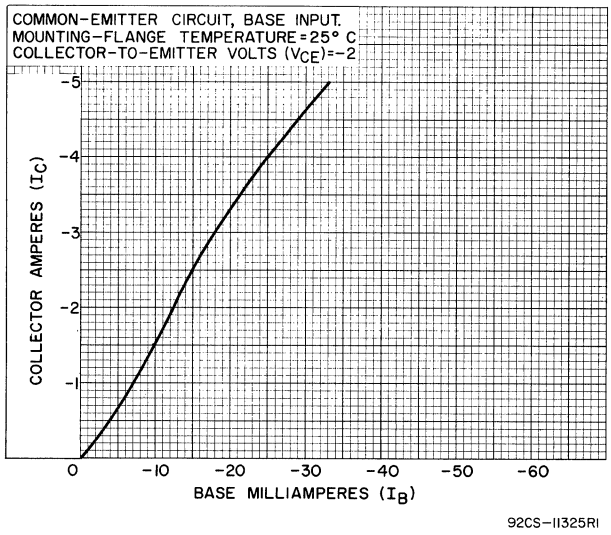


Fig.9 - Typical Current-Transfer Characteristic for Type 2N2147.

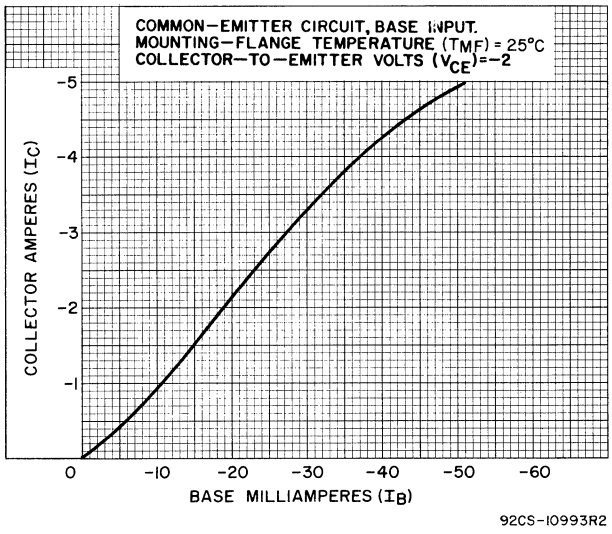


Fig.10 - Typical Current-Transfer Characteristic for Type 2N2148.

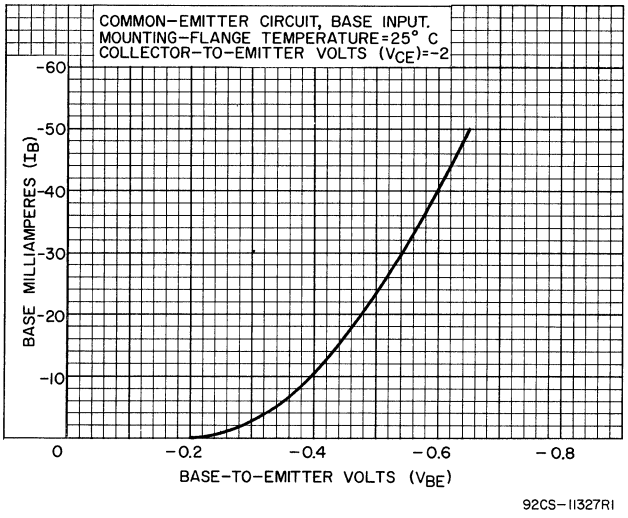


Fig.11 - Typical Input Characteristics for Type 2N2147.

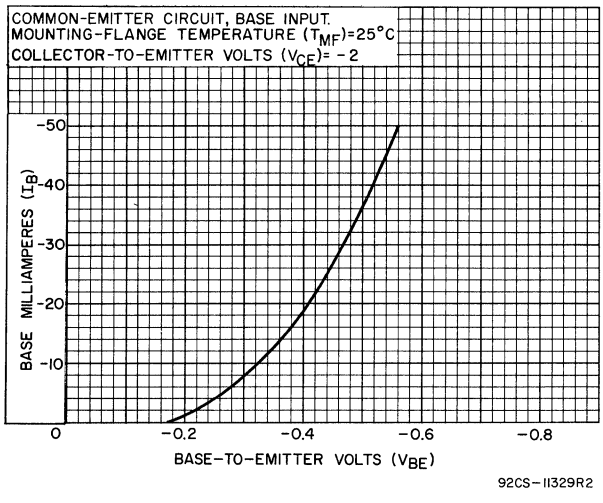
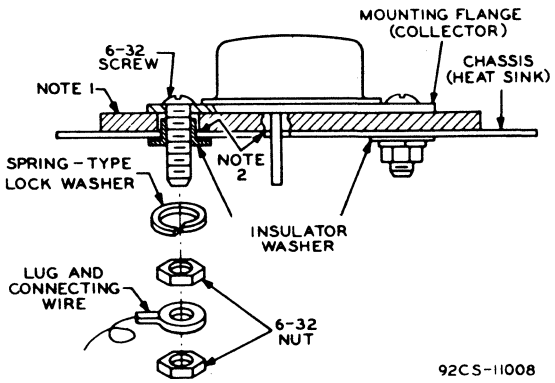


Fig.12 - Typical Input Characteristics for Type 2N2148.



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

Mounting hardware items for RCA-2N2147 and 2N2148 are available from RCA Distributors under the following RCA Part Numbers:

ITEM	RCA PART NO.
Mica Insulator	495320
Nylon Insulating Washer (2)	495334-7

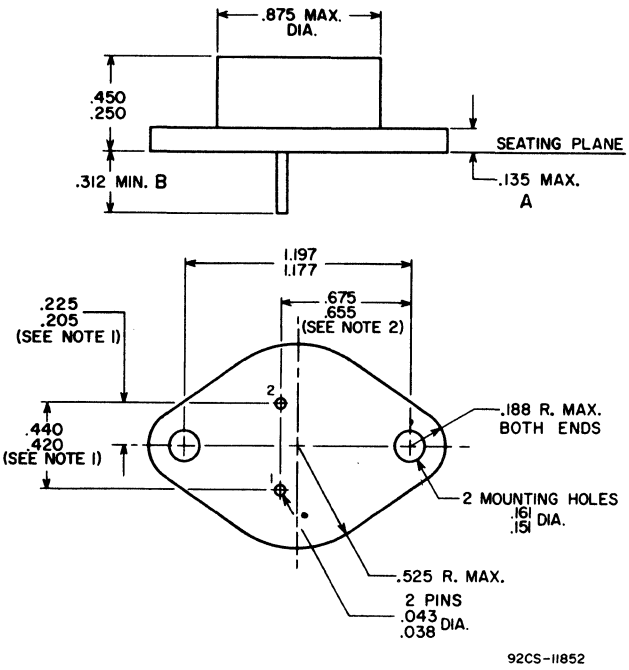
Mica insulators are also available from Reliance Mica Co., 341-351 39th St., Brooklyn, N.Y. 10032, United Mineral & Chemical Corp., 16 Hudson St., N.Y., N.Y. 10014, and other suppliers of similar components.

Insulating shoulder washers are also available from Contour Plastics, Minneapolis, Minn. and other suppliers of similar components.

Sockets for RCA-2N2147 and 2N2148 and other semiconductor devices utilizing the JEDEC TO-3 package are made by several manufacturers, and are generally available from electronic parts distributors.

Fig.13 - Suggested Mounting Arrangement for Types 2N2147, 2N2148.

DIMENSIONAL OUTLINE
For Types 2N2147, 2N2148
JEDEC No.TO-3



DIMENSIONS IN INCHES

NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

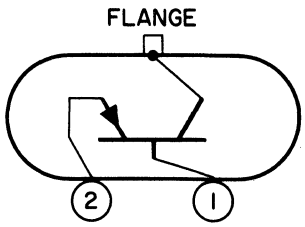
NOTE 2: TWO LEADS.

For RCA-2N2147 and 2N2148

Mounting-Flange Thickness (A) = 0.050" max.

Pin Length (B) = 0.440" min. to 0.480" max.

TERMINAL CONNECTIONS



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

RCA-2N2205 is a double-diffused planar epitaxial transistor of the silicon n-p-n type.

The 2N2205 is designed for use in military and industrial switching applications requiring high reliability and high packaging densities.

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CERL}:		
With R_{BE} = 1000 ohms and R_L = 100 ohms	20 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max.	V
COLLECTOR CURRENT, I_C	200 max.	mA
TRANSISTOR DISSIPATION; P_T:		
At case temperatures[a]: up to 25°C	1 max.	W
At case temperatures[a]: above 25°C	See Fig. 1	
At ambient temperatures: up to 25°C	0.3 max.	W
At ambient temperatures: above 25°C	See Fig. 1	
TEMPERATURE RANGE:		
Storage	-65 to +300	°C
Operating	-65 to +175	°C
LEAD TEMPERATURE:		
≥ 1/16" from seating surface for 10 seconds max.	235 max.	°C

[a]Measured at center of seating surface.

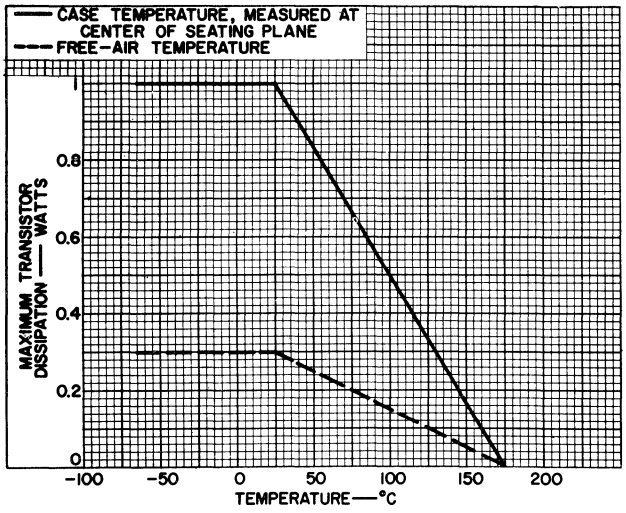
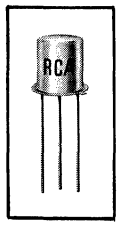


Fig. 1 - Rating Chart for Type 2N2205.

SILICON N-P-N TRANSISTOR

Epitaxial Planar Type

For Switching Applications In Military And Industrial Equipment



JEDEC TO-18

FEATURES:

- **Low collector saturation voltage V_{CE}(sat), 0.22 V at I_C = 10 mA**
- **Low collector cutoff-current I_{CBO}, 0.025 μA at V_{CB} = 15 V**
- **Short storage time — 25 ns max.**
- **Hermetically sealed JEDEC TO-18 package**

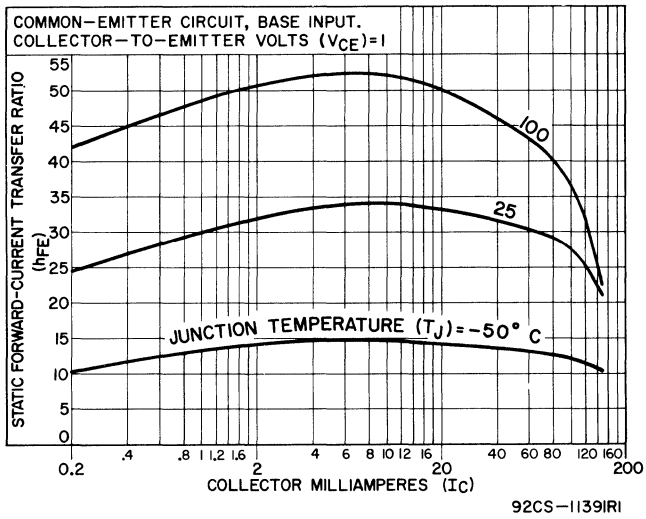


Fig. 2 - Typical DC Current-Transfer-Ratio Characteristics for Type 2N2205.

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ELECTRICAL CHARACTERISTICS

Ambient Temperature, T_A = 25° C unless otherwise specified

Characteristics	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (mA)			Min.	Max.	
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C			
Collector-Cutoff Current:										
T_A = 25° C	I_{CBO}	15	-	-	0	-	-	-	0.025	μA
T_A = 150° C		15	-	-	0	-	-	-	15	μA
Collector Current:										
With base forward biased T_A = 100° C	I_{CEX}	-	10	0.25	-	-	-	-	15	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	-	0.1	25	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	0.1	-	0	3	-	V
Collector-to-Emitter Latching Voltage:										
With R_{BE} = 1000 ohms and R_L = 100 ohms●	V_{CERL}	-	-	-	-	-	-	20	-	V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	-	-	-	1	10	0.7	0.9	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-	-	-	1	10	-	0.22	V
		-	-	-	-	5	50	-	0.35	V
Collector-to-Base Capacitance:										
f = 140 KHz	C_{ob}	10	-	-	0	-	-	-	6	pF
Static Forward Current-Transfer Ratio	h_{FE}	-	1	-	-	-	10	20	-	
Small-Signal Forward Current-Transfer Ratio:										
At frequency of 100 MHz	h_{fe}	-	10	-	-	-	10	2	-	
Storage Time (See Fig. 9):										
With collector supply volts (V_{CC}) = 10 and collector resistor (R_C) = 1000 ohms	t_s	-	-	-	-	I_{B_1} = 10, I_{B_2} = -10	10	-	25	ns
Turn-On Time (delay time plus rise time); see Fig. 10. I_{B_1} = 3 mA I_{B_2} = -1 mA	$t_d + t_r$	-	-	-	-	-	10	-	40	ns
Turn-Off Time (storage time plus fall time); see Fig. 10. I_{B_1} = 3 mA I_{B_2} = -1 mA	$t_s + t_f$	-	-	-	-	-	10	-	75	ns

●*See RCA Application Note SMA-5,* "Collector-to-Emitter Breakdown (BV_{CERL}) Voltage Test Under Operating Conditions."

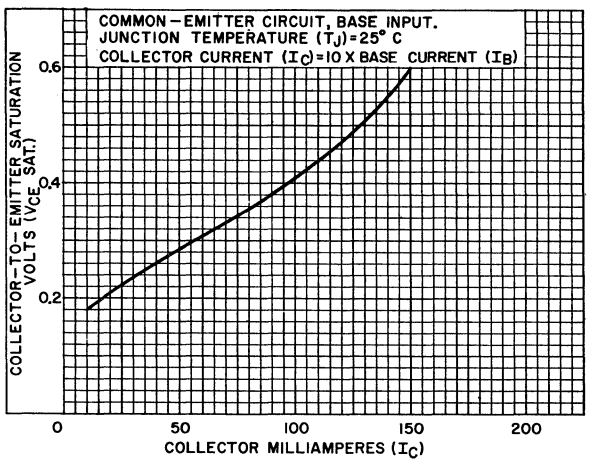


Fig. 3 - Typical Collector-to-Emitter Saturation-Voltage Characteristic for Type 2N2205.

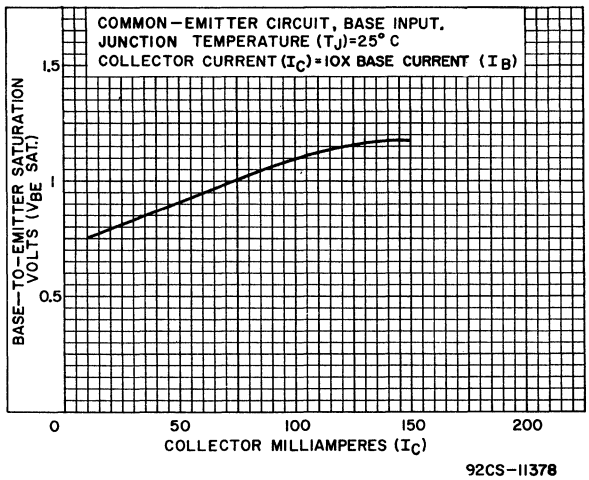


Fig. 4 - Typical Base-to-Emitter Saturation-Voltage Characteristic for Type 2N2205.

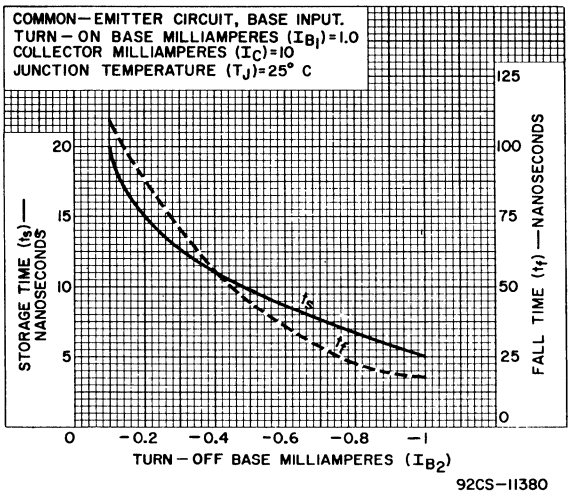


Fig. 5 - Typical Storage and Fall Times vs. Turn-Off Base Current for Type 2N2205.

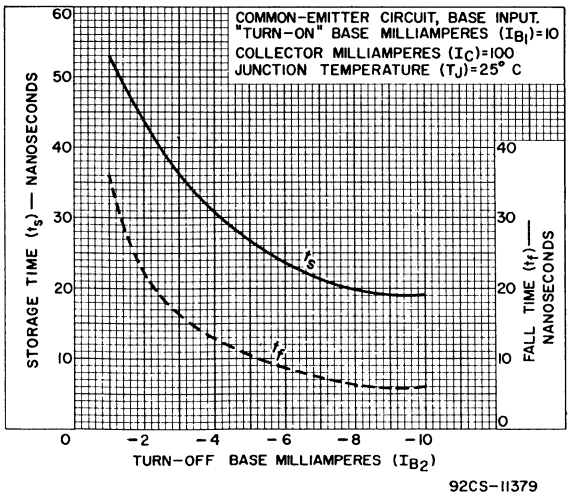


Fig. 6 - Typical Storage and Fall Times vs. Turn-Off Base Current for Type 2N2205.

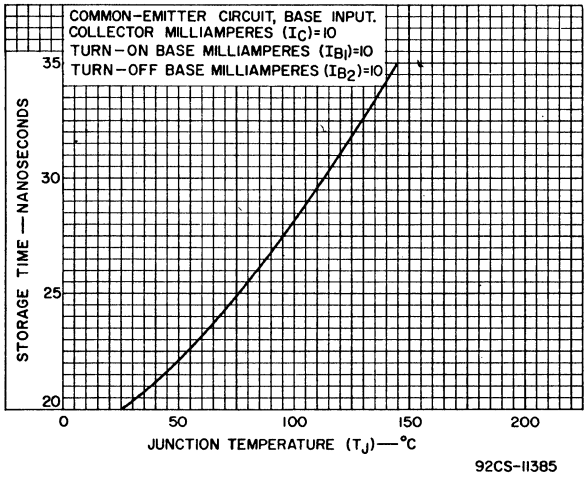


Fig. 7 - Typical Storage Time vs. Temperature for Type 2N2205.

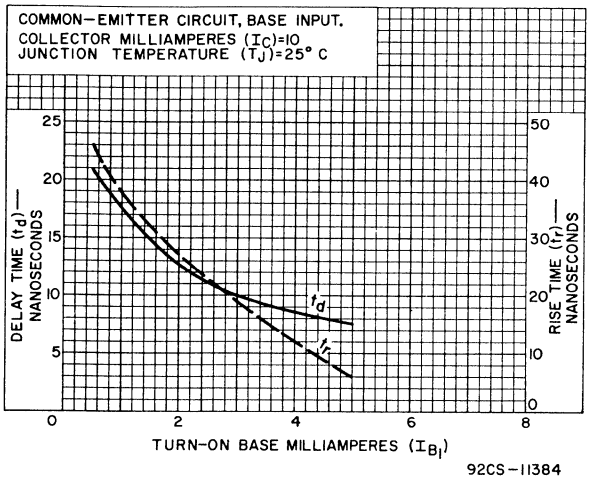


Fig. 8 - Typical Delay and Rise Times vs. Turn-On Base Current for Type 2N2205.

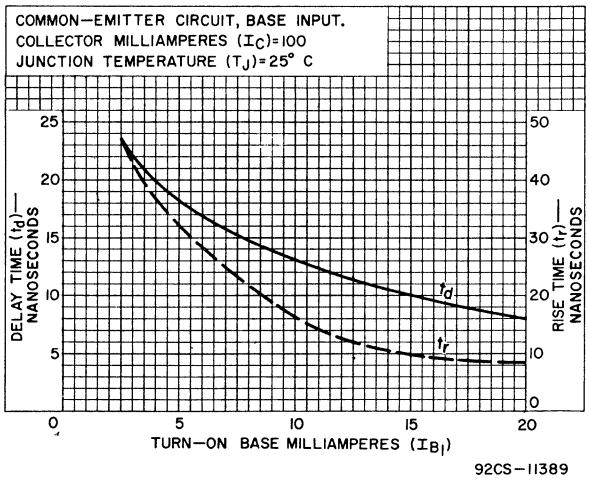
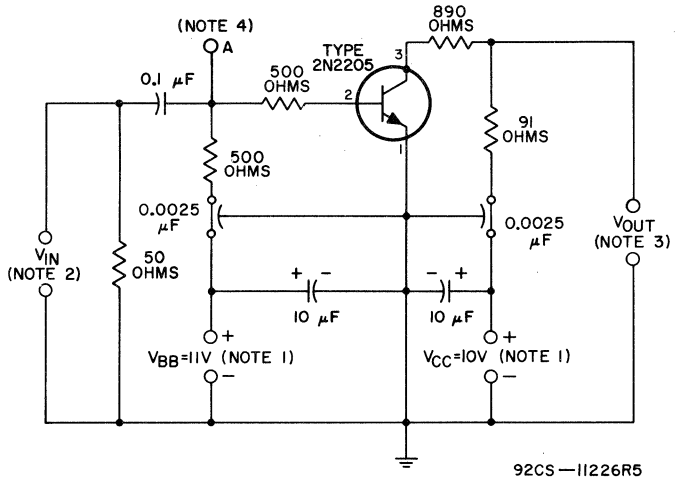


Fig. 9 - Typical Delay and Rise Times vs. Turn-On Base Current for Type 2N2205.



NOTE 1: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μF DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 2: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 3: INPUT AND OUTPUT WAVEFORMS, SHOWN BELOW, SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

NOTE 4: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

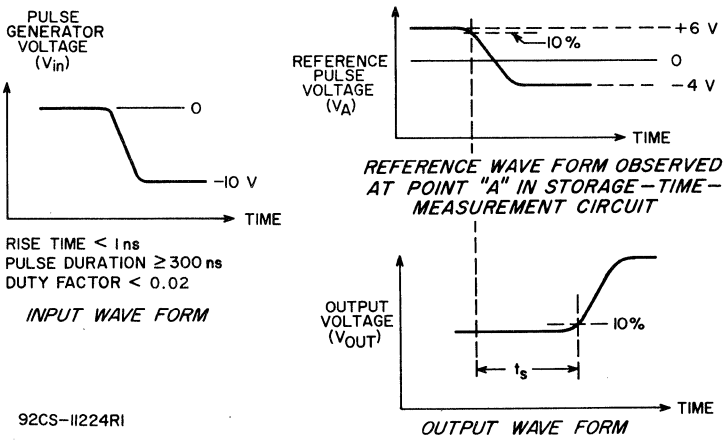
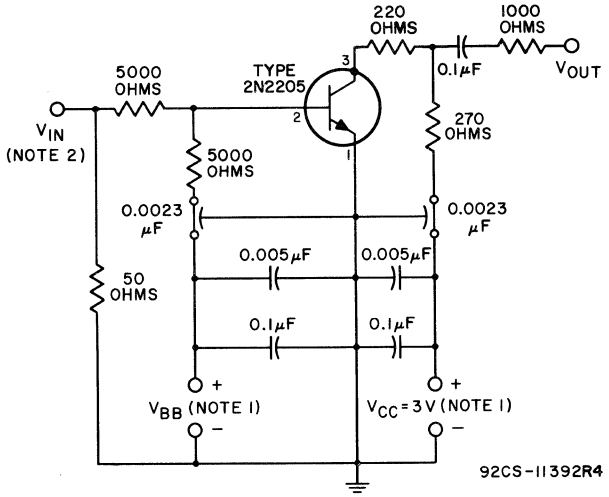


Fig. 10 - Circuit Used to Measure Storage Time (t_s) for Type 2N2205.



NOTE 1: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μF DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 2: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 3: INPUT AND OUTPUT WAVEFORMS, SHOWN BELOW, SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

NOTE 4: ALL RESISTANCE VALUES HAVE ± 1% TOLERANCE.

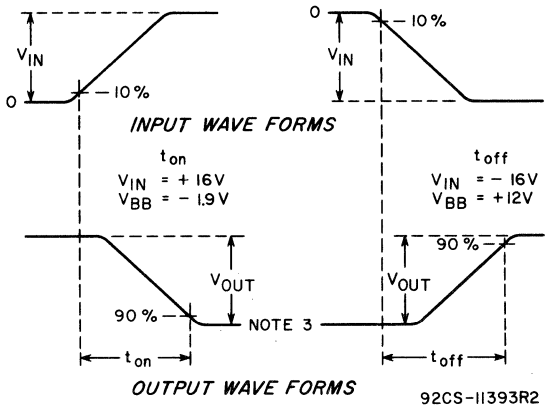
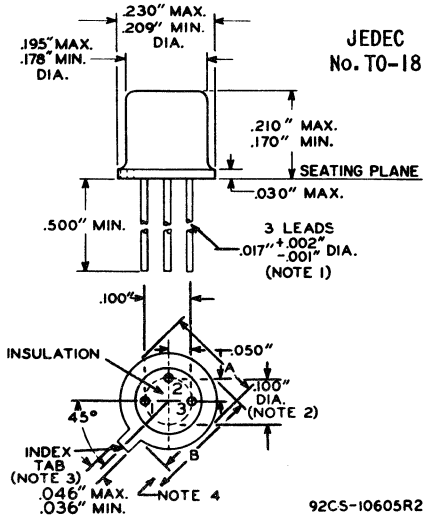


Fig. 11 - Circuit Used to Measure Turn-On Time (t_{on}) and Turn-Off Time (t_{off}) for Type 2N2205.

DIMENSIONAL OUTLINE FOR TYPE 2N2205



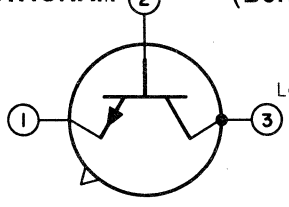
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD, A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: INDEX TAB FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM (Bottom View)



SILICON N-P-N PLANAR TRANSISTOR

2N2270

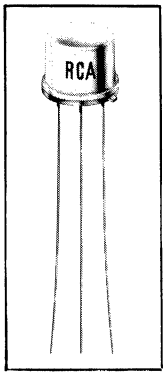
File No. 24

RCA-2N2270 is a *triple-diffused-junction* planar transistor of the silicon n-p-n type intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. It features exceptionally low noise and leakage characteristics, and very low output capacitance.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE:		
With emitter open	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With external $R_{BE} \leq 10$ ohms	60 max.	volts
With base open	45 max.	volts
EMITTER-TO-BASE VOLTAGE:		
With collector open	7 max.	volts
COLLECTOR CURRENT	1 max.	amp
TRANSISTOR DISSIPATION:		
At case temperatures: up to 25° C	5 max.	watts
At case temperatures: above 25° C	See *Rating Chart*	
At free-air temperature: up to 25° C	1 max.	watt
At free-air temperature: above 25° C	See *Rating Chart*	
TEMPERATURE RANGE:		
Storage	-65 to +200	°C
Operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE:		
1/16" ± 1/32" from case for 10 sec. max. immersion	255 max.	°C

For Small-Signal and Medium-Power Applications



JEDEC TO-5

- minimum gain-bandwidth product = 60 Mc, useful in applications from dc to 20 Mc
- operation at high junction temperatures — up to 200° C
- planar construction — insures low noise and low leakage characteristics
- very low output capacitance

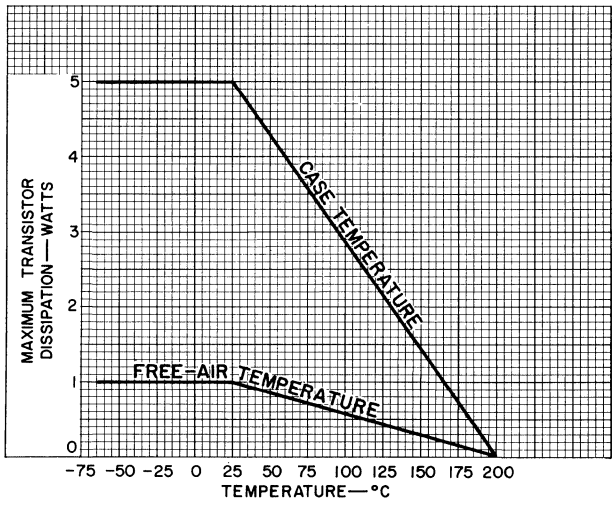


Fig. 1 Rating Chart for Type 2N2270.

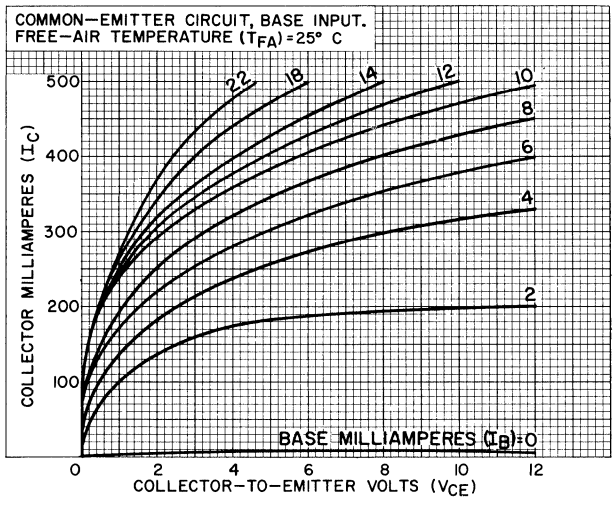


Fig. 2 - Typical Collector Characteristics at 25° C for Type 2N2270.

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Printed in U.S.A.
2N2270 6/66
Reprinted from 2N2270 2/62

ELECTRICAL CHARACTERISTICS:

At Case Temperature (T_C) of 25° C, unless otherwise specified.

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N2270		
		volts	volts	volts	ma	ma	ma	Min.	Max.	
Collector-Cutoff Current: T_C = 25° C = 150° C	I_{CBO}	60 60				0 0		- -	0.1 50	μa μa
Emitter-Cutoff Current	I_{EBO}			5	0			-	0.1	μa
DC Forward-Current Transfer Ratio	h_{FE}		10 10		150* 1			50 35	200 -	
Collector-to-Base Breakdown Voltage	BV_{CBO}				0.1			60	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0.1		7	-	volts
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$				100*			45	-	volts
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance (R_{BE}) = 10 ohms	$V_{CER(sus)}$				100*			60	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				150		15	-	0.9	volt
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$				150		15	-	1.2	volts
Small-Signal Forward-Current Transfer Ratio: At frequency of 1 Kc 20 Mc	h_{fe}		 10 10		 5 50			 30 3	 180 -	
Noise Figure: Generator resistance (R_G) = 1000 ohms, circuit bandwidth (BW) = 15 Kc, input frequency (f) = 1 Kc	NF		10		0.3			-	6	db
Output Capacitance	C_{ob}	10				0		-	15	pf
Input Capacitance	C_{ib}			0.5	0			-	80	pf
Thermal Resistance: Junction-to-case Junction-to-free air	 θ_{J-C} θ_{J-FA}							 - -	 35 175	 °C/W °C/W

* Pulse Test: Pulse duration, 300 μsec; duty factor, 1.8%.

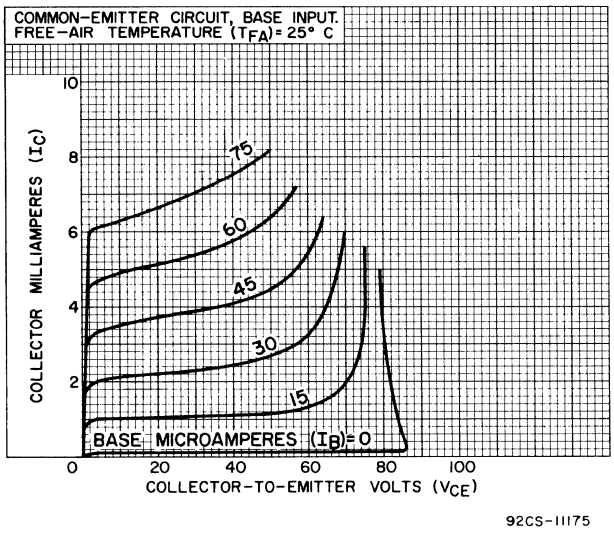


Fig. 3 - Typical Collector Characteristics at 25° C for Type 2N2270.

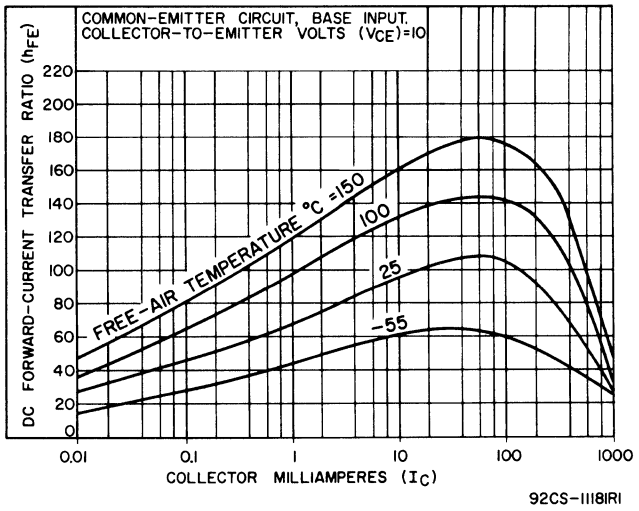


Fig. 4 - Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N2270.

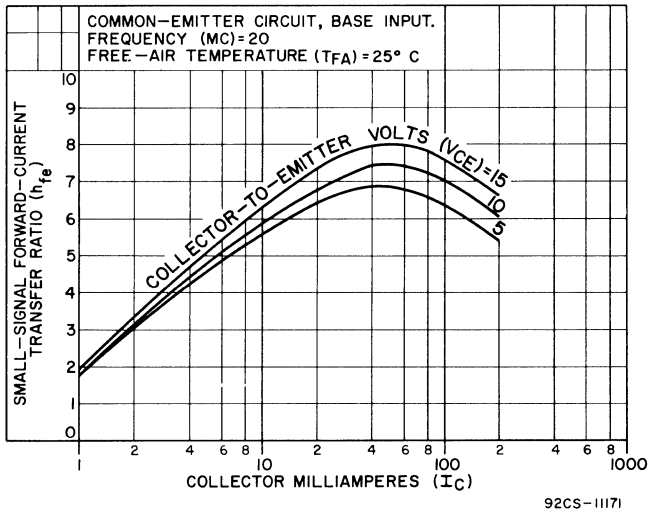


Fig. 5 - Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Type 2N2270.

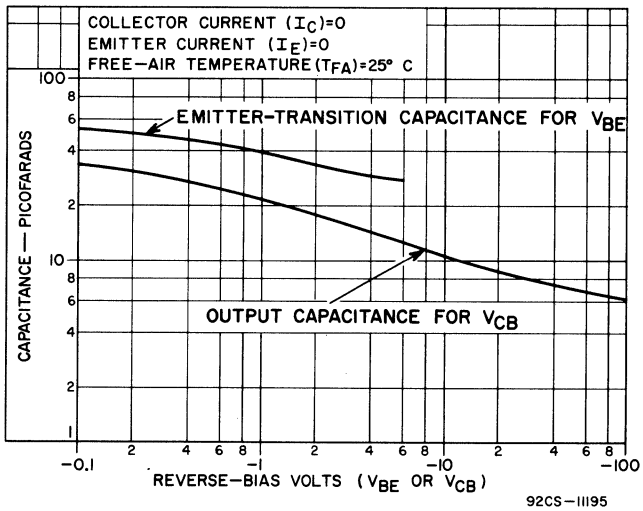


Fig. 6 - Typical Emitter-Transition-Capacitance and Output-Capacitance Characteristics for Type 2N2270.

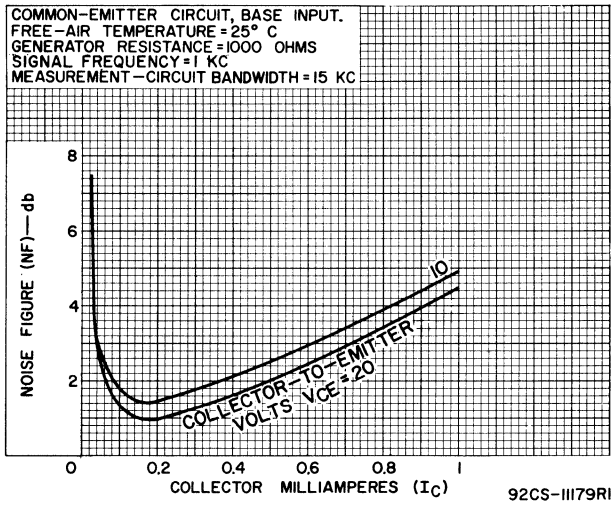
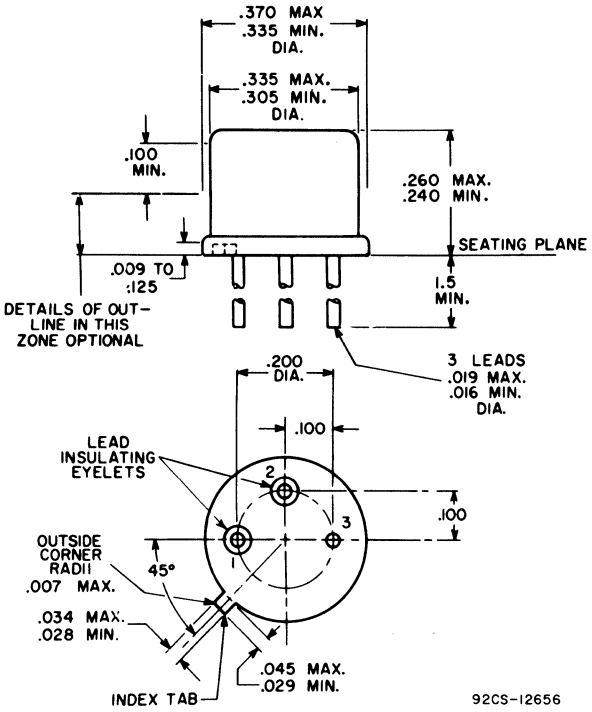


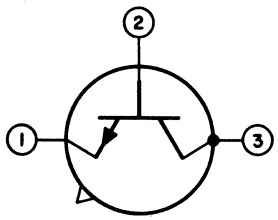
Fig. 7 - Typical AF-Noise-Figure Characteristics for Type 2N2270.

DIMENSIONAL OUTLINE
for Type 2N2270
JEDEC No. TO-5



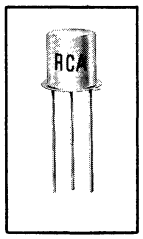
TERMINAL DIAGRAM

LEAD 1 – EMITTER
LEAD 2 – BASE



LEAD 3 – COLLECTOR, CASE

SILICON N-P-N HIGH-SPEED TRANSISTORS



JEDEC TO-18

Planar Epitaxial Types For Switching Applications In Military and Commercial Digital Equipment

RCA 2N2369A and 2N3011 are planar epitaxial transistors of the silicon n-p-n type especially suitable for high-speed saturated switching in logic applications.

The 2N2369A and 2N3011 are capable of operating over a wide range of collector current, and feature a special internal design which provides an exceptionally high ratio of emitter periphery to area. This design makes it possible to achieve both high beta and high switching speed at high values of collector current. In addition these devices feature low cutoff currents, low saturation voltages, and exceptional stability of characteristics.

The 2N2369A and 2N3011 utilize a hermetically sealed JEDEC TO-18 package.

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N2369A	2N3011	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40	30	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15	12	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4.5	5	V
COLLECTOR CURRENT, I_C	0.2	0.2	A
TRANSISTOR DISSIPATION, P_T:			
For case temperatures[a] up to 25°C	1.2	1.2	W
For case temperatures[a] above 25°C	Derate at 6.85 mW/°C		
For free-air temperatures up to 25°C	0.36	0.36	W
For free-air temperatures above 25°C	Derate at 2.06 mW/°C		
TEMPERATURE RANGE:			
Storage	-65°C to +200°C		
Operating (Junction)	-65°C to +200°C		
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/16" from seating surface for 60 seconds max.	300	300	°C

[a] Measured at center of seating surface.

Features:

- **low saturation voltages:**
  $V_{CE(sat)}$ = 0.5 V max. at I_C = 100 mA
  $V_{BE(sat)}$ = 1.6 V max. at I_C = 100 mA
- **wide operating temperature range**
  -65 to +200°C
- **low output capacitance**
  C_{ob} = 4.0 pF max.
- **high switching speeds**
  2N2369A:
  t_{on} = 12 ns, t_{off} = 18 ns at I_C = 10 mA, I_{B1} = 3 mA
  2N3011:
  t_{on} = 15 ns, t_{off} = 20 ns at I_C = 30 mA, I_{B1} = 3 mA

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Printed in U.S.A.
2N2369A, 2N3011 8-66
Supersedes issued dated 11-65

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols and Units	LIMITS				TEST CONDITIONS							
		Type 2N2369A		Type 2N3011		Ambient Temperature	Frequency	DC Collector-to-Emitter Voltage	DC Collector-to-Base Voltage	DC Emitter-to-Base Voltage	DC Emitter Current	DC Collector Current	DC Base Current
						T_A	f	V_{CE}	V_{CB}	V_{EB}	I_E	I_C	I_B
		Min.	Max.	Min.	Max.	°C	MHz	V	V	V	mA	mA	mA
Collector-Cutoff Current	I_{CBO} μA	-	30	-	-	150			20		0		
Collector-Cutoff Current	I_{CES} μA	- -	0.4 -	- -	0.4 10	25 85		20 20		0 0			
Collector-to-Base Breakdown Voltage	BV_{CBO} V	40 -	- -	- 30	- -	25 25					0 0	0.01 0.01	
Collector-to-Emitter Breakdown Voltage	BV_{CES} V	40 -	- -	- 30	- -	25 25				0 0		0.01 0.01	
Emitter-to-Base Breakdown Voltage	BV_{EBO} V	4.5 -	- -	- 5	- -	25 25					0.01 0.1	0 0	
Collector-to-Emitter Sustaining Voltage (Base open)	$V_{CE(sus)}$* V	15	-	12	-	25						10	
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$ V	- - - - -	0.2 - 0.3 0.25 0.5	- - - - -	0.2 * 0.3 * - 0.25* 0.5 *	25 85 125 25 25						10 10 10 30 100	1 1 1 3 10
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$ V	0.7 0.59 - - -	0.85 - 1.02 1.15 1.6	0.72 - - - -	0.87 - - 1.15 1.6	25 125 -55 25 25						10 10 10 30 100	1 1 1 3 10
Static Forward Current-Transfer Ratio	h_{FE}*	40 - 30 20 20	- 120 - - -	30 - 25 - 12	120 - - - -	25 25 25 -55 25		0.35 1 0.4 0.35 1				10 10 30 10 100	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\|h_{fe}\|$	5 -	- -	- 4	- -	25 25	100 100	10 10				10 20	
Common-Base, Open-Circuit Output Capacitance	C_{ob} pF	-	4	-	4	25	0.14		5		0		
									V_{CC}	$V_{BE(off)}$	I_{B_1}	I_C	I_{B_2}
									V	V	mA	mA	mA
Turn-On Time (See Figs.2 & 3)	t_{on} ($t_d + t_r$) ns	- -	12 -	- -	- 15	25 25			3 2	-3 0	3 3	10 30	- -
Turn-Off Time (See Figs.2 & 3)	t_{off} ($t_s + t_f$) ns	- -	18 -	- -	- 20	25 25			3 2		3 3	10 30	-1.5 -3
Storage Time (See Fig.1)	t_s ns	-	13	-	13	25			10		10	10	-10

* Pulse Test Conditions: Duration = 300 μs, duty factor $\leq$ 0.02.

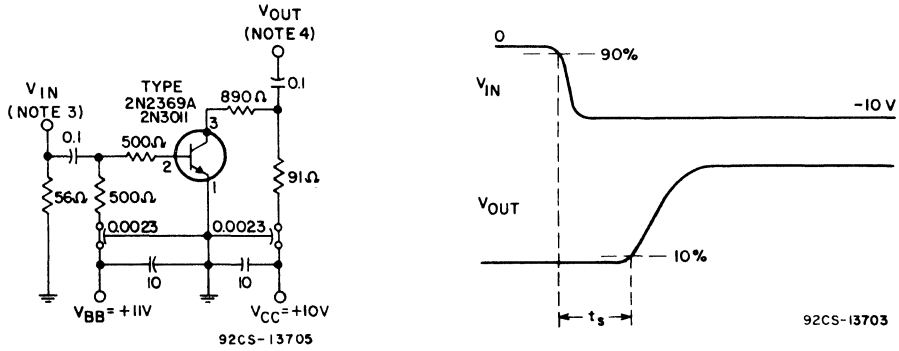


Fig. 1 - Storage Time Test Circuit and Waveforms for 2N2369A and 2N3011.

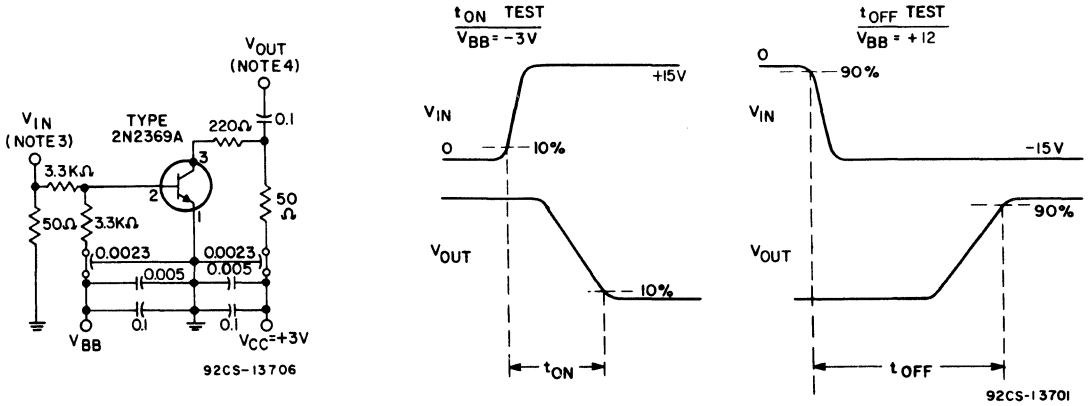


Fig.2 - Switching Time Test Circuit and Waveforms for 2N2369A.

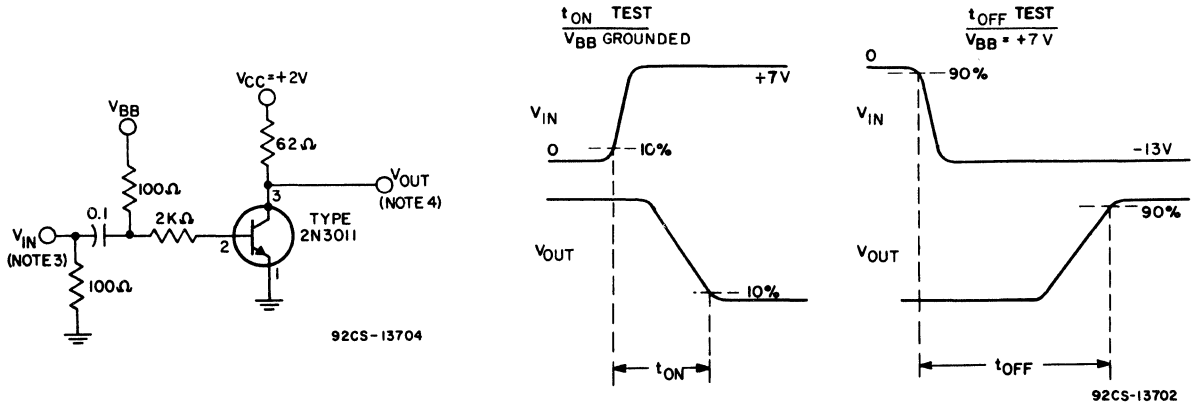


Fig.3 - Switching Time Test Circuit and Waveforms for 2N3011.

NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE; ALL CAPACITANCE VALUES ARE IN μF.

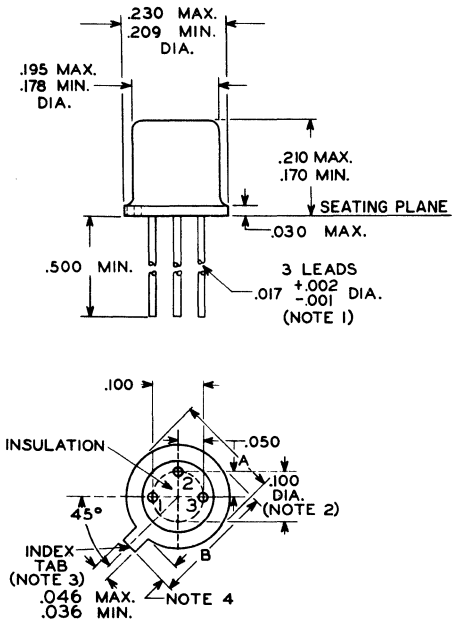
NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μF DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 ns; PULSE DURATION > 200 ns; AND DUTY FACTOR < 0.02.

NOTE 4: INPUT AND OUTPUT WAVEFORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 1 ns AND WITH A PROBE HAVING A SERIES RESISTANCE OF ≥ 100 KΩ SHUNTED BY CAPACITANCE OF < 2.5 pF.

DIMENSIONAL OUTLINE FOR 2N2369A and 2N3011

JEDEC No. TO-18



NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

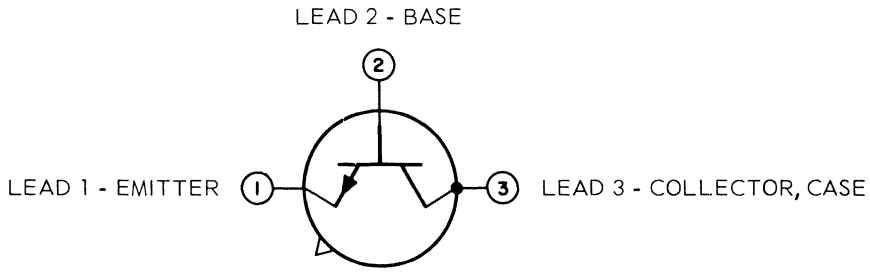
NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM

Bottom View



SILICON N-P-N PLANAR TRANSISTORS

2N2405
2N1893

File No. 34

RCA 2N2405▲ and 2N1893 are triple-diffused planar transistors of the silicon n-p-n type intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. They feature exceptionally high collector-to-emitter sustaining voltage, low leakage characteristics, high switching speeds, and high pulse beta (h_{FE}).

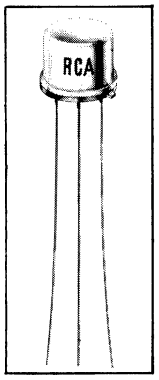
RCA 2N2405 is a direct replacement for type 2N1893 for most applications. In addition, the 2N2405 has higher voltage ratings (V_{CEO}, V_{CER}), lower saturation voltages ($V_{CE}sat$, $V_{BE}sat$), and higher sustaining voltages ($V_{CEO}sus$, $V_{CER}sus$) than the 2N1893.

Maximum Ratings, *Absolute-Maximum Values:*

	2N2405	2N1893	
COLLECTOR-TO-BASE VOLTAGE (V_{CBV}):			
With 1.5 volts reverse bias between base and emitter . .	120	-	max. volts
COLLECTOR-TO-BASE VOLTAGE (V_{CBO}):			
With emitter open. .	120	120	max. volts
COLLECTOR-TO-EMITTER VOLTAGE (V_{CER}):			
With external R_{BE} ≤ 10 ohms.	140	100	max. volts
With external R_{BE} = 500 ohms	120	-	max. volts
COLLECTOR-TO-EMITTER VOLTAGE (V_{CEO}):			
With base open . . .	90	80	max. volts
EMITTER-TO-BASE VOLTAGE (V_{EBO}):			
With collector open.	7	7	max. volts
COLLECTOR CURRENT (I_C)	1	0.5	max. amp
TRANSISTOR DISSIPATION (P_T):			
At case temperatures up to 25° C.	5	3	max. watts
At case temperatures above 25° C.	See *Fig.1*	See *Fig.2*	
At free-air temperatures up to 25° C.	1	0.8	max. watt
At free-air temperatures above 25° C.	See *Fig.1*	See *Fig.2*	
TEMPERATURE RANGE:			
Storage.	-65to+200	-65to+300	°C
Operating (Junction).	-65to+200	-65to+200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32" from seating surface for 10 seconds max..	255	255	max. °C

▲ Formerly Developmental No. TA-2235A

For Small-Signal and Medium-Power Applications



JEDEC TO-5

- operation at high junction temperature—up to 200° C
- planar construction—insures low noise and low leakage characteristics
- very low output capacitance

RCA-2N2405 Features

- minimum gain-bandwidth product = 120 Mc, useful in applications from dc to 50 Mc
- high sustaining voltage—$V_{CEO}(sus)$ = 90 volts minimum at I_C = 100 ma, controlled for values of R_{BE} from 0 to 100000 ohms
- very low saturation voltages—
  $V_{CE}(sat)$ = 0.5 volt maximum at I_C = 150 ma
  $V_{BE}(sat)$ = 1.1 volts maximum at I_C = 150 ma

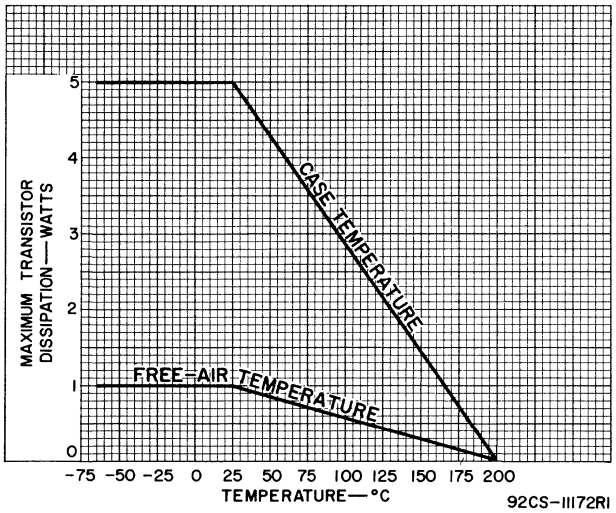


Fig. 1 - Rating Chart for Type 2N2405.

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Printed in U.S.A.
2N2405, 2N1893 6/66
Reprinted from 2N2405, 2N1893 6/63

ELECTRICAL CHARACTERISTICS, *Case temperature, T_C = 25° C unless otherwise specified:*

Characteristic	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Emitter Volts	DC Current (ma)			Type 2N2405		Type 2N1893		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: T_C = 25° C 150° C	I_{CBO}	90 90			0 0			- -	0.01 10	- -	0.01 15	μa μa
Emitter-Cutoff Current	I_{EBO}			5			0	-	0.01	-	0.01	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	120	–	120	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	7	–	7	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					15 5	150 50	- -	0.5 0.2	- -	5 1.2	volts volts
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$					15 5	150 50	- -	1.1 0.9	- -	1.3 0.9	volts volt
Collector-to-Emitter Sustaining Voltage: With base open With external R_{BE} = 10 ohms 500 ohms	 $V_{CEO}(sus)$ $V_{CER}(sus)$					 0 0	 100[b] 30[b] 100[b] 100[b]	 90 90 140 120	 – – – –	 - 80 100 -	 – – – –	 volts volts volts volts
DC Forward-Current Transfer Ratio: T_C = -55° C	h_{FE}		10 10 10 10 10				500[b] 150[b] 10 0.1 10	25 60 35 - 20	– 200 – – –	- 40 35 20 20	– 120 – – –	
Small-Signal Forward-Current Transfer Ratio: f = 1 kc 1 kc 1 kc 20 Mc	h_{fe}		5 5 10 10				1 5 5 50	- 50 - 6	– 275 – –	30 - 45 2.5	100 – – –	
Input Resistance (at f = 1 kc)	h_{ib}	5 10					1 5	24 4	34 8	20 4	30 8	ohms ohms
Voltage-Feedback Ratio (at f = 1 kc)	h_{rb}	5 10					1 5	- -	3×10^{-4} 3×10^{-4}	- -	1.25×10^{-4} 1.5×10^{-4}	
Output Conductance (at f = 1 kc)	h_{ob}	5 10					1 5	- -	0.5 0.5	- -	0.5 0.5	μmho μmho
Output Capacitance	C_{ob}	10			0			-	15	-	15	pf
Input Capacitance	C_{ib}			0.5			0	-	80	-	85	pf
Noise Figure (Wide-Band) Generator resistance (R_G) = 500 ohms Circuit Bandwidth (BW) = 15 kc Reference signal frequency = 1 kc	NF		10				0.3	-	6	-	–	db
Thermal Resistance: Junction-to-case Junction-to-free air	 θ_{J-C} θ_{J-FA}							 - -	 35 175	 - -	 58.3 219	 °C/watt °C/watt

[b] Pulsed. Pulse duration = 300 μsec; duty factor = 1.8%.

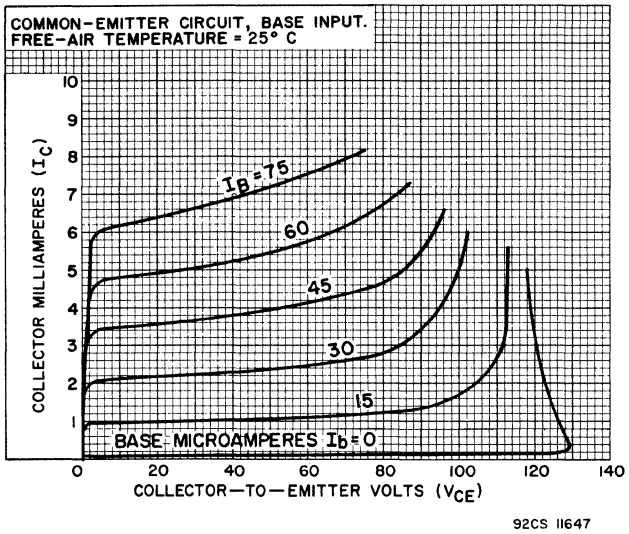


Fig. 8 - Typical Collector Characteristics at 25° C for Type 2N2405.

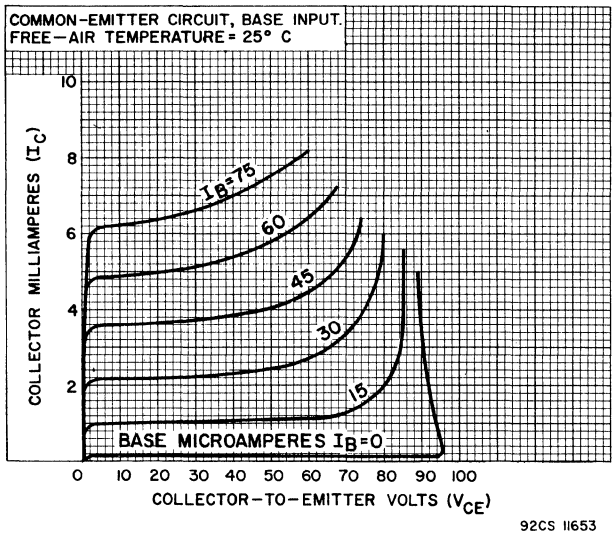


Fig. 9 - Typical Collector Characteristics at 25° C for Type 2N1893.

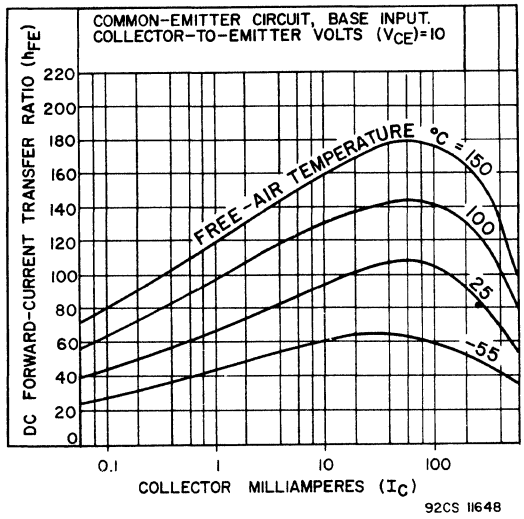


Fig. 10-Typical DC Beta Characteristics for Types 2N2405 and 2N1893.

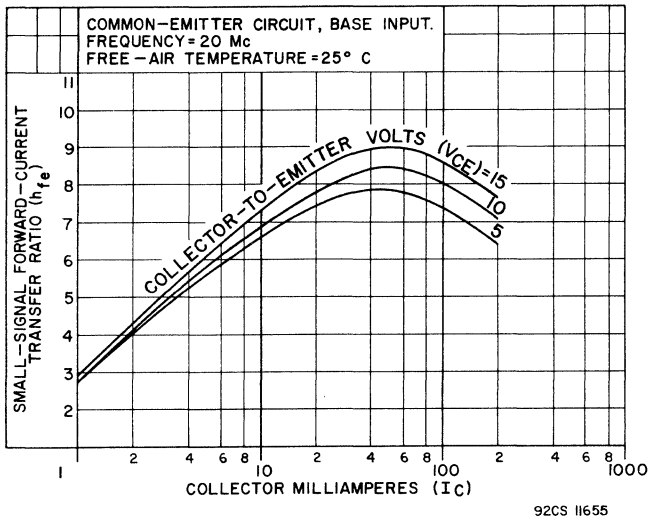


Fig. 11-Typical Small-Signal Beta Characteristics for Types 2N2405 and 2N1893.

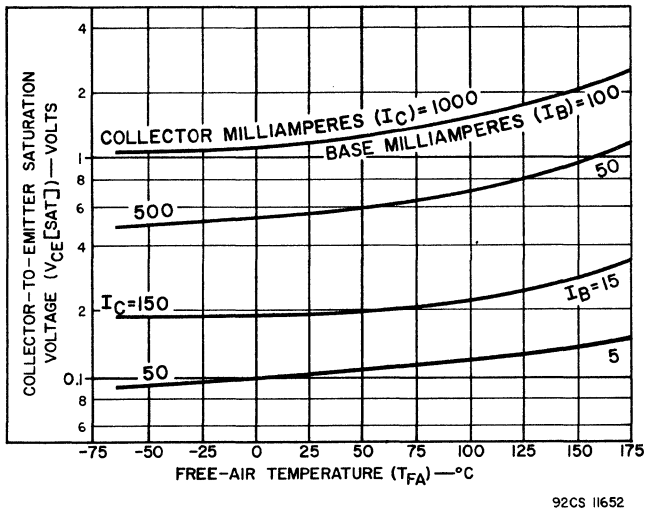


Fig. 12 - Typical Saturation Characteristics for Types 2N2405 and 2N1893.

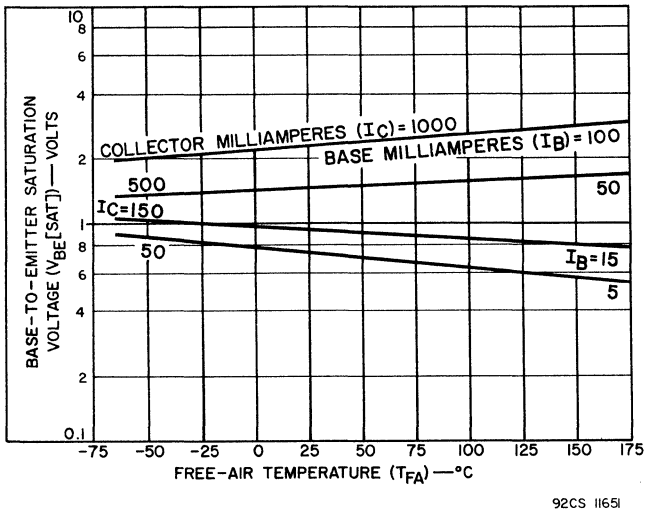


Fig. 13 - Typical Saturation Characteristics for Types 2N2405 and 2N1893.

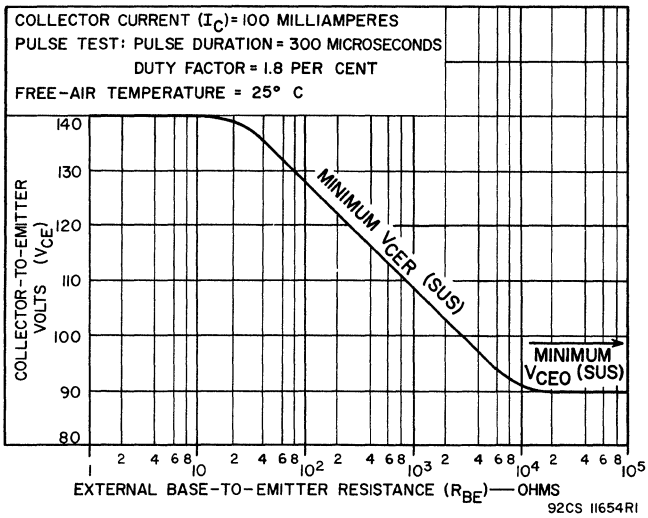


Fig. 14 - Sustaining Voltage Characteristic for Type 2N2405.

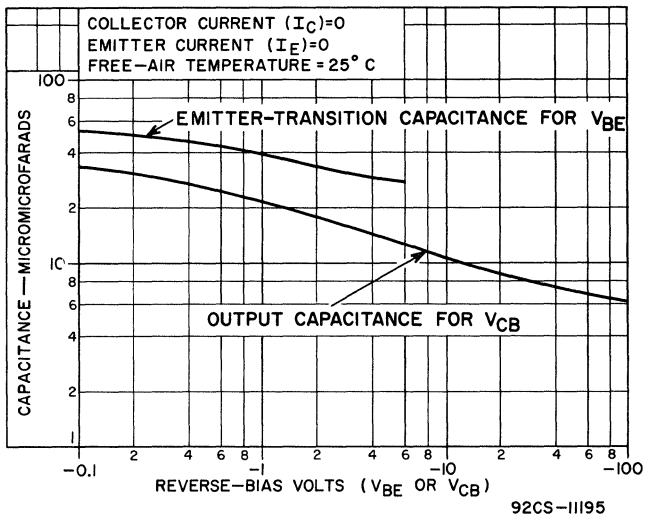


Fig. 15 - Typical Capacitance Characteristics for Types 2N2405 and 2N1893.

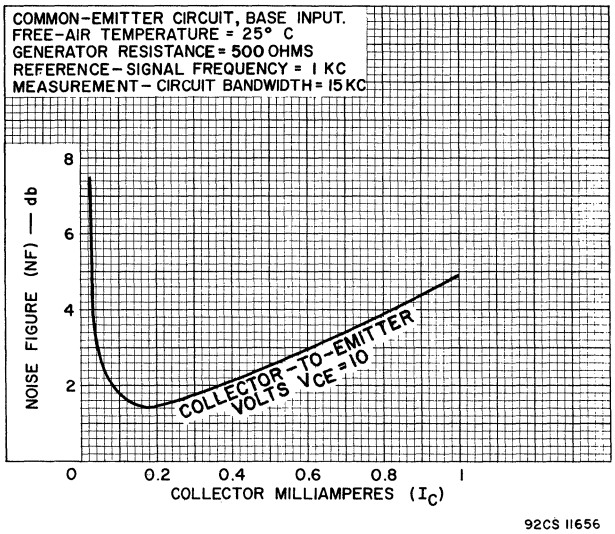


Fig. 16 - Typical Wide-Band Noise Characteristic for Type 2N2405.

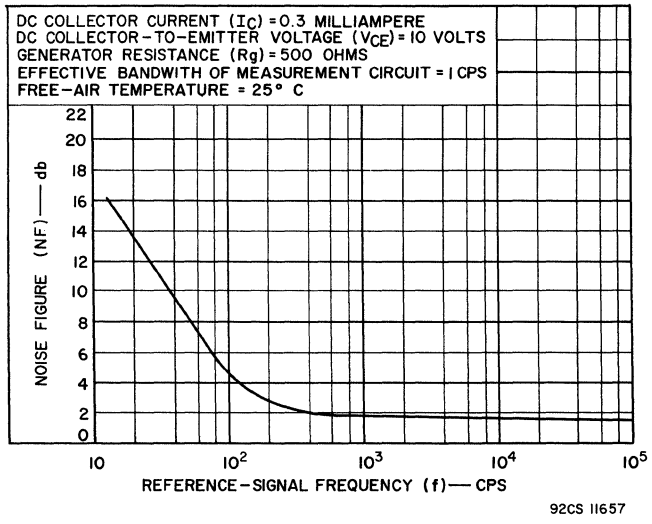


Fig. 17 - Typical Narrow-Band Noise Characteristic for Type 2N2405.

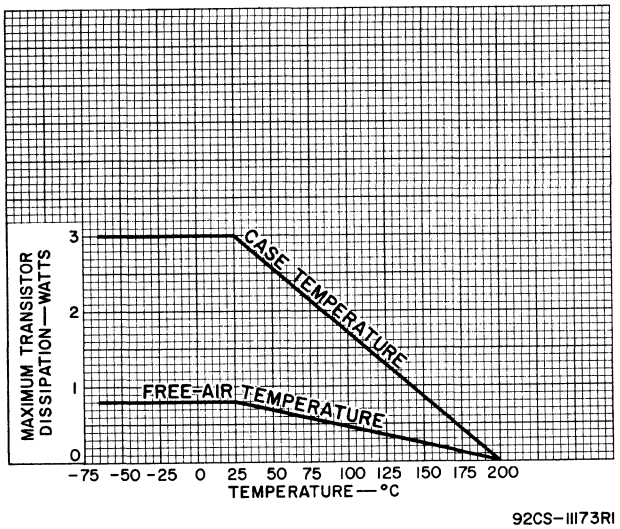


Fig. 2 - Rating Chart for Type 2N1893.

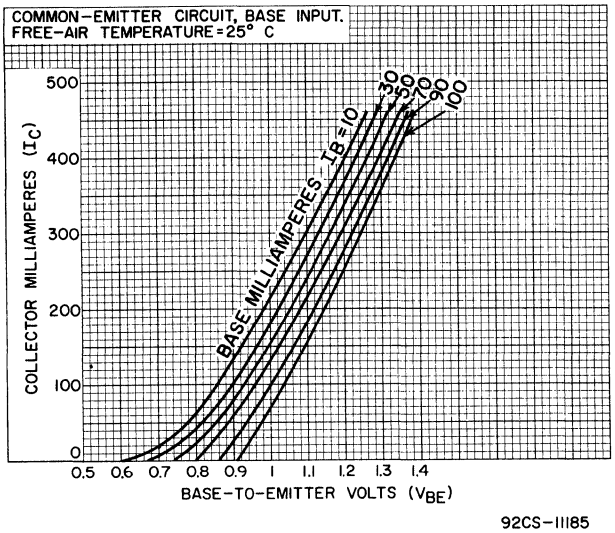


Fig. 3 - Typical Transfer Characteristics for Types 2N2405 and 2N1893.

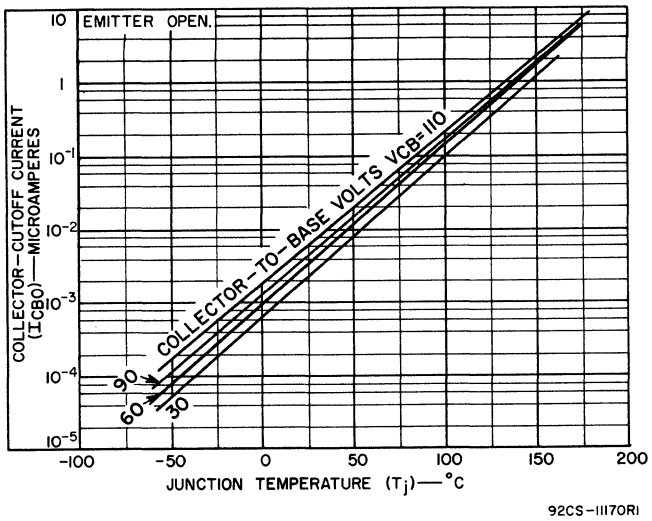


Fig. 4 - Typical Cutoff Characteristics for Types 2N2405 and 2N1893.

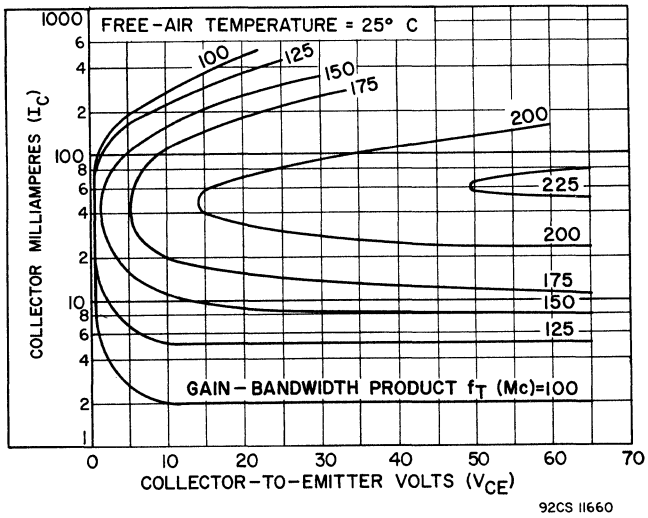


Fig. 5 - Typical Gain-Bandwidth Product Characteristics for Types 2N2405 and 2N1893.

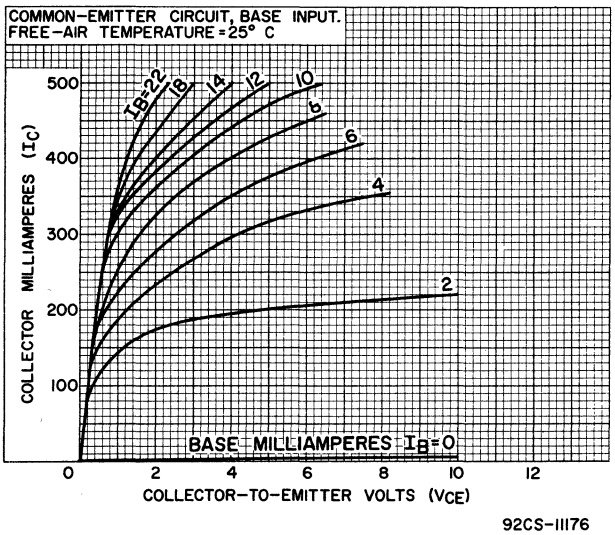


Fig. 6 - Typical Collector Characteristics at 25° C for Type 2N2405.

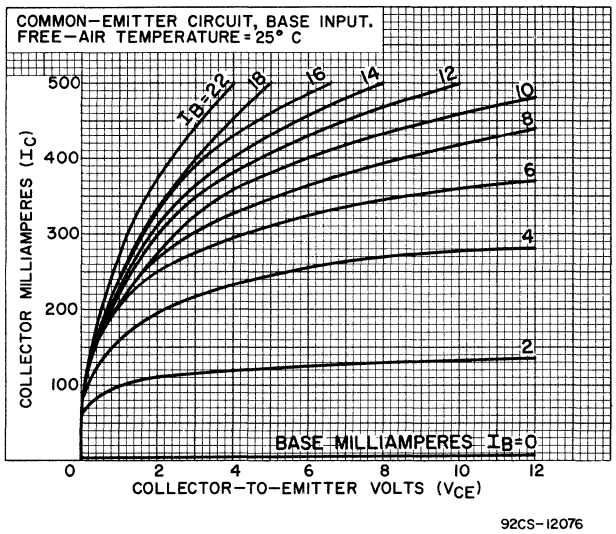
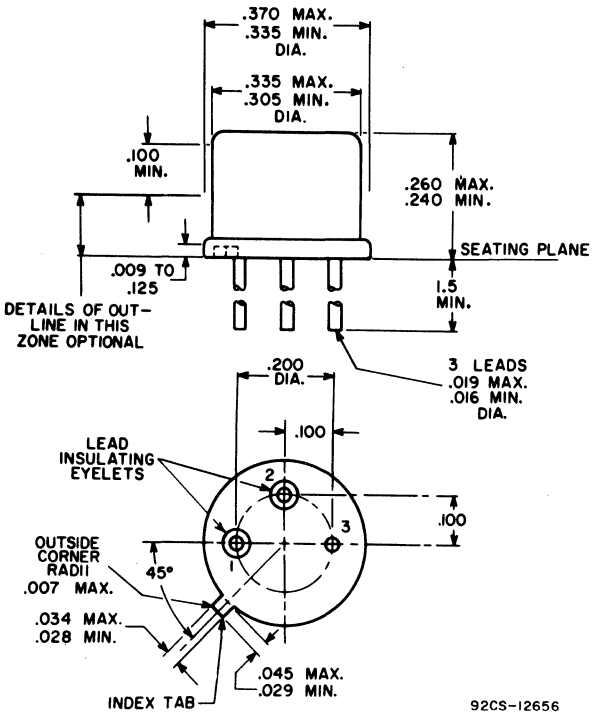


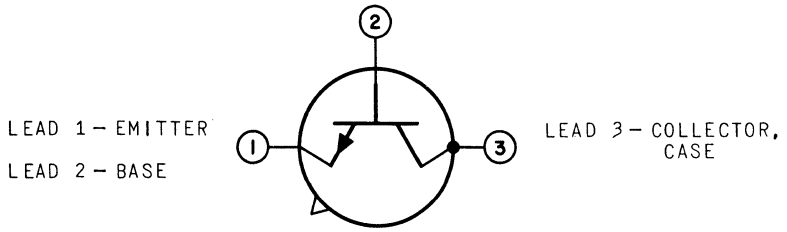
Fig. 7 - Typical Collector Characteristics at 25° C for Type 2N1893.

DIMENSIONAL OUTLINE
All Dimensions in Inches

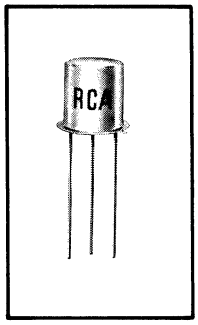
JEDEC No. TO-5



TERMINAL DIAGRAM



SILICON N-P-N ULTRA-HIGH-SPEED TRANSISTORS



Epitaxial Planar Types For Switching Applications In Military and Commercial Data-Processing Equipment

RCA-2N2475 and 2N709 are silicon epitaxial planar transistors specifically designed for ultra-high-speed logic-circuit applications.

The exceptional stability and ruggedness of the planar construction of these types together with their ultra-high switching speeds make these transistors especially suited for use in logic-circuit applications in military and commercial data-processing equipment.

The 2N2475 can replace the 2N709 and features a wider useful range of collector current and higher switching speeds.

RCA-2N2475 utilizes a new small transistor package which is similar to the standard JEDEC TO-18 package except for smaller case height.

- epitaxial structure — insures low collector saturation voltage at high collector current
- planar construction — insures low collector cutoff current (I_{CBO}) and exceptional stability throughout life
- short storage time (t_s) — 6 nsec maximum
- low collector cutoff current (I_{CBO})—0.05 μa maximum
- high gain-bandwidth product (f_T) — 600 Mc minimum
- low output capacitance (C_{ob}) — 3 pf maximum

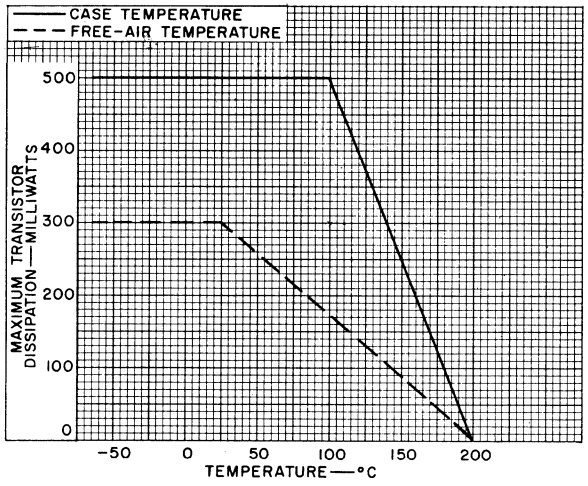
RCA–2N2475 Also Features:

- wider useful range of collector current
- higher switching speeds

COMPUTER SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N2475	2N709	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	15	15 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	6	6 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4 max.	volts
COLLECTOR CURRENT, I_C. .	Limited by power dissipation		
TRANSISTOR DISSIPATION:			
At free-air temperatures up to 25° C	300	300 max.	mw
above 25° C	See *Fig.1*		
At case temperatures up to 100°C	500	500 max.	mw
above 100°C	See *Fig.1*		
TEMPERATURE RANGE:			
Storage	-65 to +200	-65 to +200	°C
Operating (Junction).	-65 to +200	-65 to +200	°C
LEAD TEMPERATURE:			
1/16" ± 1/32" from seating surface for 10 seconds max. . . .	300	300 max.	°C



92CS-11733

Fig. 1 - Rating Chart for Types 2N2475 and 2N709.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N2475, 2N709 7-66
Supersedes issue dated 7-62

Electrical Characteristics, *Free-air temperature (T_{FA}) = 25° C unless otherwise specified*

Characteristic	Symbol	TEST CONDITIONS										LIMITS						Units
		Circuit	DC Collector Volts			DC Emitter Volts	DC Milliamperes					Type 2N2475			Type 2N709			
			V_{CE}	V_{CB}	V_{CC}	V_{EB}	I_C	I_B	I_E	I_{B_1}	I_{B_2}	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector Cutoff Current: At T_{FA} = 25°C At T_{FA} = 150°C	I_{CBO}			5 5					0 0			- -	0.002 0.9	0.05 5	- -	0.002 0.9	0.05 5	μa μa
Collector-to-Emitter Sustaining Voltage	$V_{CEO}(sus)$ [a]						10	0				6	10	-	6	10	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$						3 20	0.15 0.66				-	0.28	0.4	-	0.26	0.3	volt volt
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$						3 20	0.15 0.66				0.8	0.9	1.0	0.7	0.77	0.85	volt volt
Collector-to-Base Breakdown Voltage	BV_{CBO}						0.01		0			15	30	-	15	30	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}						0		0.01			4	7	-	4	7	-	volts
DC Forward Current Transfer Ratio:																		
At T_{FA} = 25°C	h_{FE}		1				30								15	43	-	
= 25°C			0.3				1					20	40	-				
= 25°C			0.5				10								20	53	120	
= 25°C			0.5				50					20	36	-				
= 25°C			0.4				20					30	50	150				
= -55°C			0.4				20					15	24	-				
= -55°C			0.5				10								10	29	-	
Small-Signal Forward-Current Transfer Ratio	h_{fe} [b]		4 2				5 20					6	8	-	6	8	-	
Output Capacitance	C_{ob} [c]			5					0			-	2.4	3	-	2.1	3	pf
Input Capacitance	C_{ib} [c]					0.5	0					-	2.0	2.5	-	1.8	2	pf
Storage Time	t_s	Fig. 2					5			5	5	-	3.2	6	-	4.1	6	nsec
Turn-On Time (delay time plus rise time)	t_{on}	Fig. 3					20 10			1 2	1 1	-	7.3	20	-	6.4	15	nsec nsec
Turn-Off Time (storage time plus fall time)	t_{off}	Fig. 3					10 20			1 1	1 1	-	9.0	15	-	8.3	15	nsec nsec

[a] Pulsed conditions

[b] At 100 Mc

[c] At 140 Kc (approx.)

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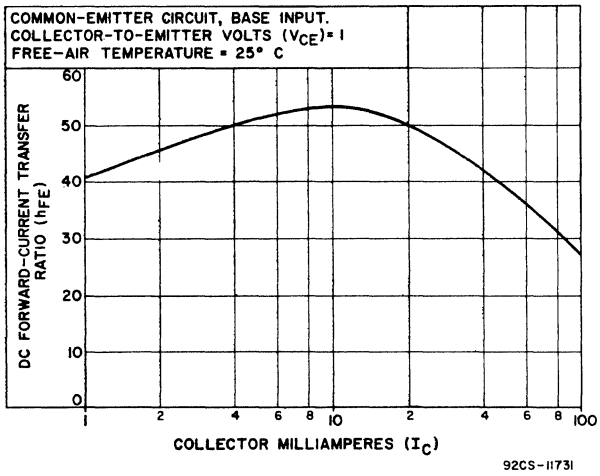


Fig. 4 - Typical DC Forward-Current Transfer-Ratio Characteristic for Type 2N2475.

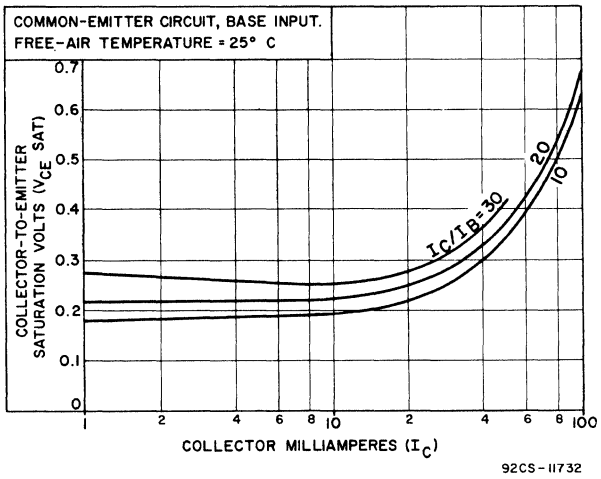


Fig. 7 - Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N2475.

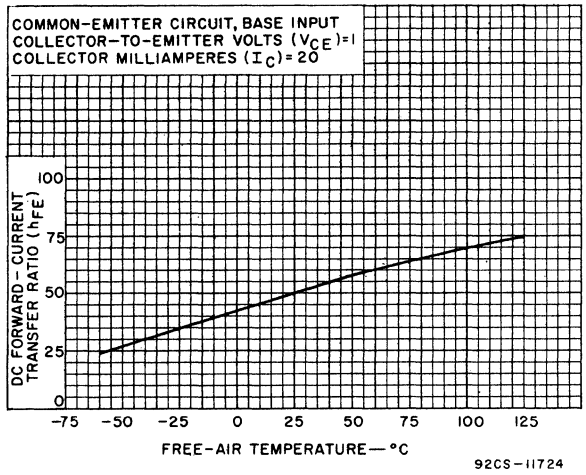


Fig. 5 - Typical DC Forward-Current Transfer-Ratio Characteristic for Type 2N2475.

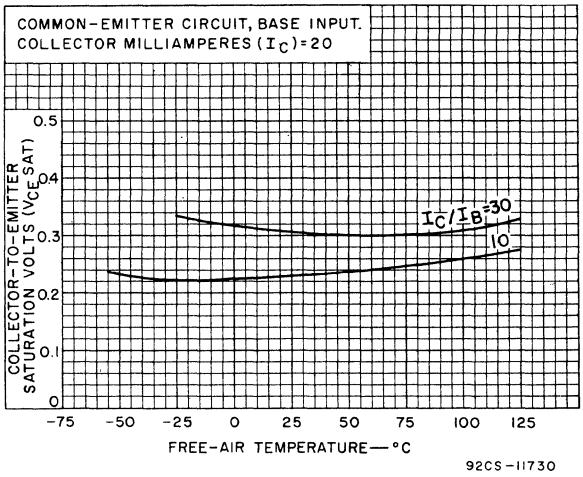


Fig. 8 - Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N2475.

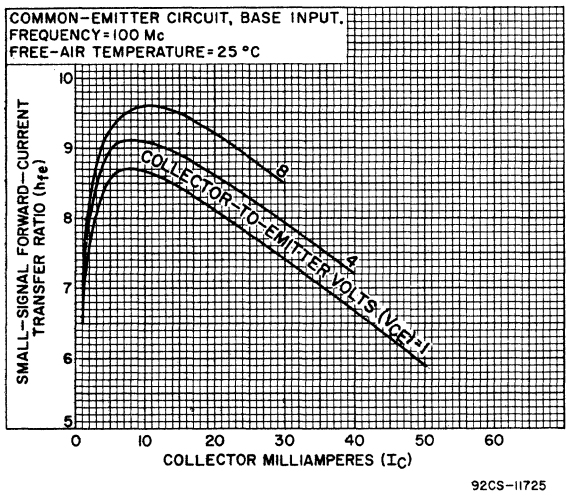


Fig. 6 - Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Type 2N2475.

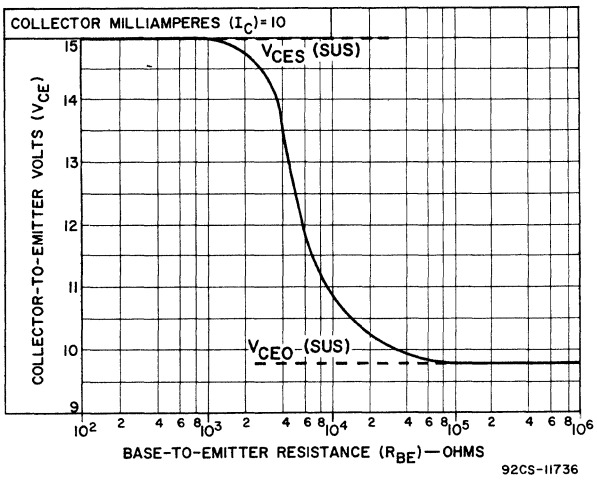


Fig. 9 - Typical Collector-to-Emitter Sustaining Voltage Characteristic for Type 2N2475.

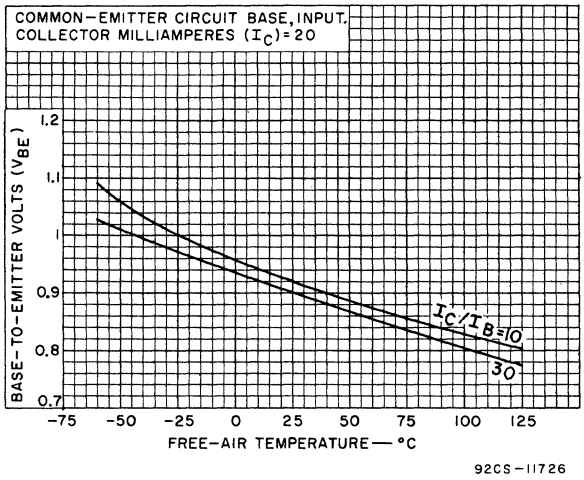


Fig. 10 - Typical Base-to-Emitter Voltage Characteristics for Type 2N2475.

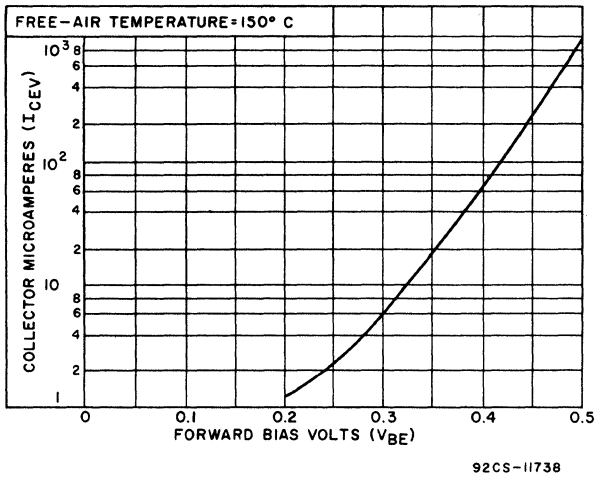


Fig. 12 - Typical Variation of Collector Current vs. Forward Base Bias for Type 2N2475.

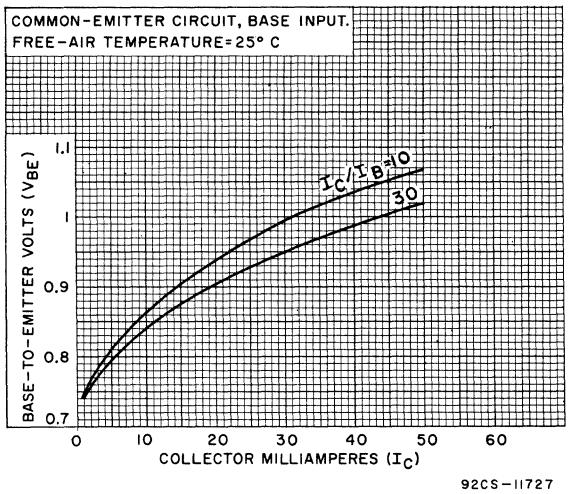


Fig. 11 - Typical Base-to-Emitter Voltage Characteristics for Type 2N2475.

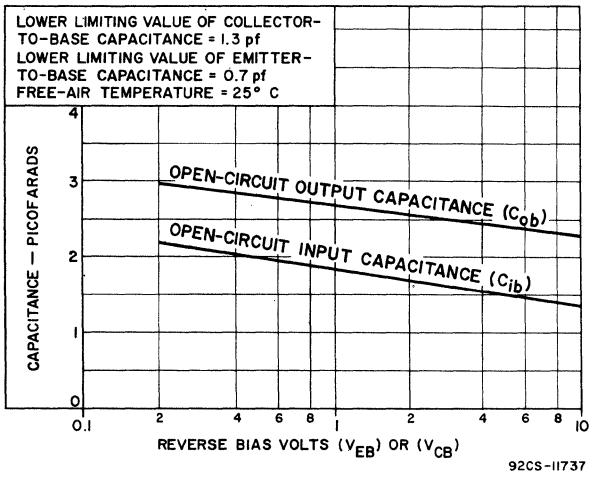
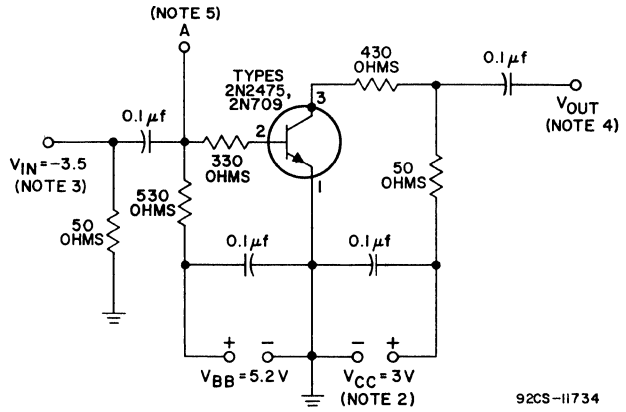


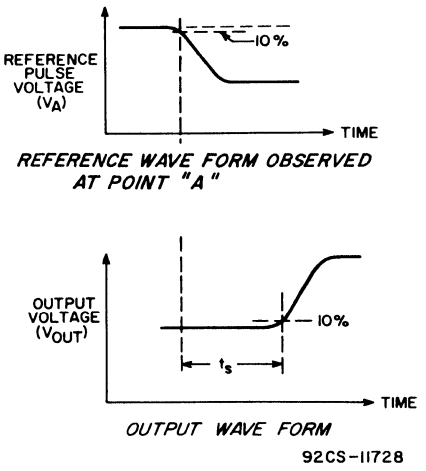
Fig. 13 - Typical Variation of Input and Output Capacitance vs. Reverse Bias Voltage for Type 2N2475.



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

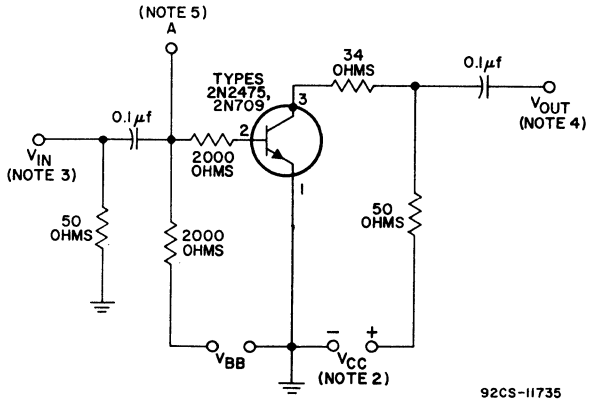
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 NSEC; PULSE DURATION > 300 NSEC; AND DUTY FACTOR < 2%.



NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

Fig. 2 - Circuit Used to Measure Storage Time (t_s) for Types 2N2475 and 2N709.

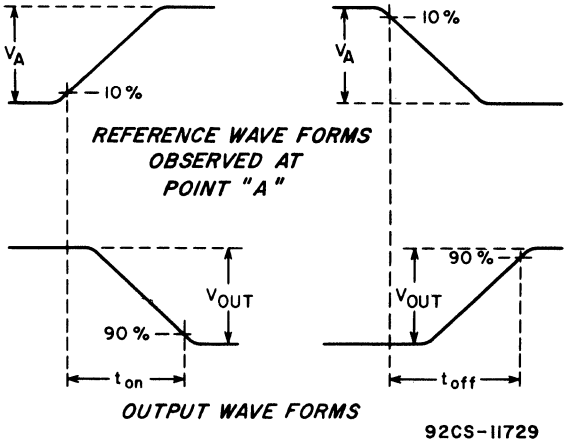


NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

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NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 NSEC; PULSE DURATION > 300 NSEC; AND DUTY FACTOR < 2%.

NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

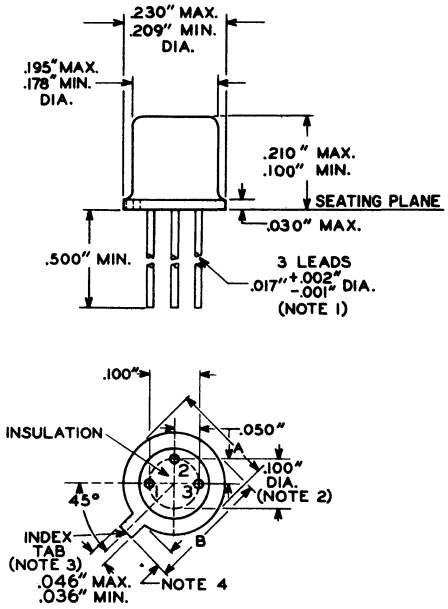


t_{on}	t_{off}
V_{BB} = −1.0 V	V_{BB} = +5 V
V_{IN} = +4 V (2N2475) V_{IN} = +6 V (2N709)	V_{IN} = −4 V
V_{CC} = +1.8 V (2N2475) V_{CC} = +1 V (2N709)	V_{CC} = +1.8 V (2N2475) V_{CC} = +1 V (2N709)

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

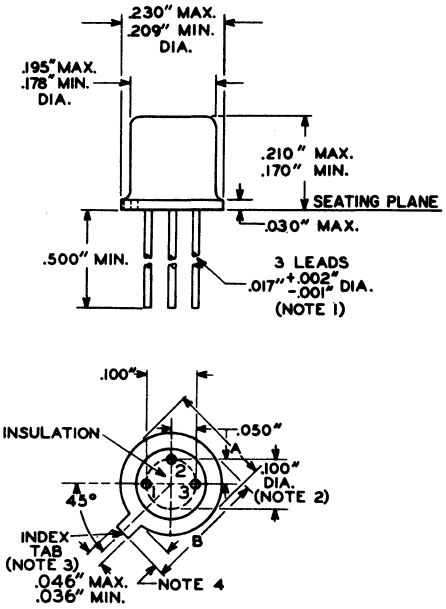
Fig. 3 - Circuit Used to Measure Turn-On Time (t_{on}) and Turn-Off Time (t_{off}) for Types 2N2475 and 2N709.

DIMENSIONAL OUTLINE
For Type 2N2475



92CS-11739

DIMENSIONAL OUTLINE
For Type 2N709
JEDEC No. TO-18



92CS-10605R2

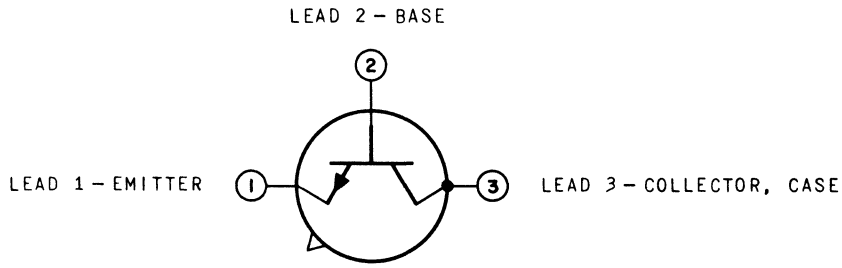
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" – 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM – 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM
For Types 2N2475 and 2N709
Bottom View



RCA TRANSISTORS

For Core-Driver and Line-Driver Service

2N2476
2N2477
2N3512

File No. 47

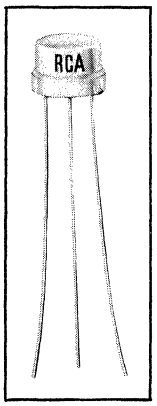
RCA-2N2476, 2N2477 and 2N3512 are double-diffused epitaxial planar transistors of the silicon n-p-n type.

These transistors feature high breakdown voltages, low saturation voltages and fast switching speeds over a wide range of collector current. These features make these devices well suited for core-driver and line-driver service in high performance computers and in other critical industrial applications.

The 2N2476, 2N2477 and 2N3512 are hermetically sealed in a JEDEC TO-5 package designed to provide very low thermal resistance. This construction permits these devices to dissipate substantial amounts of power internally in high-duty-factor or non-saturating applications.

SILICON N-P-N HIGH-VOLTAGE TRANSISTORS

For Core-Driver and Line-Driver Service in Data-Processing Equipment and other Critical Industrial Applications



JEDEC TO-5

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N2476 2N2477	2N3512	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	60	60 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	20	35 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	5 max.	V
COLLECTOR CURRENT, I_C	Limited by dissipation		
TRANSISTOR DISSIPATION, P_T:			
For case temperatures[a] up to 25°C	2	4 max.	W
For case temperatures[a] above 25°C	Derate at 11.4	22.8	mW/°C
For ambient temperatures up to 25°C	0.6	0.8 max.	W
For ambient temperatures above 25°C	Derate at 3.4	4.6	mW/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)	-65 to +200		°C
LEAD TEMPERATURE (During Soldering):			
At distances not closer than 1/32" to seating surface for 10 seconds max.	200	230 max.	°C

[a] Measured at center of seating surface.

FEATURES:

- **excellent power handling capability**

  2N2476, 2 max. W
  2N2477, 2 max. W
  2N3512, 4 max. W
  } at T_C = 25°C

- **high gain-bandwidth product**

  2N2476, 2N2477: f_T = 250 MHz min.

  2N3512 f_T = 375 MHz typ.

- **fast switching speeds**

  2N3512 t_{on} = 16 ns typ., t_{off} = 27 ns typ. at I_C = 150 mA

  2N2476, 2N2477: t_{on} = 25 ns max., t_{off} = 45 ns max. at I_C = 150 mA

- **low output capacitance**

  2N2476, 2N2477: C_{ob} = 10 pF max.

  2N3512, C_{ob} = 5.8 pF max.

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Trademark(s) ® Registered
Marca(s) Registrada(s)

Printed in U.S.A.
2N2476, 2N2477, 2N3512 8-66
Supersedes 2N2476,2N2477 dated 8-62; 2N3512 dated 8-64

ELECTRICAL CHARACTERISTICS, At T_A = 25°C unless otherwise specified.

Characteristics	Symbols	TEST CONDITIONS					LIMITS									Units
		Collector-to-Emitter Voltage V_{CE}	Emitter-to-Base Voltage V_{EB}	Collector Current I_C	Emitter Current I_E	Base Current I_B	2N2476			2N2477			2N3512			
		V	V	mA	mA	mA	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Collector-Cutoff Current at T_A = 25°C at T_A = 150°C	I_{CBO}		V_{CB}=30 V_{CB}=30		0 0		- -	- -	0.2 200	- -	- -	0.2 200	- -	- -	- -	μA μA
Collector-Cutoff Current at T_A = 25°C at T_A = 100°C	I_{CEV}	30 30	0.3 0.3				- -	- -	- -	- -	- -	- -	- -	- -	0.5 100	μA μA
Emitter-Cutoff Current	I_{EBO}		5	0			-	-	100	-	-	100	-	-	100	μA
Base-Cutoff Current	I_{BEV}	30	0.3				-	-	-	-	-	-	-	-	0.5	μA
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			50		0	20*	-	-	20*	-	-	35	-	-	V
Collector-to-Base Breakdown Voltage	BV_{CBO}			0.01	0		60	-	-	60	-	-	60	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	0.1		5	-	-	5	-	-	5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			150 150 500		7.5 3.75 50	- - -	- - -	0.4 - 0.75	- - -	- - -	- 0.4 0.65	- - -	0.28 - 0.45*	0.4 - 1*	V V V
Base-to-Emitter Voltage	V_{BE}			150 150		7.5 3.75	- -	- -	1 -	- -	- -	- 0.95	- -	0.77 -	1 -	V V
Static-Forward-Current Transfer Ratio	h_{FE}	1 0.4		500 150			- 20	- -	- -	- 40	- -	- -	10* -	- -	- -	
Magnitude of Small-Signal Forward-Current Transfer Ratio at f = 100 MHz	$\lvert h_{fe} \rvert$	10		50			2.5	-	-	2.5	-	-	2.5	3.75	-	
Output Capacitance at f = 140 kHz	C_{ob}		V_{CB}=10		0		-	-	10	-	-	10	-	5.8	10	pF
			V_{CC}			$I_{B1} = -I_{B2}$										
Storage Time See Fig.21	t_s		6.4	150		15	-	-	25	-	-	25	-	17	30	ns
Turn-On-Time See Fig.22	t_{on}		6.4	150		15	-	-	25	-	-	25	-	16	30	ns
Turn-Off-Time See Fig.21	t_{off}		6.4	150		15	-	-	45	-	-	45	-	27	45	ns

* Pulsed conditions - Pulse duration ≤ 400 μs; duty factor ≤ 0.03.

TYPICAL CHARACTERISTICS

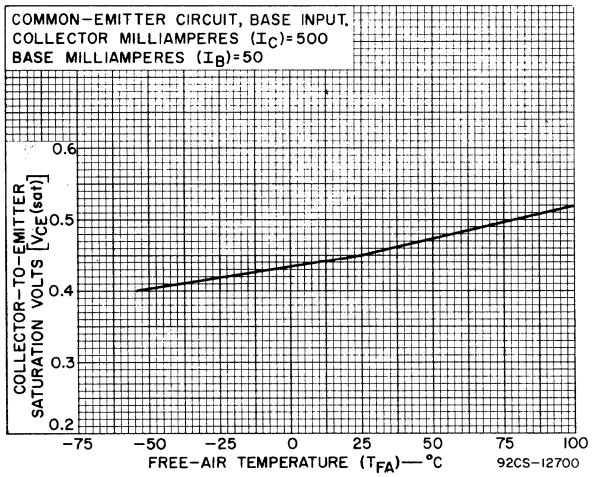


Fig.7 - Collector-to-Emitter Saturation-Voltage vs Temperature for Type 2N3512.

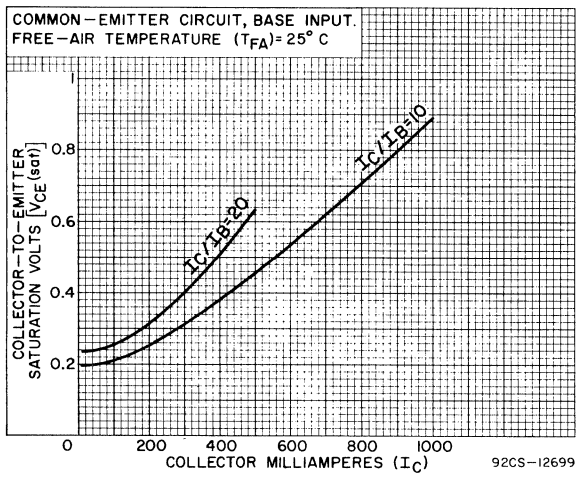


Fig.8 - Collector-to-Emitter Saturation-Voltage Characteristics for Type 2N3512.

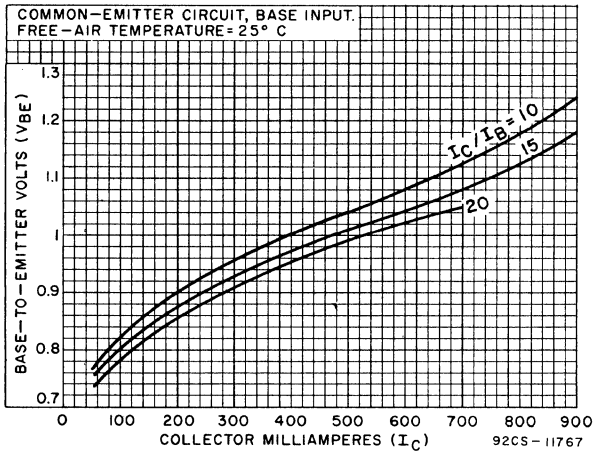


Fig.9 - Base-to-Emitter Voltage Characteristics for Type 2N2476.

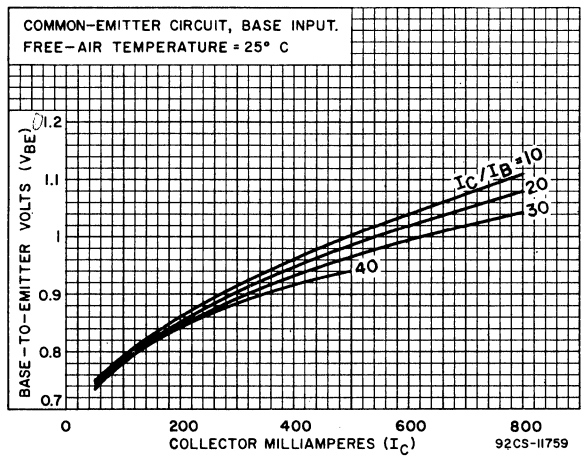


Fig.10 - Base-to-Emitter Voltage Characteristics for Type 2N2477.

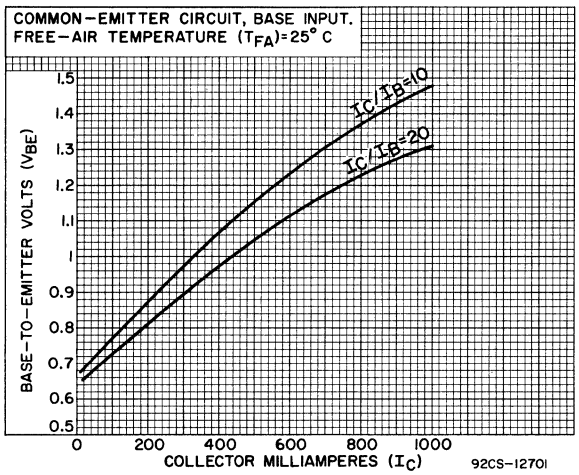


Fig.11 - Base-to-Emitter Voltage Characteristics for Type 2N3512.

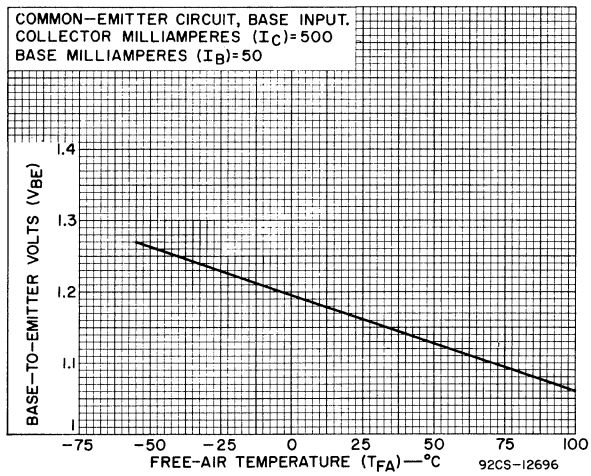


Fig.12 - Base-to-Emitter Voltage vs Temperature for Type 2N3512.

TYPICAL CHARACTERISTICS

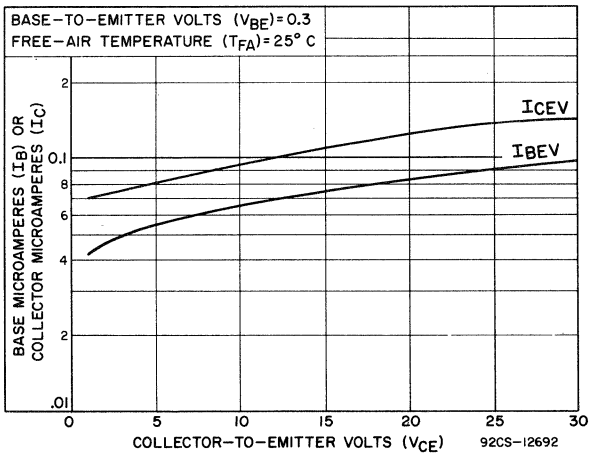


Fig.13 - Cutoff-Current Characteristics for Type 2N3512.

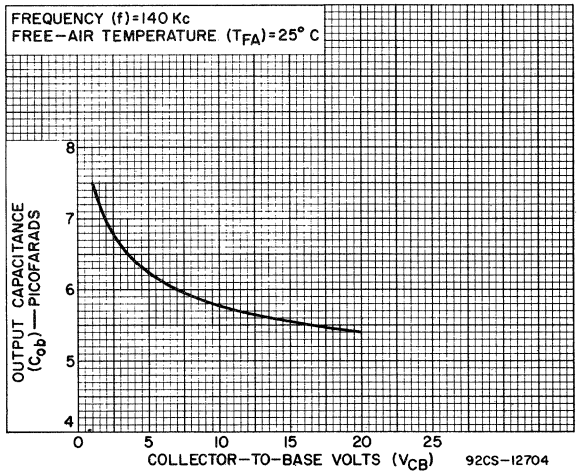


Fig.14 - Output Capacitance Characteristic for Type 2N3512.

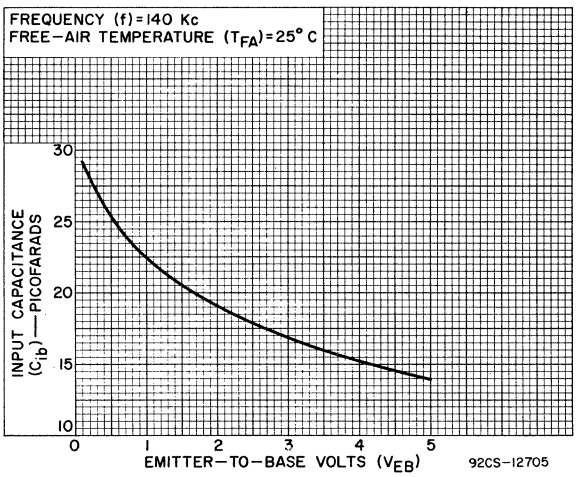


Fig.15 - Input Capacitance Characteristic for Type 2N3512.

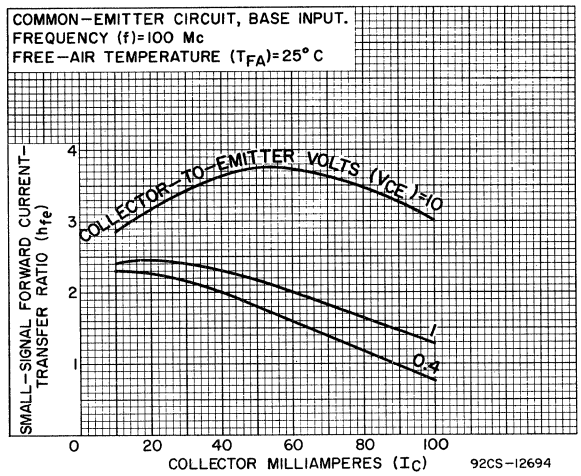


Fig.16 - Small-Signal Forward-Current Transfer-Ratio Characteristics for Type 2N3512.

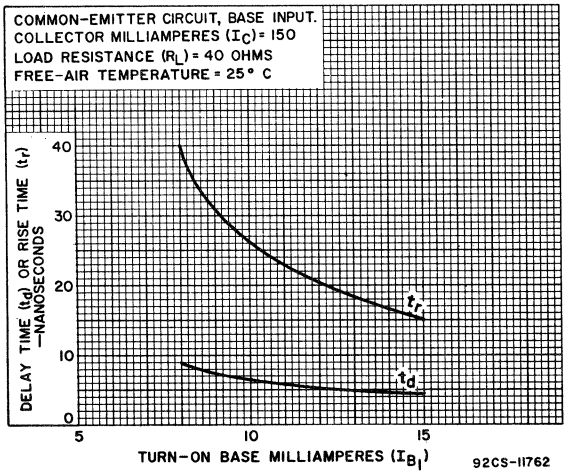


Fig.17 - Delay and Rise Times vs Turn-On Base Current for Type 2N2476.

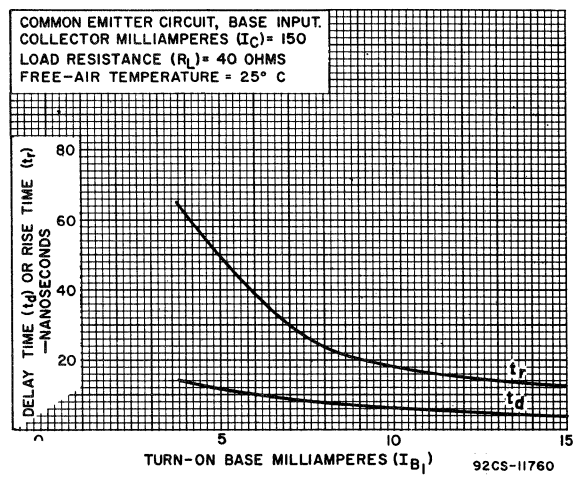


Fig.18 - Delay and Rise Times vs Turn-On Base Current for Type 2N2477.

TYPICAL CHARACTERISTICS

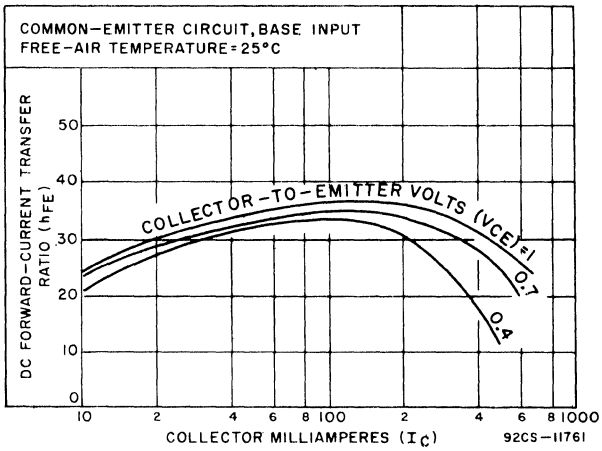


Fig.1 - Static-Forward-Current Transfer-Ratio Characteristics for Type 2N2476.

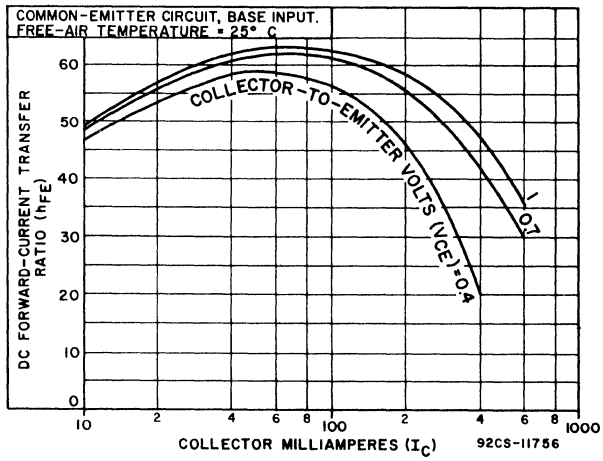


Fig.2 - Static-Forward-Current Transfer-Ratio Characteristics for Type 2N2477.

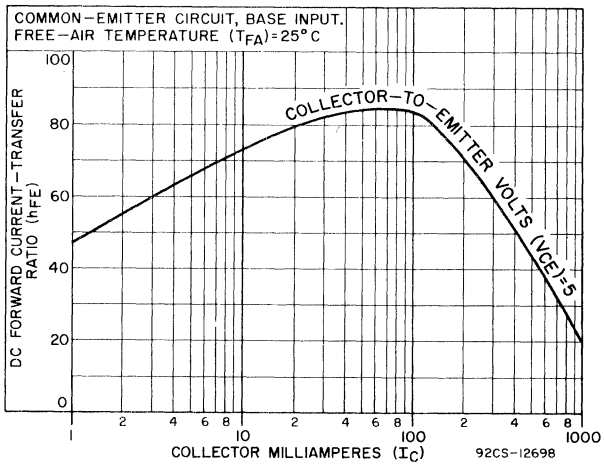


Fig.3 - Static-Forward-Current Transfer-Ratio Characteristic for Type 2N3512.

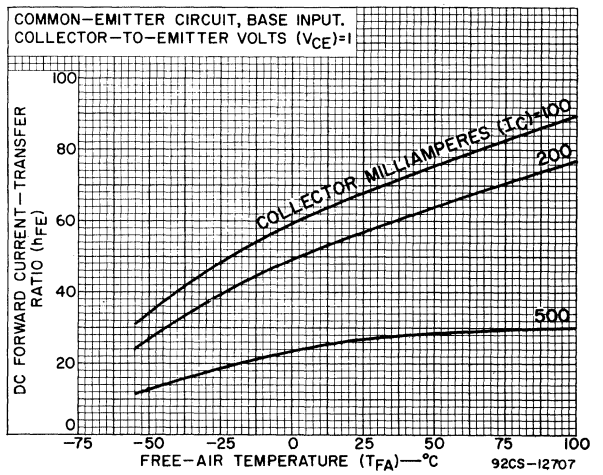


Fig.4 - Static-Forward-Current Transfer-Ratio vs Temperature for Type 2N3512.

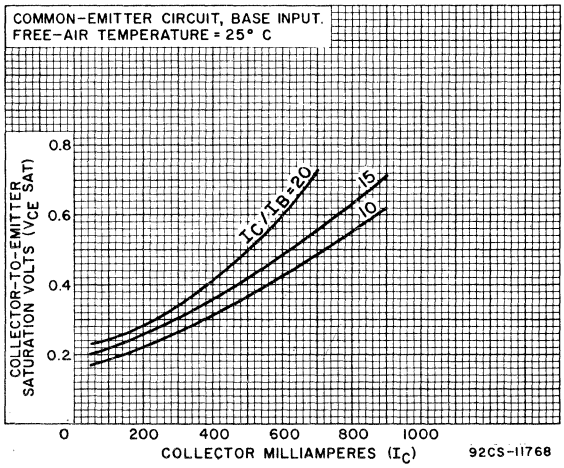


Fig.5 - Collector-to-Emitter Saturation-Voltage Characteristics for Type 2N2476.

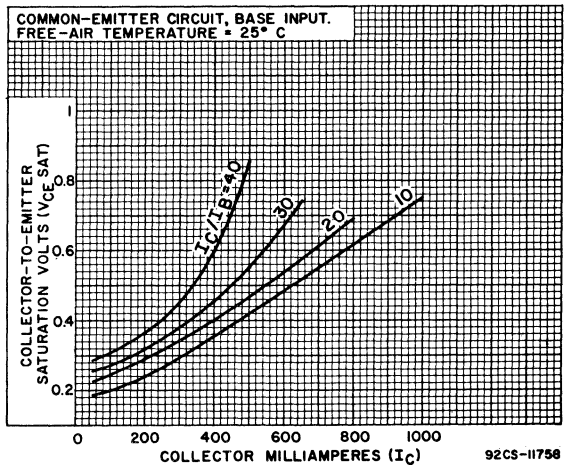


Fig.6 - Collector-to-Emitter Saturation-Voltage Characteristics for Type 2N2477.

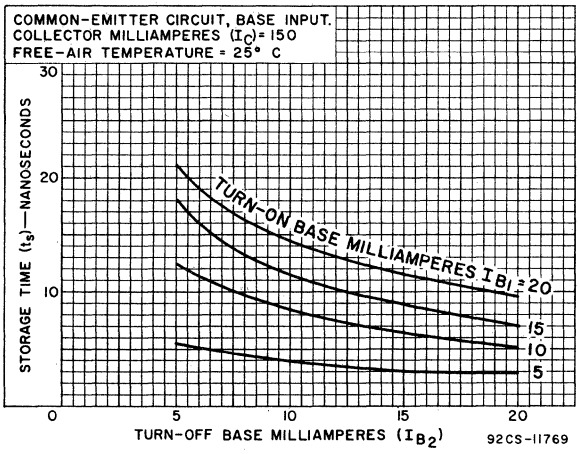


Fig.19 - Storage Time vs Turn-Off Base Current for Type 2N2476.

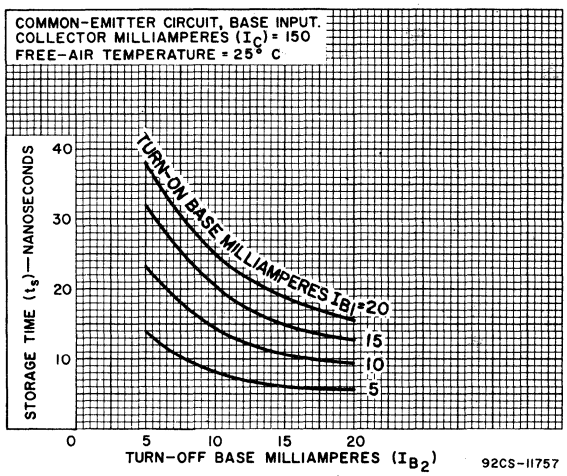


Fig.20 - Storage Time vs Turn-Off Base Current for Type 2N2477.

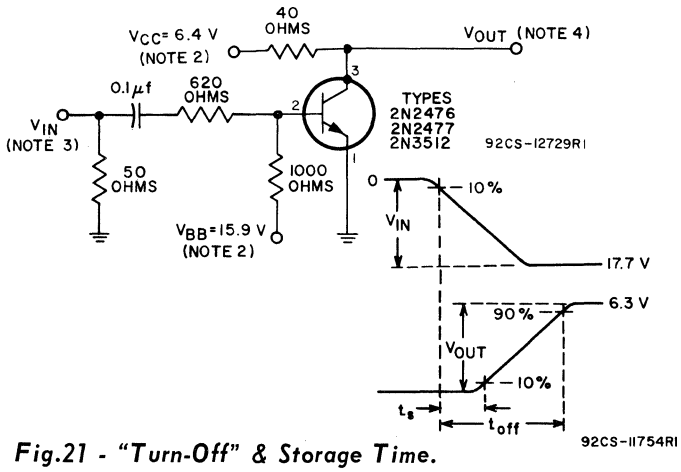


Fig.21 - "Turn-Off" & Storage Time.

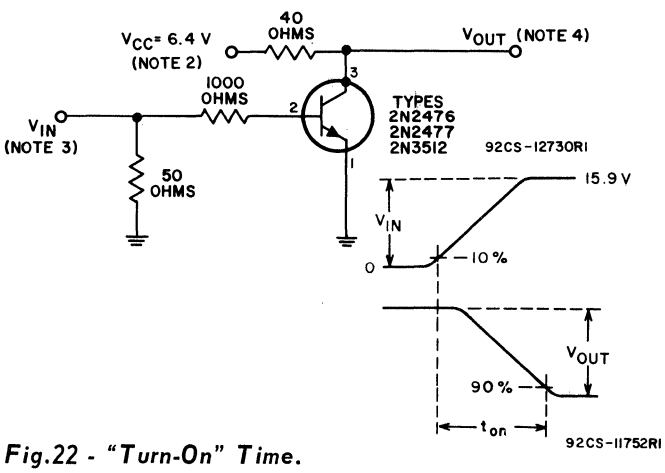


Fig.22 - "Turn-On" Time.

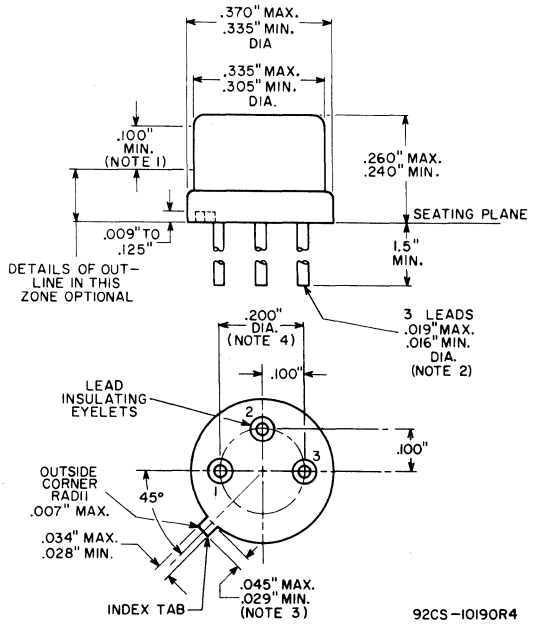
Note 1: All Resistance Values have ± 1 Per Cent Tolerance.

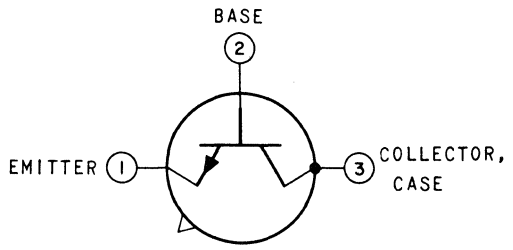
Note 2: With Certain Types of Power Supplies, it May be Necessary to Connect 25-μF Decoupling Capacitors Across the Power-Supply Terminals for V_{CC} and V_{BB}.

Note 3: Input Voltage (V_{IN}) Obtained from Mercury-Relay Type Pulse Generator having an Output Impedance of 50 ohms. V_{IN} Rise Time < 2 ns; Pulse Duration > 150 ns; and Duty Factor < 2%.

Note 4: Input and Output Wave Forms Monitored by Means of a Sampling Oscilloscope having a Rise Time < 0.5 ns, Input Capacitance of Probe < 2.5 pF with Shunt Resistance of 1 Megohm.

TEST CIRCUITS FOR "Turn-On", "Turn-Off", and STORAGE TIMES.





NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" - 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

GERMANIUM P-N-P TRANSISTORS



Small-Signal AF-Amplifiers for Consumer-Product and Industrial Equipment

- high beta (h_{fe}) at low current levels—
  2N2613: 120 min., 200 typ. at I_C = -0.5 ma
  2N2614: 100 min., 160 typ. at I_C = -1 ma
- high cutoff frequency—f_{hfb} = 10 Mc typ.
- uniform gain characteristics over entire audio-frequency spectrum

2N2613 FEATURES:

- low noise figure—4 db max.
- low saturation current
- exceptional performance at low idling currents (0.3 to 0.7 ma)

2N2614 FEATURES:

- uniform high beta (h_{fe}) over entire current range

RCA-2N2613 and 2N2614 are alloy-junction transistors of the germanium p-n-p type intended primarily for use in small-signal and other low-power stages of high-quality audio-frequency amplifier equipment. Both types feature high small-signal beta (h_{fe}), excellent linearity of h_{fe} over the entire range of collector current, high cutoff frequency (f_{hfb}), and uniform gain characteristics over the entire audio-frequency spectrum.

RCA-2N2613 is a low-noise, high-gain type, for use in the input and low-level stages of equipment having stringent performance requirements at low idling-current levels (0.3 to 0.7 ma). In addition to its low noise figure and high beta, the 2N2613 features low saturation currents for excellent thermal stability at low current levels.

In a common-emitter-type circuit, RCA-2N2613 can provide a noise figure of 4 db max., a small-signal beta (h_{fe}) of 200 typical, and a cutoff frequency (f_{hfe}) of 50 Kc typical. It can deliver an output-signal current of 200 μa with a signal-to-noise ratio of better than 60 db, for a 1-μa input-signal current from a high-impedance source. These performance characteristics make the 2N2613 particularly suitable for use in the input stages of phonograph amplifiers using either ceramic or magnetic pickups, tape recorders and players, microphone amplifiers, and similar applications requiring devices having exceptionally low noise characteristics.

RCA-2N2614 is a high-gain, small-signal amplifier type for use in low-to-medium level audio amplifier and driver stages. Because of its excellent beta linearity, the 2N2614 can provide high gain over its entire operating current range.

In driver applications, the 2N2614 when used with a typical heat sink having a thermal resistance of 50°C/watt can dissipate 225 milliwatts and deliver a maximum power output of 100 milliwatts. This amount of power is sufficient to drive to full output a 25-watt output stage having a power gain of 24 db.

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Maximum Ratings, *Absolute-Maximum Values:*

	2N2613	2N2614		
COLLECTOR-TO-BASE VOLTAGE (V_{CBO})	-30	-40	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (V_{CER}) R_{BE} = 10000 ohms	-25	-35	max.	volts
EMITTER-TO-BASE VOLTAGE (V_{EBO})	-25	-25	max.	volts
COLLECTOR CURRENT (I_C)	-50	-50	max.	ma
EMITTER CURRENT (I_E)	50	50	max.	ma
TRANSISTOR DISSIPATION (P_T):				
In free air at T_{FA} up to 55° C	120	120	max.	mw
Derating factor	2.6	2.6		mw/°C
With infinite heat sink at T_C up to 55° C	-	300	max.	mw
Derating factor	-	6.67		mw/°C
With typical heat sink (θ = 50°C/w) at T_C up to 55° C	-	225	max.	mw
Derating factor	-	5		mw/°C
TEMPERATURE:				
Storage (Free-air)	-65 to +100			°C
Operating (Junction)[a]	+100		max.	°C
Leads - At distances not less than 1/32" from seating surface for 10 sec. max. (during soldering)	+255	+255	max.	°C

[a] See *Operating Considerations.*

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N2613, 2N2614 7-66
Supersedes issue dated 6-63

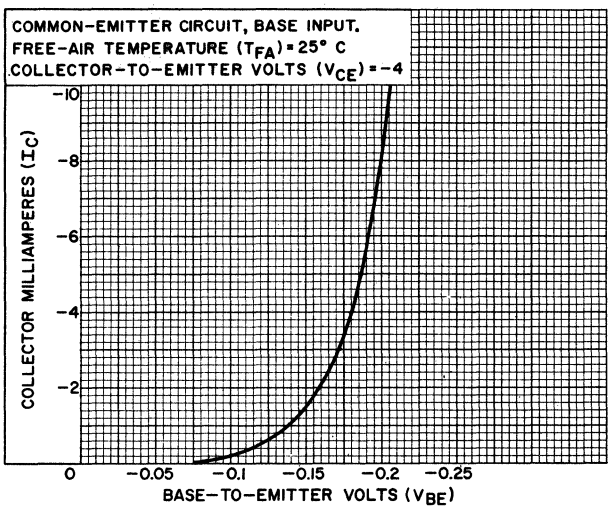


Fig. 1 - Typical Transfer Characteristic for Type 2N2613.

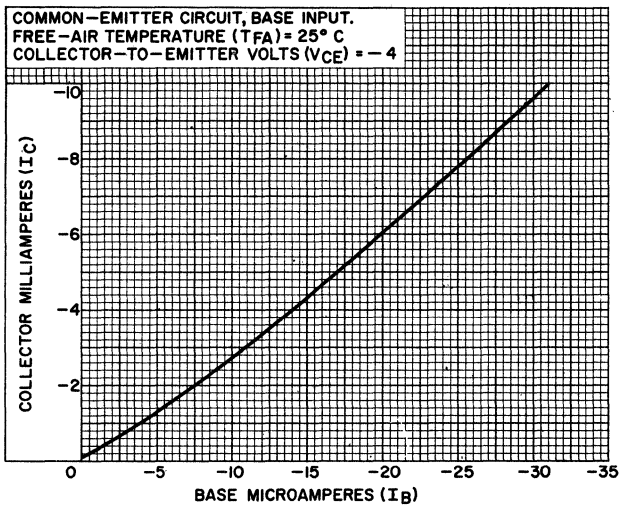


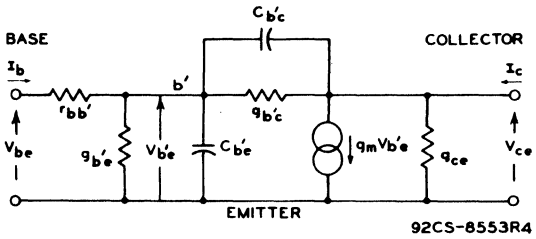
Fig. 2 - Typical Current-Transfer Characteristic for Type 2N2613.

ELECTRICAL CHARACTERISTICS, *at a Free-Air Temperature (T_{FA}) of 25° C*

Characteristics	Symbols	TEST CONDITIONS						LIMITS						Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	External Base-Emitter Resistance R_{BE}	Type 2N2613			Type 2N2614			
		Volts	Volts	Volts	Ma	Ma	ohms	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-20			0			-	-	-5	-	-	-5	μa
Emitter-Cutoff Current	I_{EBO}			-20		0		-	-	-7.5	-	-	-7.5	μa
Collector-to-Emitter Breakdown Voltage	BV_{CER}					-1	10000	-25	-	-	-35	-	-	volts
Collector-to-Base Breakdown Voltage	BV_{CBV}			-2		-0.05		-30	-	-	-40	-	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.05	0		-25	-	-	-25	-	-	volts
Small-Signal Forward-Current Transfer Ratio (Measured at 1 kc)	h_{fe}		-4 -6			-0.5 -1		120 -	200 -	300 -	- 100	- 160	- 250	
Small-Signal Forward-Current Transfer-Ratio Cutoff Frequency	f_{hfb}		-4.5 -6			-0.5 -1		- 4	10 -	- -	- 4	- 10	- -	Mc Mc
Extrinsic Base-Lead Resistance Measured at 20 Mc	$r_{bb'}$		-4.5 -6			-0.5 -1		- -	300 -	- -	- -	- 300	- -	ohms ohms
Noise Figure: Reference Signal Frequency = 1 kc Circuit Bandwidth = 1.1 kc Generator Resistance = 1000 ohms	NF●		4.5			-0.5		-	-	4●	-	-	-	db
Equivalent RMS Noise Input Current over the frequency range 20 to 20000 cps: External Base-to-Emitter Resistance = 50000 ohms	i_N●		-4.5			-0.5		-	-	0.001●	-	-	-	μa
Collector-to-Base Feedback Capacitance	C_{cb}		-4.5 -6			-0.5 -1		- -	10 -	- -	- -	- 9	- 12	pf pf
Real Part of Common-Emitter Short-Circuit Input Impedance	h_{ie}		-6			-1		-	-	450	-	-	450	ohms

● If the device is operated at free-air temperature above 25°C, the maximum value for this characteristic may be higher than that shown.

EQUIVALENT CIRCUIT
With Corresponding Small-Signal Parameters for RCA-2N2613, 2N2614



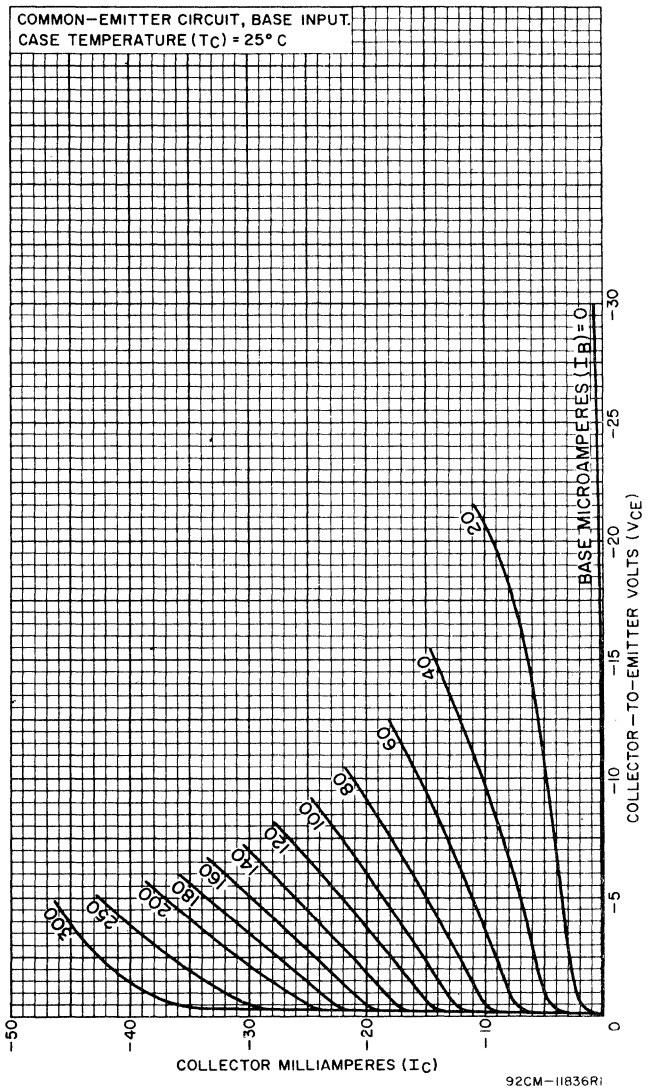
92CS-8553R4

		2N2613	2N2614	
V_{ce}	=	−4.5	−6	volts
I_c	=	−0.5	−1	ma
$r_{bb'}$	=	300	300	ohms
$g_{b'e}$	=	95	250	μmhos
$g_{b'c}$	=	0.4	0.35	μmho
g_{ce}	=	5	6	μmhos
$C_{b'e}$	=	300	750	pf
$C_{b'c}$	=	10	9	pf
g_m	=	19200	38500	μmhos

NOTE: The approximate frequency f for unity power amplification based on this equivalent circuit is given by:

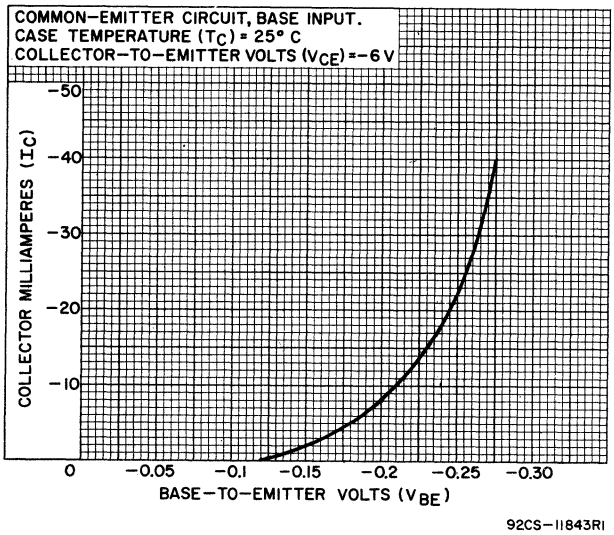
$$f = \frac{1}{4\pi}\sqrt{\frac{g_m}{r_{bb'}\, C_{b'c}\, C_{b'e}}}$$

Fig. 3 - "Hybrid π" Equivalent Circuit.



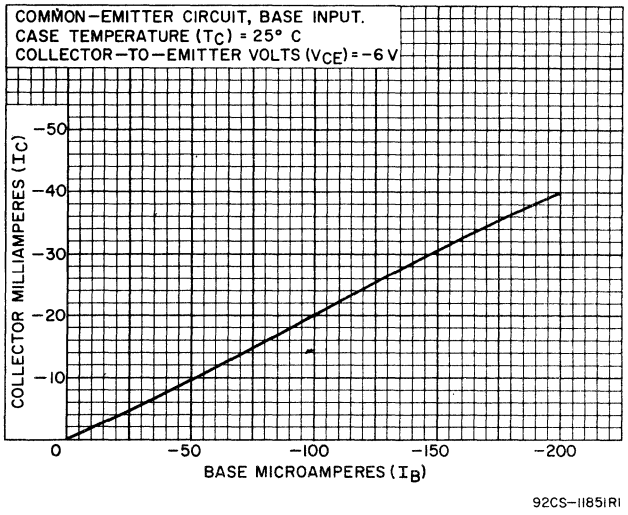
92CM-11836R1

Fig. 4 - Typical Collector Characteristics for Type 2N2614.



92CS-11843R1

Fig. 5 - Typical Transfer Characteristic for Type 2N2614.



92CS-11851R1

Fig. 6 - Typical Transfer Characteristic for Type 2N2614.

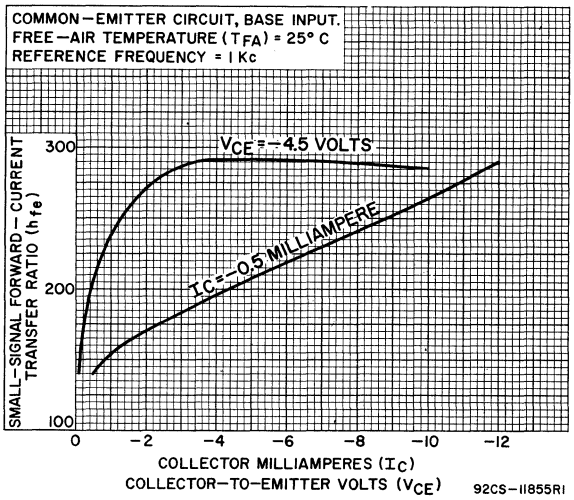


Fig. 7 - Typical Small-Signal Beta (h_{fe}) Characteristics for Type 2N2613.

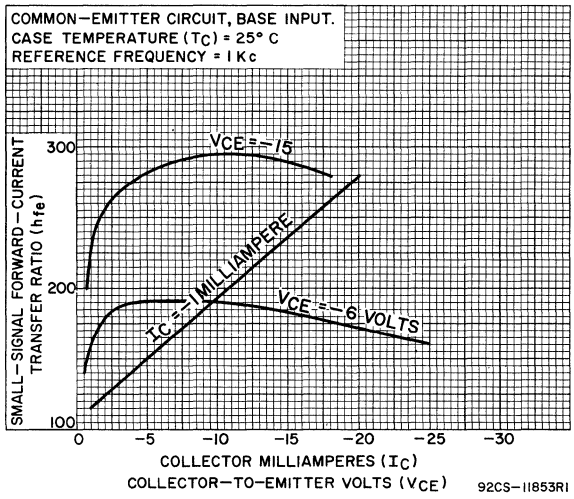


Fig. 8 - Typical Small-Signal Beta (h_{fe}) Characteristics for Type 2N2614.

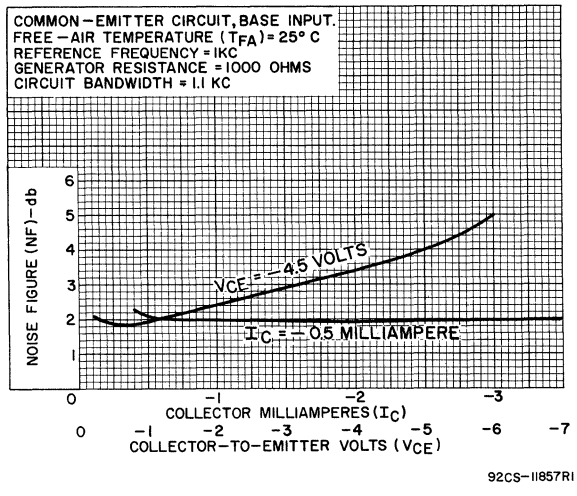


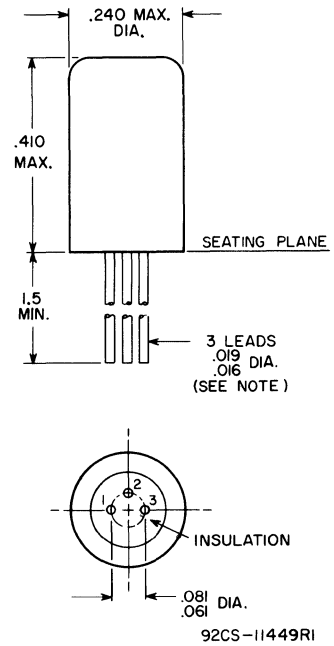
Fig. 9 - Typical Noise Characteristics for Type 2N2613.

OPERATING CONSIDERATIONS

The 2N2613 and 2N2614 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

To insure excellent noise performance of the 2N2613, the junction temperature for this device should be kept as low as possible.

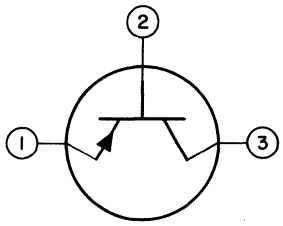
DIMENSIONAL OUTLINE
JEDEC No. TO-1
All Dimensions in Inches



NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TERMINAL DIAGRAM

LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR



SILICON N-P-N PLANAR TRANSISTORS

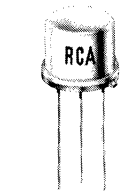
2N2631
2N2876

File No. 32

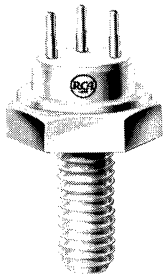
RCA-2N2876 and 2N2631 are triple-diffused planar transistors of the silicon n-p-n type. These devices are intended for applications in AM, FM, and CW service at frequencies up to 150 Mc.

The 2N2876 utilizes a stud-mounted TO-60 package which is electrically isolated from all the electrodes and is designed to provide excellent performance at very high frequencies. The 2N2631 TO-39 package is identical to the JEDEC TO-5 package except for shorter leads (0.5 inch).

For Large-Signal, High-Power, VHF Applications in Military and Industrial Communications Equipment



JEDEC TO-39



JEDEC TO-60

RF SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

	2N2876	2N2631		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	80	80	max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open, V_{CEO}	60	60	max.	volts
With V_{BE} = -1.5 volts, V_{CEV}	80	80	max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4	max.	volts
COLLECTOR CURRENT, I_C	2.5	1.5	max.	amp
TRANSISTOR DISSIPATION, P_T:				
At case temperatures up to 25°C	17.5	8.75	max.	watts
At case temperatures above 25°C	Derate linearly 100 mw/°C	Derate linearly 50 mw/°C		
TEMPERATURE RANGE:				
Storage	-65 to +200	-65 to +200		°C
Operating (Junction)	-65 to +200	-65 to +200		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥ 1/32" from ceramic wafer for 10 sec. max.	230	-	max.	°C
At distances ≥ 1/32" from seating surface for 10 sec. max.	-	230	max.	°C

- High Power Output, Unneutralized (P_{OUT}):
  - 10 w min. at 50 Mc, 3 w min. at 150 Mc } 2N2876
  - 7.5 w min. at 50 Mc, 3 w min. at 150 Mc } 2N2631
- High Voltage Ratings:
  - V_{CBO} = 80 volts max.
  - V_{CEO} = 60 volts max.
- 100 per cent tested to assure freedom from second breakdown in class A operation at maximum ratings

RCA-2N2876 Features:

- Low Thermal Resistance (θ_{J-C})—
  high-thermal-conductivity ceramic insulation between collector and mounting stud
- Isolated Stud Package:
  - all three electrodes electrically isolated from case —for design flexibility
  - heavy copper mounting stud—for effective contact with heat sink
  - pin terminals arranged on a .200" pin-circle diameter —fit commercially available sockets

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N2876, 2N2631 5/66
Reprinted from 2N2876,2N2631 6/63

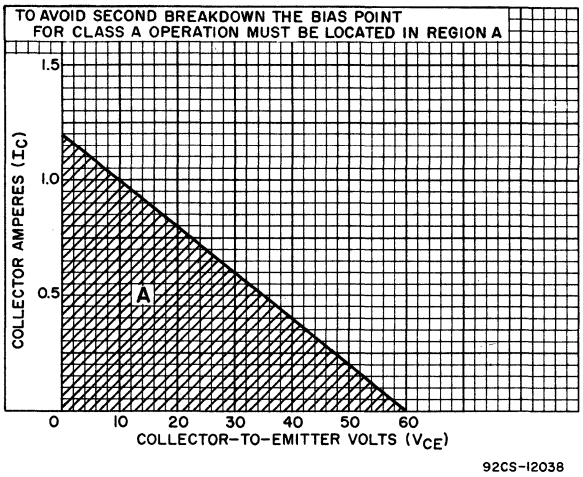


Fig. 1 - Region of Safe Operation (Without second breakdown) in Class A Service for Type 2N2876.

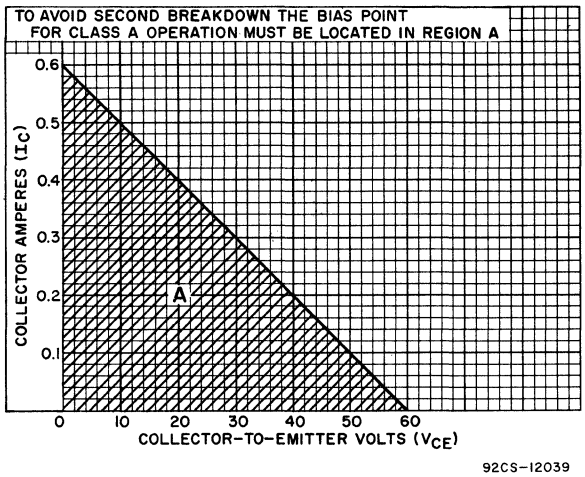


Fig. 2 - Region of Safe Operation (Without second breakdown) in Class A Service for Type 2N2631.

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)			2N2876		2N2631		
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	30			0			-	0.1	-	0.1	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.5	80	-	80	-	volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO}(sus)$					0	500*	60	-	60	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			-1.5			0.1	80	-	80	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	-	4	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					300	1.5 amp	-	-	-	1	volt
						500	2.5 amp	-	1	-	-	volt
Feedback Capacitance (Measured at 140 Kc)	$C_{b'c}$	30			0			-	20	-	20	pf
RF Power Output, Unneutralized (see *Fig.3*):	P_{out}											
Measured at 50 Mc			28				500	10[a]	-	-	-	watts
50 Mc			28				375	-	-	7.5[b]	-	watts
150 Mc			28				275	3[b]	-	3[b]	-	watts
Gain-Bandwidth Product	f_T		28				250	200 (typ.)		200 (typ.)		Mc
Base Spreading Resistance (Measured at 400 Mc)	$r_{bb'}$		28				250	6.0 (typ.)		6.0 (typ.)		ohms
Collector-to-Case Capacitance	C_C							-	6	-	-	pf

* Pulsed. Pulse duration ≤ 5 μsec; duty factor ≤ 1%.

[a] For P_{IN} = 2 watts.

[b] For P_{IN} = 1 watt.

TYPICAL OPERATION CHARACTERISTICS FOR TYPE 2N2631

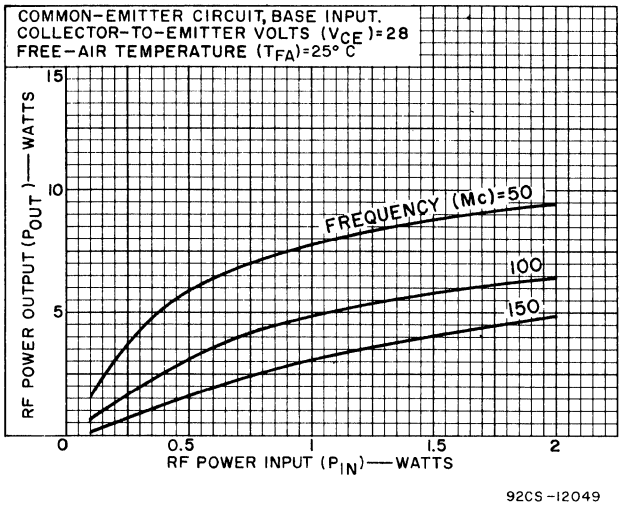


Fig. 8

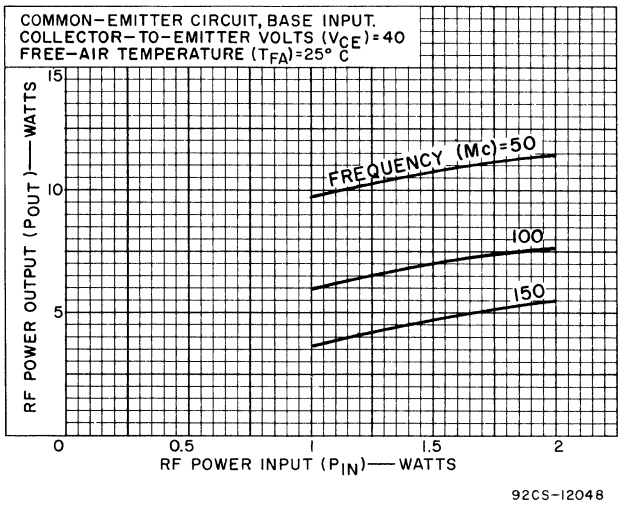


Fig. 10

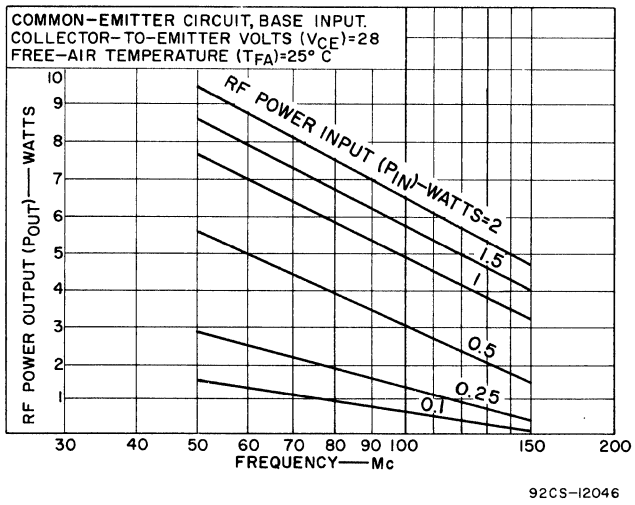


Fig. 9

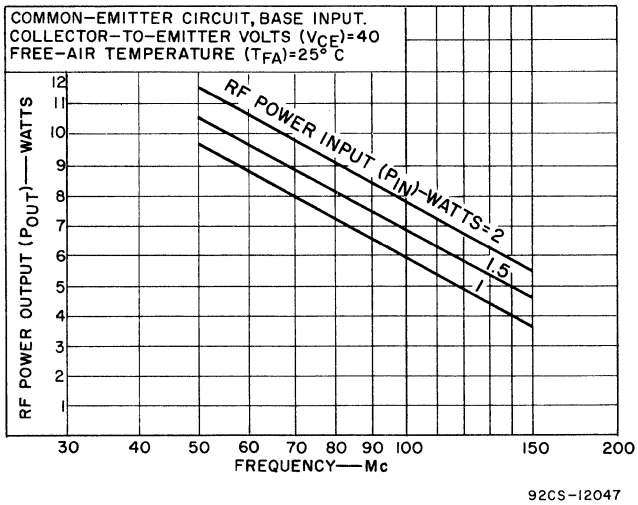
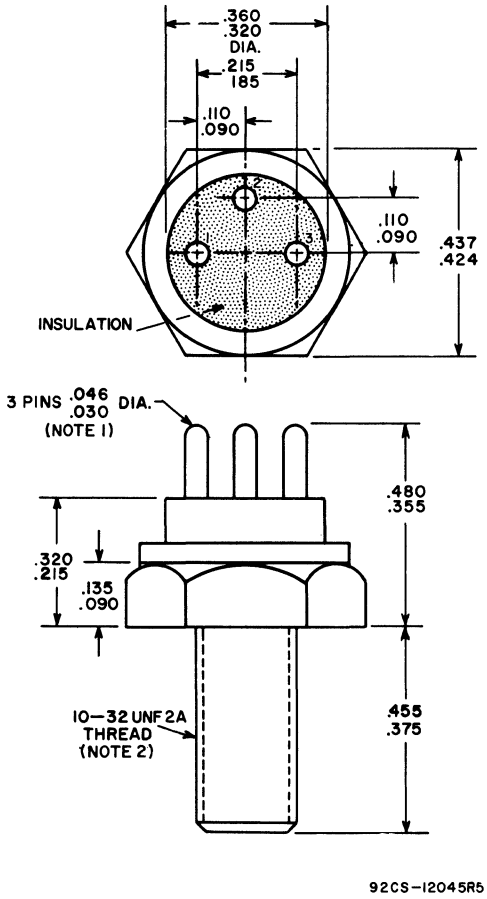


Fig. 11

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DIMENSIONAL OUTLINES

2N2876

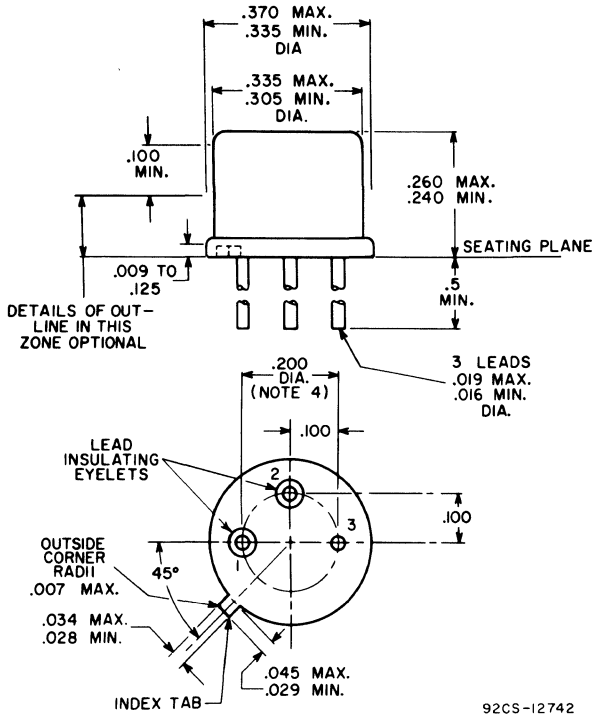


NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200" AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.035" MIN., 0.045" MAX.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

NOTE 3: THIS DEVICE MAY BE OPERATED IN ANY POSITION.

2N2631



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

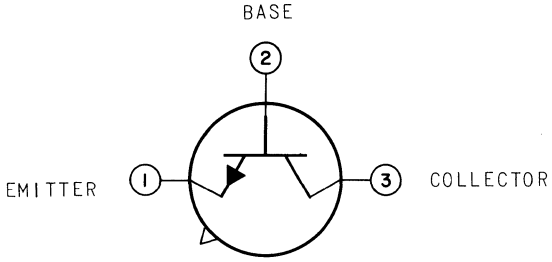
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

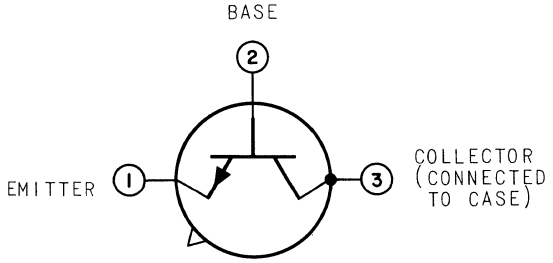
NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" − 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

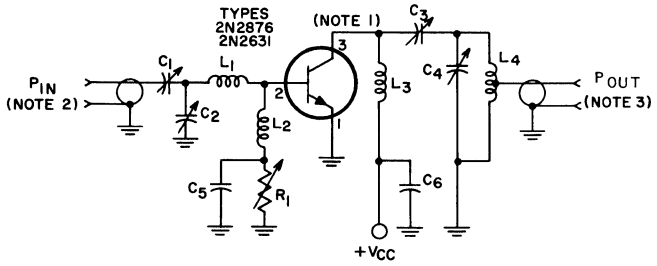
TERMINAL DIAGRAMS
(Bottom View)

2N2876



2N2631





NOTE 1: COLLECTOR GROUNDED TO CASE IN TYPE 2N2631; SEE *TERMINAL DIAGRAM*.

NOTE 2: GENERATOR IMPEDANCE = 50 OHMS.

NOTE 3: LOAD IMPEDANCE = 50 OHMS.

	For 50-Mc Operation	For 150-Mc Operation
$C_1\,C_2\,C_3\,C_4$	8-60 pf	4-40 pf
$C_5\,C_6$	0.005 μf	0.005 μf
L_1	8 turns No. 16 wire, 3/8" ID x 9/16" long	1 turn No. 16 wire, 1/4" ID x 3/16" long
L_2	Ferrite choke, Z = 750 (±20%) ohms	Ferrite choke, Z = 750 (±20%) ohms
L_3	10 μh	1.5 μh
L_4	7 turns No. 14 wire, 1/2" ID x 7/8" long, tap 2 turns from ground end	3 turns No. 14 wire, 3/8" ID x 3/4" long, tap 1-1/2 turns from ground end
R_1	5000 ohms	50 ohms

Fig. 3 - Circuit of Unneutralized Amplifier Used to Measure Power Output of Types 2N2876 and 2N2631.

TYPICAL OPERATION CHARACTERISTICS FOR TYPE 2N2876

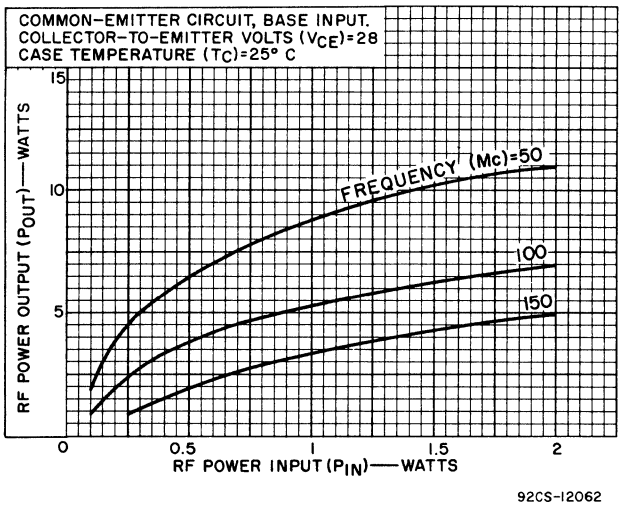


Fig. 4

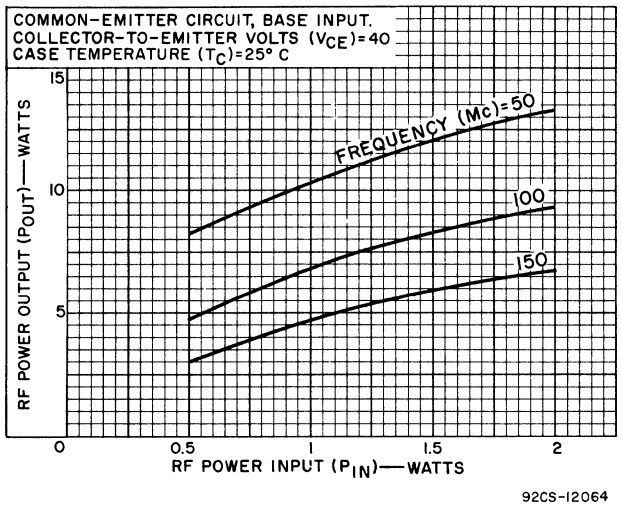


Fig. 6

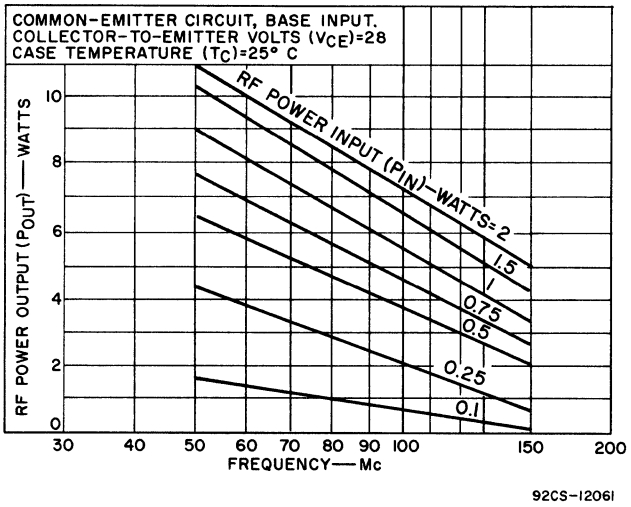


Fig. 5

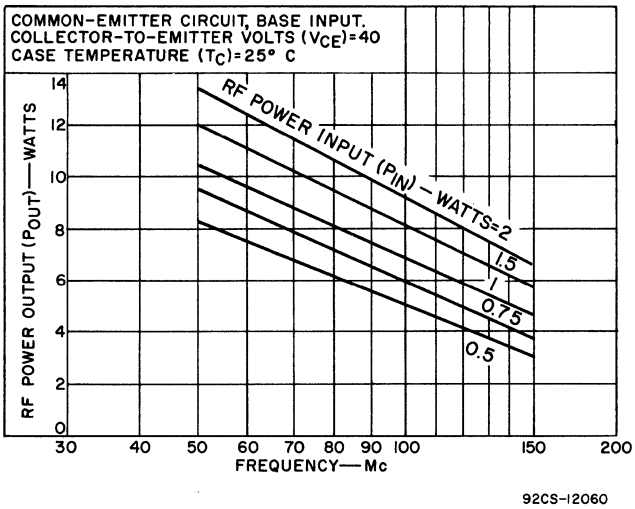
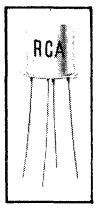


Fig. 7


RCA

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-72

For VHF and UHF Applications

RCA-2N2708 is a silicon n-p-n double-diffused epitaxial-type planar transistor intended for amplifier and mixer applications at frequencies up to 200 MHz and oscillator applications up to 500 MHz.

The 2N2708 utilizes a hermetically sealed 4-lead JEDEC TO-72 package. All active transistor elements are insulated from the case, which may be grounded by the 4th lead in applications requiring shielding of the device.

RF SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	35 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	20 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max.	V
COLLECTOR CURRENT, I_C	Limited by dissipation	
TRANSISTOR DISSIPATION, P_T:		
At case temperatures*: Up to 25°C	300 max.	mW
Above 25°C	derate at 1.72	mW/°C
At ambient temperatures: Up to 25°C	200 max.	mW
Above 25°C	derate at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage and operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances not less than 1/16" from seating surface for 10 seconds max.	265 max.	°C

* Measured at center of seating surface.

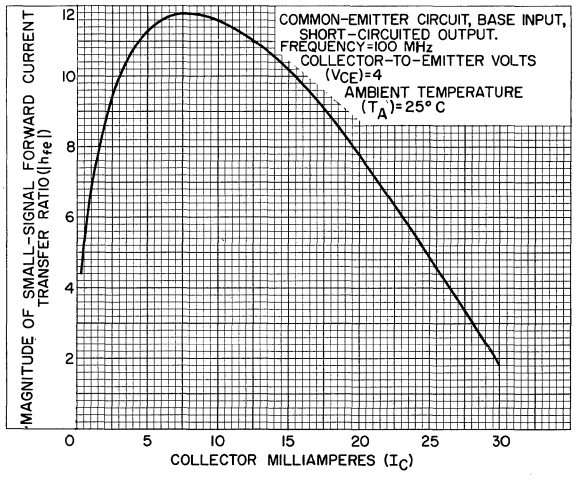


Fig.1 - Typical 100-MHz Small-Signal Forward-Current-Transfer-Ratio Characteristic for 2N2708.

FEATURES

- high gain-bandwidth product (f_T) – 700 MHz min.
- high neutralized power gain (G_{pe}) – 15 dB min. at 200 MHz
- high unneutralized power gain (G_{pe}) – 12 dB typ. at 200 MHz
- low collector-to-base feedback capacitance (C_{cb}) – 1 pF max.

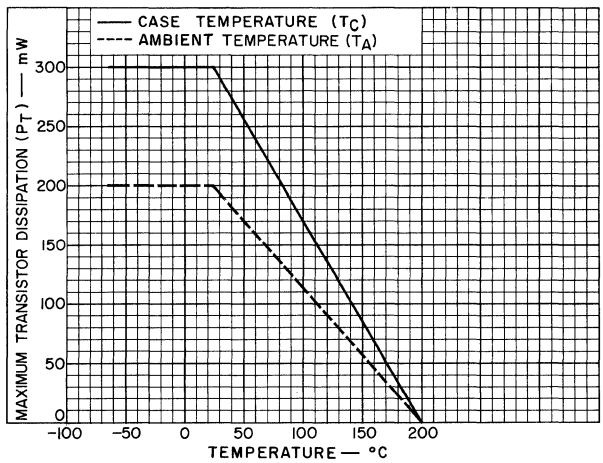


Fig.2 - Rating Chart for 2N2708.

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Printed in U.S.A.
2N2708 10-66
Supersedes issue dated 4-64

ELECTRICAL CHARACTERISTICS, *Ambient Temperature (T_A) = 25°C, Unless Otherwise Specified:*

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Emitter Volts	DC Current (Milliamperes)			Type 2N2708		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current: T_A = 25°C 150°C	I_{CBO}	15 15			0 0			- -	10 1	nA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		1 μA	35	-	V
Collector-to-Emitter Breakdown Voltage[a]	BV_{CEO}[b]					0	3	20	-	V
Static Forward-Current Transfer Ratio	h_{FE}		2				2	30	200	
Magnitude of Small-Signal Forward Current-Transfer Ratio (Measured at 100 MHz)	$\|h_{fe}\|$		15				2	7	12	
Small-Signal Forward Current-Transfer Ratio (Measured at 1 kHz)	h_{fe}		15				2	30	180	
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10 μA		0	3	-	V
Collector-to-Base Feedback Capacitance (Measured at 0.1 to 1 MHz)[e]	C_{cb}	15			0			-	1	pF
Input Capacitance (Measured at 140 kHz See *Fig.3*)[c]	C_{ib}			0.5			0	1.4(typ.)		pF
Collector-to-Base Time Constant (Measured at 31.9 MHz)[d]	$r_b'C_c$	15					2	9	33	ps
Small-Signal Common Emitter Power Gain, Neutralized (Measured at 200 MHz See *Fig.11*)[d]	G_{pe}		15				2	15	22	dB
Small-Signal Common Emitter Power Gain, Unneutralized (Measured at 200 MHz See *Fig.11*)[d]	G_{pe}		15				2	12(typ.)		dB
Measured Noise Figure: f = 200 MHz, generator resistance = 50 Ω See *Fig.11*[d]	NF		15				2	-	7.5	dB
Measured Noise Figure: f = 60 MHz, generator resistance, 400 Ω	NF		6				1	3.5(typ.)		dB

[a] Pulse Test.
[b] Sustaining Voltage.
[c] With lead No.4 (case) not connected.
[d] Lead No.4 grounded.
[e] Three-terminal measurement: Lead No.1 (emitter) and Lead No.4 (case) connected to guard terminal.

SMALL-SIGNAL "Y" PARAMETERS (TYPICAL) FOR 2N2708

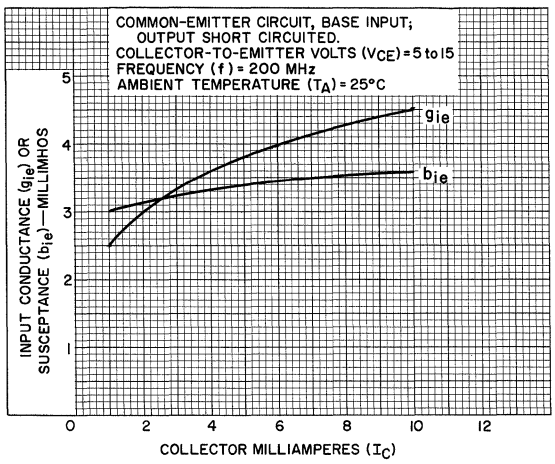


Fig.3

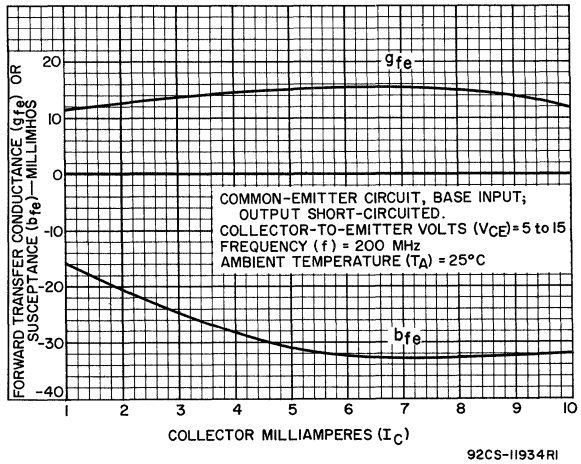


Fig.4

SMALL-SIGNAL "Y" PARAMETERS (TYPICAL) FOR 2N2708

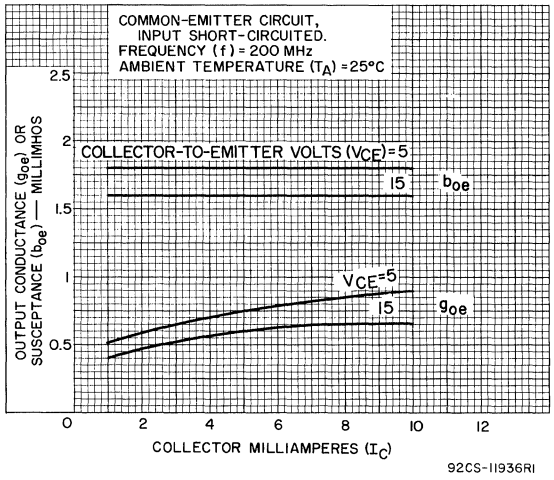


Fig.5

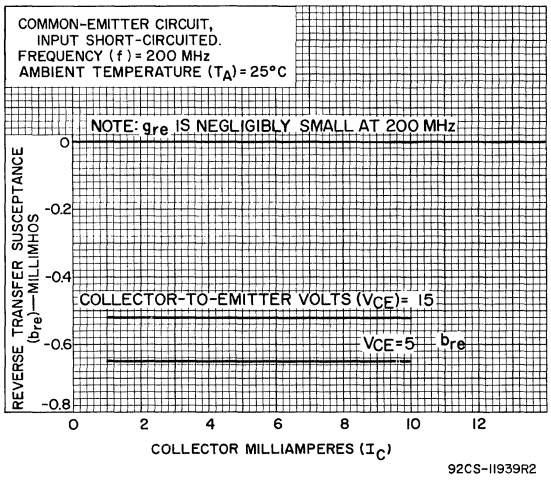


Fig.6

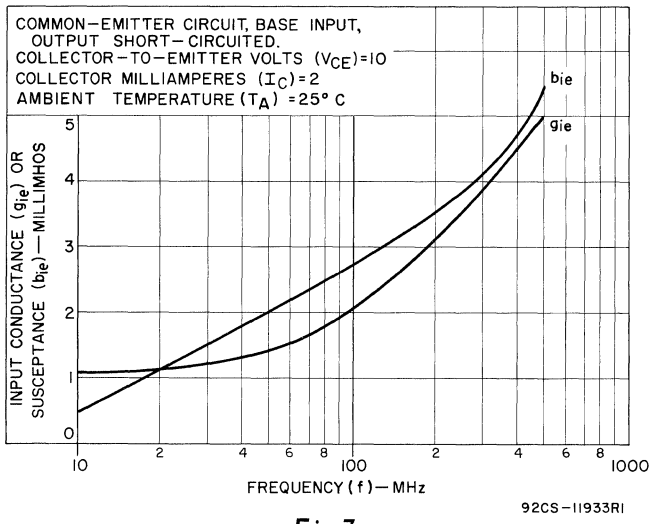


Fig.7

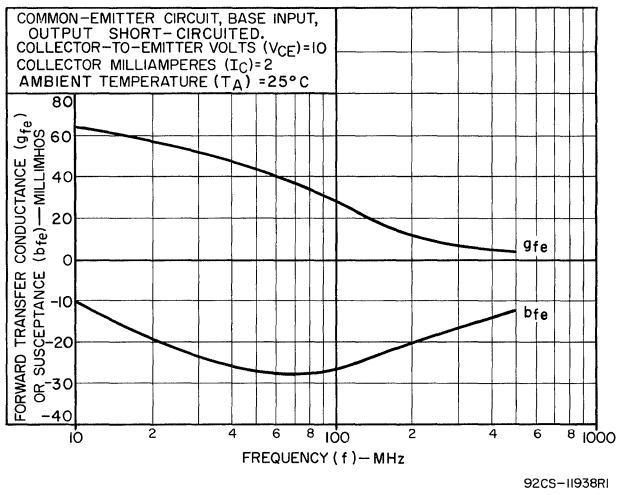


Fig.8

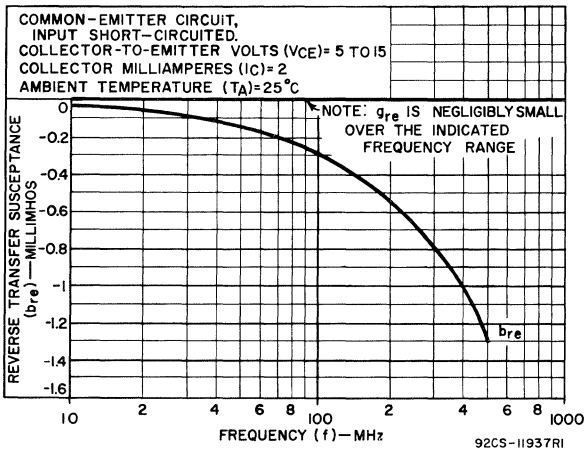


Fig.9

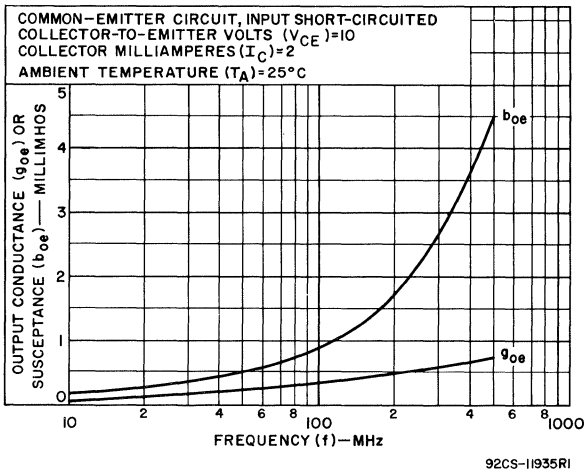
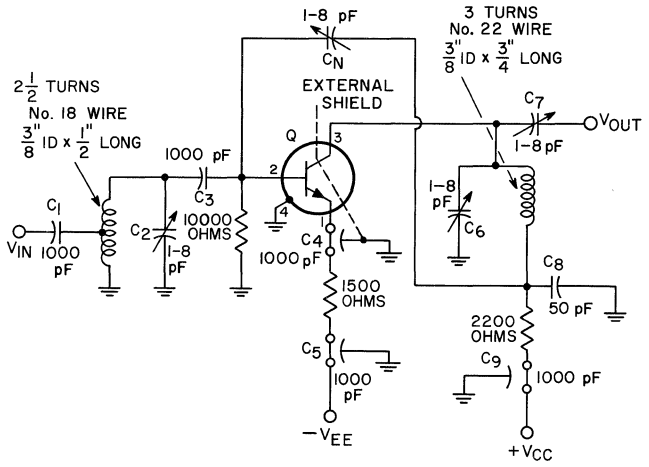


Fig.10

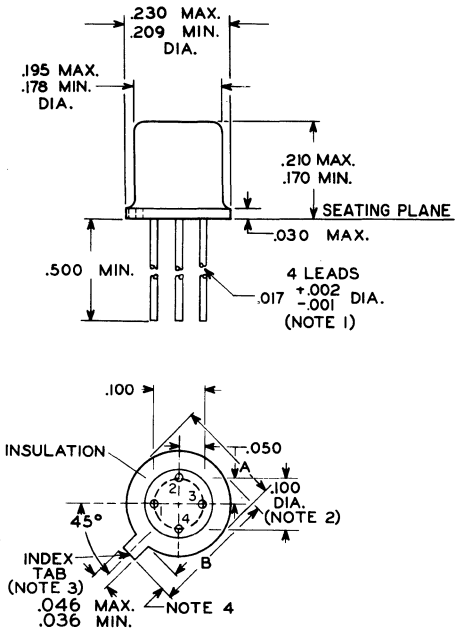


Q = Type 2N2708.

NOTE: (Neutralization Procedure): (a) Connect a 200-MHz signal generator (with R_g = 50 ohms) to the input terminals of the amplifier. (b) Connect a 50-ohm rF voltmeter across the output terminals of the amplifier. (c) Apply V_{EE} and V_{CC} and adjust C_2, C_6, and C_7 for maximum amplifier output voltage, adjusting the signal generator output and C_2, C_6, and C_7 if necessary for 5 mV at the output of the amplifier circuit. (d) Interchange the connections to the signal generator and the output indicator. (e) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the input. (f) Repeat steps (a), (b), and (c).

Fig.11 - Neutralized Amplifier Circuit used to Measure Power Gain and Noise Figure at 200 MHz for 2N2708.

DIMENSIONAL OUTLINE
JEDEC TO-72



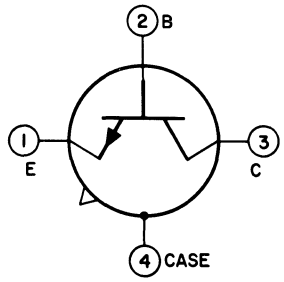
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

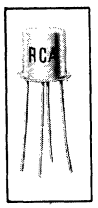
NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM - 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

TERMINAL DIAGRAM
Bottom View



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector
Lead 4 - Connected to case

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-72

For UHF Applications in Industrial and Military Equipment

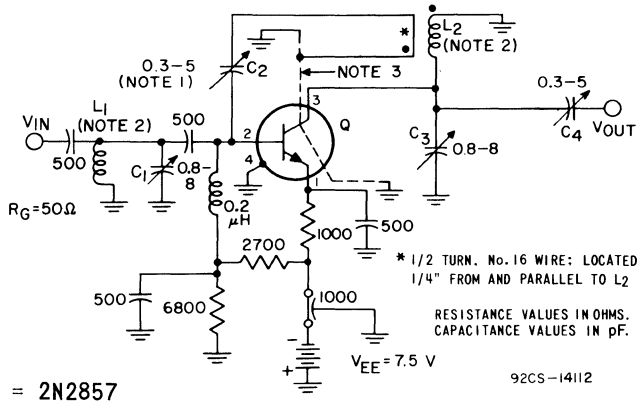
RCA-2N2857 is a double-diffused epitaxial planar transistor of the silicon n-p-n type. It is extremely useful in low-noise-amplifier, oscillator, and converter applications at frequencies up to 500 MHz in the common-emitter configuration, and up to 1200 MHz in the common-base configuration.

The 2N2857 utilizes a hermetically sealed four-lead JEDEC TO-72 package. All active elements of the transistor are insulated from the case, which may be grounded by means of the fourth lead in applications requiring shielding of the device.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max.	V
COLLECTOR CURRENT, I_C	40 max.	mA
TRANSISTOR DISSIPATION, P_T:		
At case temperatures* up to 25° C.	300 max.	mW
At case temperatures* above 25° C.	Derate at 1.72	mW/°C
At ambient temperatures up to 25°C	200 max.	mW
At ambient temperatures above 25° C.	Derate at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage and Operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32 inch from seating surface for 10 seconds max	265 max.	°C

* Measured at center of seating surface.



Q = 2N2857

NOTE 1: (NEUTRALIZATION PROCEDURE): (A) CONNECT A 450-MHz SIGNAL GENERATOR (WITH R_G = 50 Ω) TO THE INPUT TERMINALS OF THE AMPLIFIER. (B) CONNECT A 50-Ω RF VOLTMETER ACROSS THE OUTPUT TERMINALS OF THE AMPLIFIER. (C) APPLY V_{EE}, AND WITH THE SIGNAL GENERATOR ADJUSTED FOR 5 mV OUTPUT FROM THE AMPLIFIER, TUNE C_1, C_3, AND C_4 FOR MAXIMUM OUTPUT. (D) INTERCHANGE THE CONNECTIONS TO THE SIGNAL GENERATOR AND THE RF-VOLTMETER. (E) WITH SUFFICIENT SIGNAL APPLIED TO THE OUTPUT TERMINALS OF THE AMPLIFIER, ADJUST C_2 FOR A MINIMUM INDICATION AT THE INPUT. (F) REPEAT STEPS (A), (B), AND (C) TO DETERMINE IF RETUNING IS NECESSARY.

NOTE 2: L_1 & L_2 — SILVER-PLATED BRASS ROD, 1-1/2" LONG x 1/4" DIA. INSTALL AT LEAST 1/2" FROM NEAREST VERTICAL CHASSIS SURFACE.

NOTE 3: EXTERNAL INTERLEAD SHIELD TO ISOLATE THE COLLECTOR LEAD FROM THE EMITTER AND BASE LEADS.

Fig. 1 - Neutralized amplifier circuit used to measure 450 MHz power gain and noise figure for type 2N2857.

FEATURES

- high gain-bandwidth product— f_T = 1000 MHz min.
- high converter (450-to-30 MHz) gain— G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz
- high power gain as neutralized amplifier— G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz
- high power output as uhf oscillator— P_o = { 30 mW min., 40 mW typ. at 500 MHz; 20 mW typ., at 1 GHz }
- low device noise figure— NF = { 4.5 dB max. as 450 MHz amplifier; 7.5 dB typ. as 450-to-30 MHz converter }
- low collector-to-base time constant — $r_b'C_c$ = 7 ps typ.
- low collector-to-base feedback capacitance— C_{cb} = 0.6 pF typ.

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Printed in U.S.A.
2N2857 9-66
Supersedes issue dated 4-64

ELECTRICAL CHARACTERISTICS, *At an Ambient Temperature, T_A = 25° C, Unless Otherwise Specified*

Characteristic	Symbol	Frequency f	TEST CONDITIONS: DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Base Current I_B	DC Collector Current I_C	LIMITS: Type 2N2857 Min.	Typ.	Max.	Units
		MHz	V	V	V	mA	mA	mA				
Collector-Cutoff Current	I_{CBO}	T_A = 25°C T_A = 150°C	15 15			0 0			-	-	10 1.0	nA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}					0		0.001	30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}						0	3	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					-0.01		0	2.5	-	-	V
Static Forward-Current Transfer Ratio	h_{FE}			1				3	30	-	150	
Small-Signal Forward-Current Transfer Ratio	h_{fe}	0.001[c] 100[c]		6 6				2 5	50 10	- -	220 19	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1[b]	10			0			-	0.6	1.0	pF
Input Capacitance	C_{ib}	0.1 to 1[a]			0.5			0	-	1.4	-	pF
Collector-to-Base Time Constant	$r_b'C_c$	31.9[c]	6			-2			4	7	15	ps
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit (See Fig. 1)	G_{pe}	450[c]		6				1.5	12.5	-	19	dB
Power Output as Oscillator (See Fig. 2)	P_o	≥ 500[a]	10			-12			30	-	-	mW
UHF Device Noise Figure	NF	450[c, d, f]		6				1.5	-	3.8	4.5	dB
UHF Measured Noise Figure	NF	450[c, d]		6				1.5	-	-	5.0	dB
VHF Device Noise Figure	NF	60[b, d]		6				1	-	2.2	-	dB

[a] Fourth lead (case) not connected

[b] Three-terminal measurement: Lead No. 1 (Emitter) and lead No. 4 (Case) connected to guard terminal.

[c] Fourth lead (case) grounded.

[d] Generator resistance, R_g = 50 ohms.

[e] Generator resistance, R_g = 400 ohms.

[f] Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test circuit (0.25 dB) and the contribution of the following stages in the test set-up (0.25 dB).

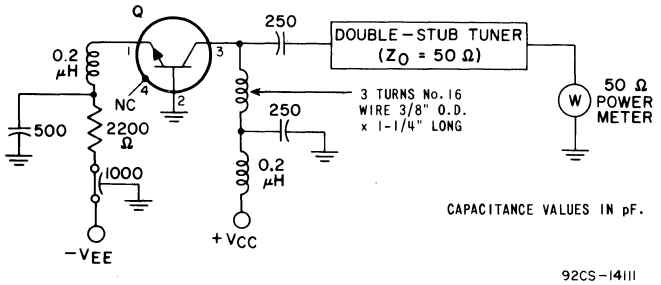


Fig. 2 - Oscillator circuit used to measure 500-MHz power output for type 2N2857.

Q = 2N2857

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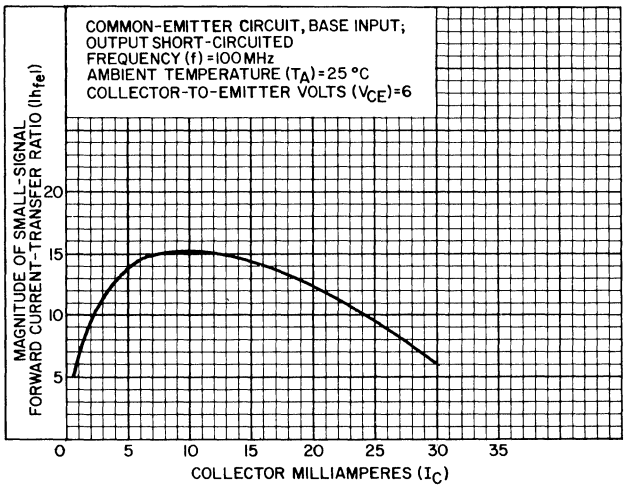


Fig. 3 - Small-signal beta characteristic for type 2N2857.

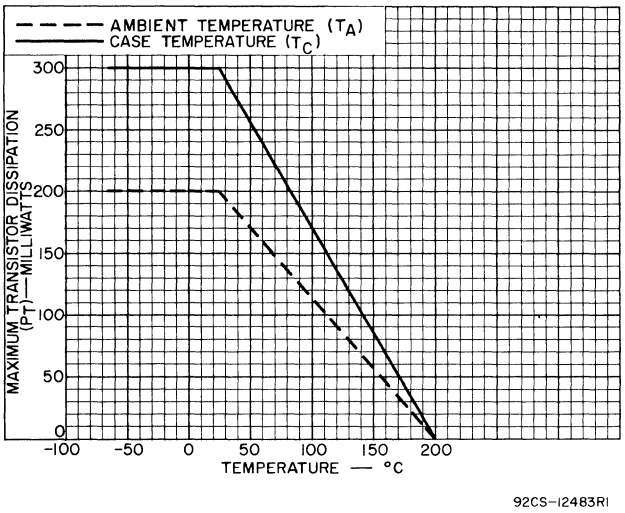


Fig. 4 - Rating chart for type 2N2857.

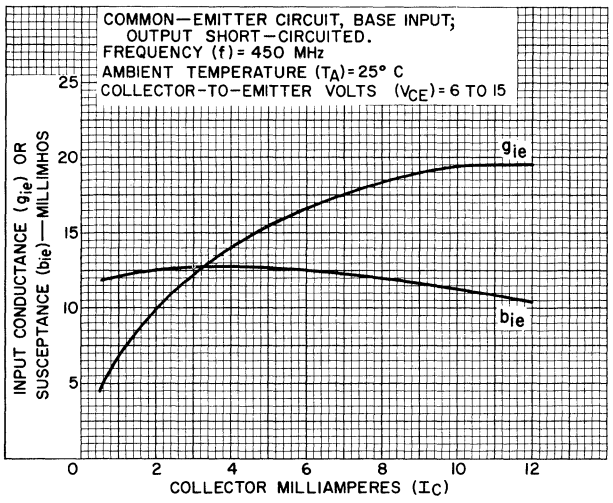


Fig. 5 - Input admittance (y_{ie}).

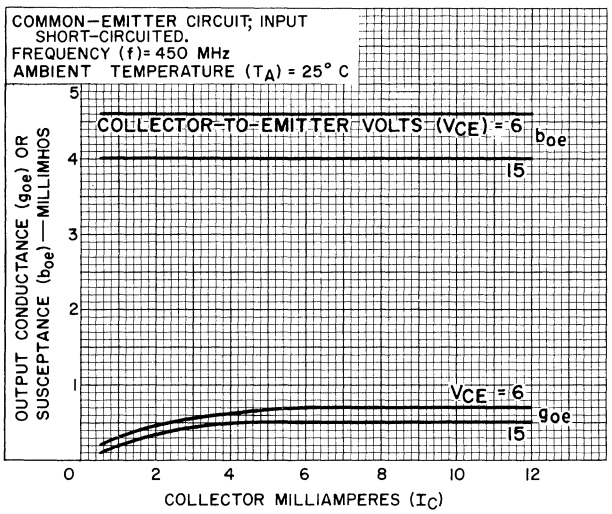


Fig. 6 - Output admittance (y_{oe}).

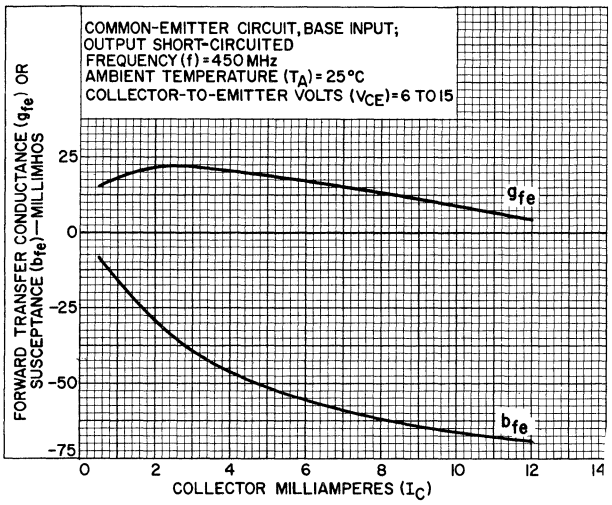


Fig. 7 - Forward transadmittance (y_{fe}).

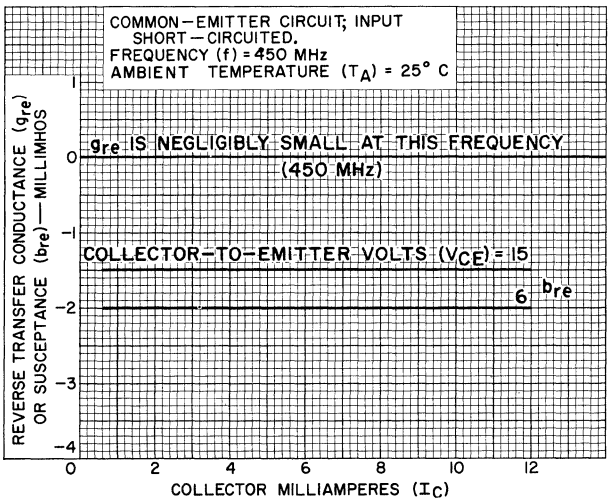


Fig. 8 - Reverse transadmittance (y_{re}).

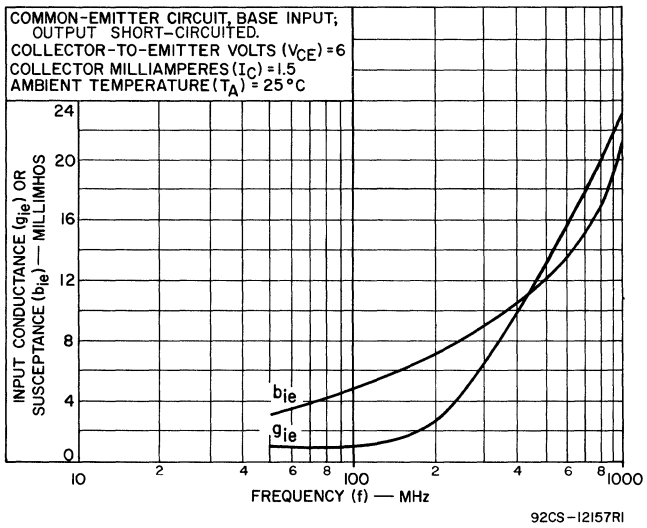


Fig. 9 - Input admittance (y_{ie}).

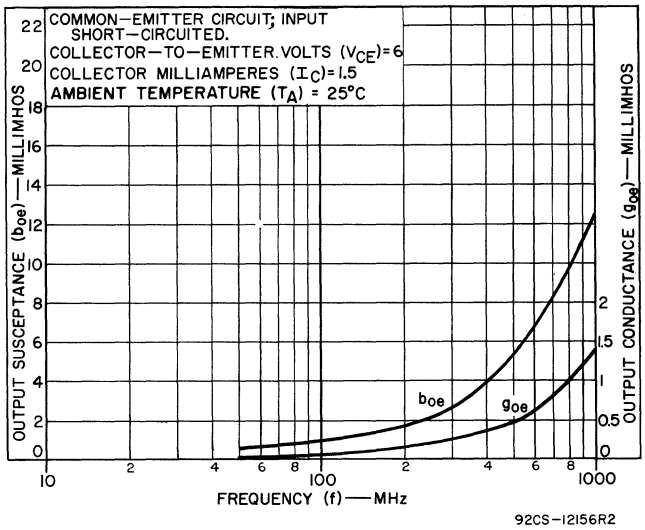


Fig. 10 - Output admittance (y_{oe}).

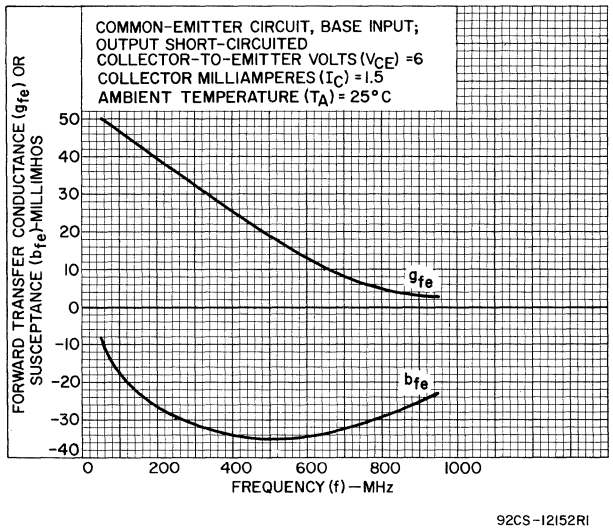


Fig. 11 - Forward transadmittance (y_{fe}).

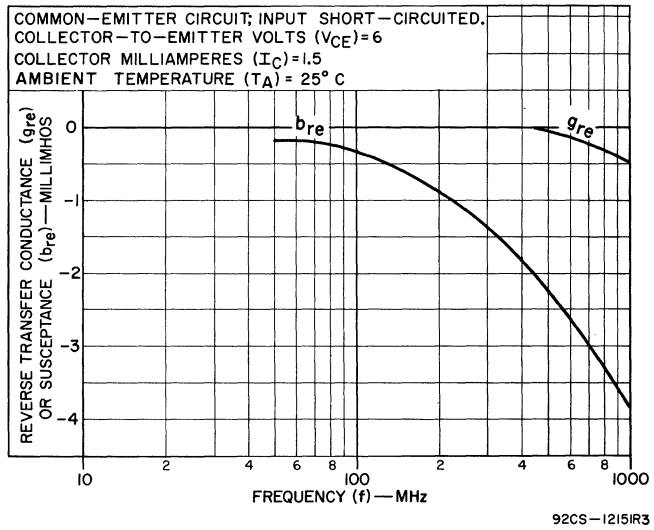
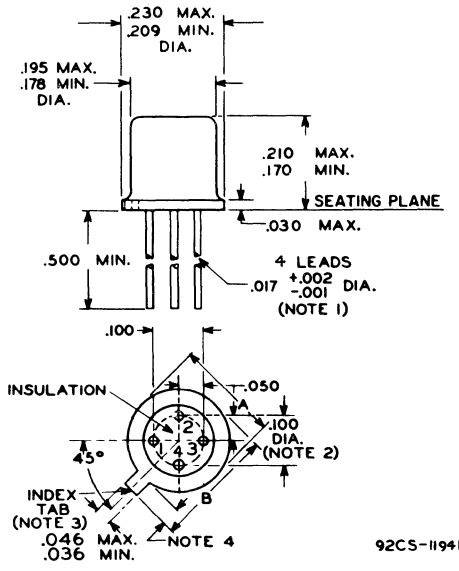


Fig. 12 - Reverse transadmittance (y_{re}).

DIMENSIONAL OUTLINE

JEDEC TO-72



NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. FROM 0.250" TO THE END OF THE LEAD A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" − 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAX. WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

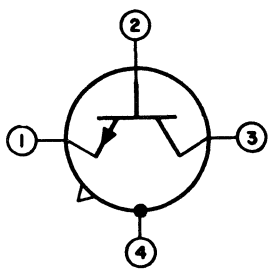
NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM − 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER A FROM DIMENSION B.

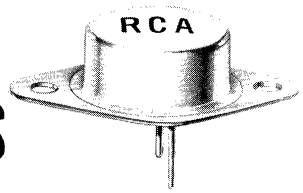
TERMINAL DIAGRAM

Bottom View

LEAD 1 − EMITTER
LEAD 2 − BASE
LEAD 3 − COLLECTOR
LEAD 4 − CONNECTED TO CASE



GERMANIUM P-N-P POWER TRANSISTORS



Actual Size

For AF Power-Amplifier and other Large-Signal Applications in Commercial, Industrial, and Military Equipment

RCA-2N2869/2N301 and RCA-2N2870/2N301A are alloy-junction power transistors of the germanium p-n-p type, designed for use in a wide variety of applications in commercial, industrial, and military equipment. These transistors are similar to and unilaterally interchangeable with types 2N301 and 2N301A respectively, but have substantially higher voltage, current, and dissipation ratings, lower saturation voltages, and linearity of beta over a wider range of collector current.

RCA-2N2869/2N301 and RCA-2N2870/2N301A can be used as direct replacements for types 2N301 and 2N301A respectively in existing equipment. Because of their higher ratings and superior characteristics, these new transistors also can provide greater power output and better performance than the 2N301 and 2N301A in new equipment designs.

RCA-2N2869/2N301 and RCA-2N2870/2N301A supersede RCA types 2N301 and 2N301A.

RCA-2N2869/2N301 and RCA-2N2870/2N301A are particularly suitable for use in class A and class B af-output-amplifier stages of automobile radio receivers and mobile communications equipment. They are also capable of providing very efficient performance in dc-to-dc and dc-to-ac power-conversion circuits.

The 2N2870/2N301A has higher collector-to-base voltage rating (-80 volts) than the 2N2869/2N301 (-60 volts), and is intended for use in applications requiring this higher voltage capability. The 2N2870/2N301A also has a lower collector-to-emitter saturation voltage (-0.3 volt typ., -0.5 volt max.) than the 2N2869/2N301 (-0.4 volt typ., -0.75 volt max.).

- High Breakdown Voltages—
  BV_{CBO} for 2N2870/2N301A = -80 volts min.
  BV_{CBO} for 2N2869/2N301 = -60 volts min.
- Low Saturation Voltages—
  $V_{CE}(sat)$ for 2N2870/2N301A = -0.3 volt typ.
  $V_{CE}(sat)$ for 2N2869/2N301 = -0.4 volt typ.
- Very Low Collector Saturation Current $I_{CBO}(sat)$ = -100 μa max. at V_{CB} = -0.5 volt—
  Assures Excellent Operating Stability for Wide Temperature Variations
- High Dissipation Capability = 30 watts max.
- High Collector Current Capability = -10 amp. max.
- High Large-Signal (DC) Beta = 90 typ.
- Excellent Beta Linearity — Essentially linear up to 10 amp. I_C
- At V_{CC} = -14.4 volts:
  (a) 5 watts output (5% THD) with 38 db power gain in single-ended class A_1 Service
  (b) 12 watts output (5% THD) with 30 db power gain in push-pull class B service
- Hermetically Sealed JEDEC TO-3 Package

Maximum Ratings, *Absolute-Maximum Values:*

	2N2869/ 2N301	2N2870/ 2N301A	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-60	-80 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	-50	-50 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	-10	-10 max.	volts
COLLECTOR CURRENT, I_C	-10	-10 max.	amp
EMITTER CURRENT, I_E	+10	+10 max.	amp
BASE CURRENT, I_B	-3	-3 max.	amp

* Measured at center of seating surface.

TRANSISTOR DISSIPATION:			
At Mounting-Flange Temperatures*—			
Up to +55° C	30	30 max.	watts
Above +55° C	See *Fig.1*		
TEMPERATURE RANGE:			
Storage and Operating (Junction)	-65 to +100		°C
PIN TEMPERATURE (During Soldering):			
At distance of not less than 1/32" from seating surface for 10 seconds max.	255	255	°C

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Printed in U.S.A.

2N2869/2N301,
2N2870/2N301A 7-66
Supersedes issue dated 8-63

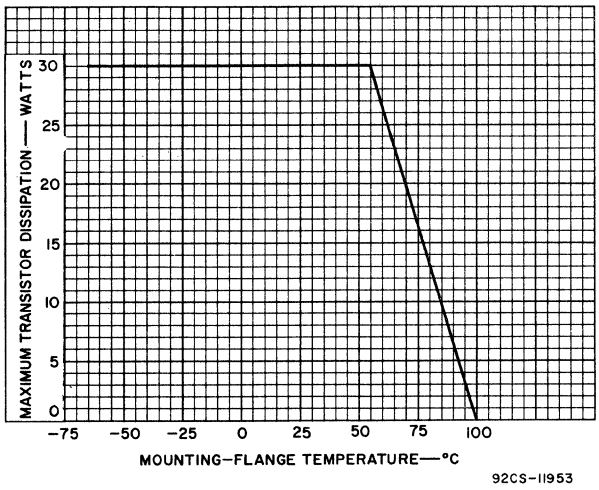


Fig.1 - Rating Chart for Types 2N2869/2N301 and 2N2870/2N301A.

Electrical Characteristics, *at a Mounting-Flange Temperature, T_{MF}*, of 25° C*

Characteristics	Symbols	TEST CONDITIONS					LIMITS						Units
		DC Collector-to Base Voltage V_{CB}	DC Collector-to Emitter Voltage V_{CE}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N2869/2N301			Type 2N2870/2N301A			
		volts	volts	amp	ma	amp	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-to-Base Breakdown Voltage	BV_{CBO}			-0.005	0		-60	-	-	-80	-	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			-0.6		0	-50	-	-	-50	-	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	-2		-10	-	-	-10	-	-	volts
Collector-Cutoff Current	I_{CBO}	-30			0		-	-	-0.5	-	-	-0.5	ma
Saturation Collector-Cutoff Current	$I_{CBO}(sat)$	-0.5			0		-	-	-0.1	-	-	-0.1	ma
DC Forward-Current Transfer Ratio	h_{FE}		-2	-1			50	90	165	50	90	165	
Base-to-Emitter Voltage	V_{BE}		-2	-1			-	-0.3	-0.5	-	-0.3	-0.5	volt
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			-5		-0.5	-	-0.4	-0.75	-	-0.3	-0.5	volt
Gain-Bandwidth Product	f_T		-2	-1			200	450	-	200	450	-	Kc

* Measured at center of seating surface.

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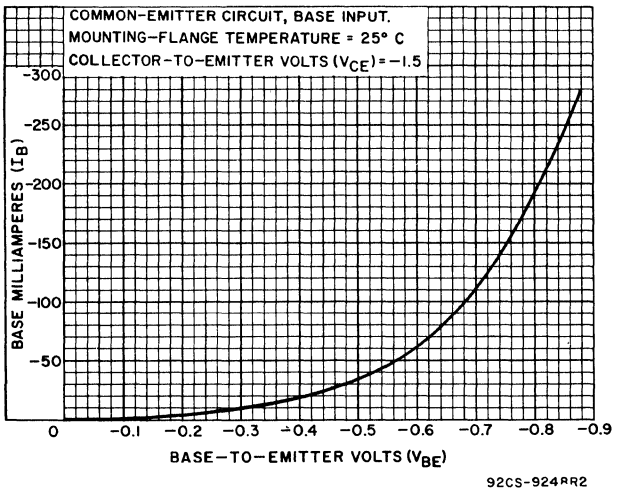


Fig.4 - Typical Input Characteristic for Types 2N2869/2N301 and 2N2870/2N301A

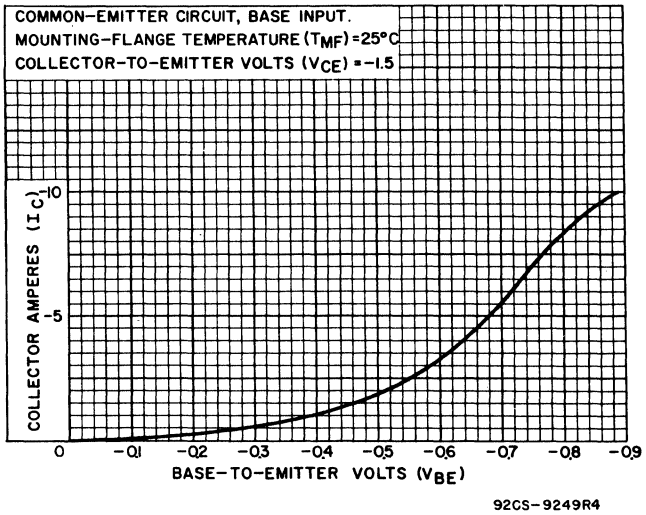


Fig.5 - Typical Transfer Characteristic for Types 2N2869/2N301 and 2N2870/2N301A

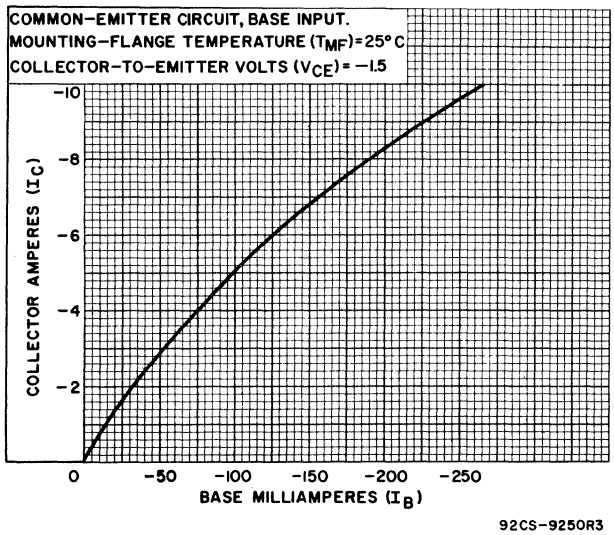


Fig.6 - Typical Current-Transfer Characteristic for Types 2N2869/2N301 and 2N2870/2N301A

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

In class A service, to insure stable operation and low distortion, it will be necessary to provide some degeneration in the emitter circuit. This degeneration may be accomplished by using an unbypassed resistor in the emitter circuit.

In class B service, if the 2N2869/2N301 or 2N2870/2N301A is operated near its maximum collector voltage rating, it is important that circuit arrangements be made to prevent thermal runaway. A convenient method is to reduce the base-to-emitter forward voltage by an amount equal to approximately 0.002 volt for each degree centigrade that the mounting-flange temperature is above 25° C.

In the design of circuits using the RCA-2N2869/2N301 and 2N2870/2N301A it is extremely important to assure that the maximum junction-temperature rating of 100° C is not exceeded. This consideration is especially important in af-amplifier and other applications involving complex signal waveforms and other factors capable of producing high peak values of dissipation, such as

(a) oscillation or "ringing" due to excessive or improperly neutralized feedback
(b) phase shifts due to circuit capacitances and/or reactive loads
(c) variations in load impedance
(d) overdriving of transistors
(e) high line voltage

Because of the short thermal time constant of the RCA-2N2869/2N301 and 2N2870/2N301A (approximately 15 milliseconds), the rise in junction temperature produced when so-called "instantaneous" peak values of dissipation are sustained for longer than 15 milliseconds may be as great as 1.5° C per watt. The circuit designer, therefore, must select operating conditions such that no possible combination of the factors listed above, or any other operating condition will cause the junction temperature to rise above 100° C.

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

The 2N2869/2N301 and 2N2870/2N301A should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

These transistors can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

It is essential that the mounting flange which serves as the collector terminal be securely fastened to a heat sink, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE TRANSISTOR.

The mounting-flange temperature of the 2N2869/2N301 or 2N2870/2N301A will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the transistor-mounting-flange temperature above the design value.

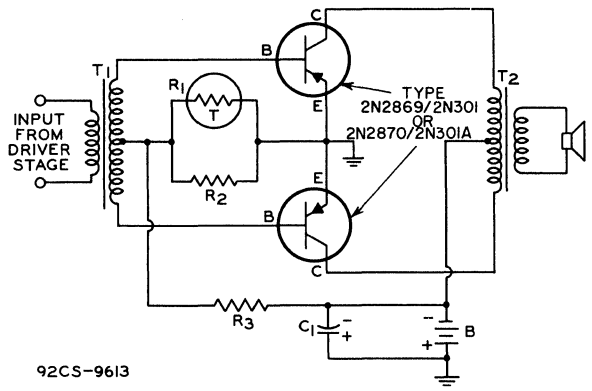
Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

Typical Operation for Types 2N2869/2N301 and 2N2870/2N301A in the Class B Push-Pull Audio Power-Amplifier Circuit of Fig.2:

At Mounting-Flange Temperature of 80° C and Signal Frequency of 400 cps
Unless otherwise specified, values are for two transistors

DC Supply Voltage	−14.4	volts
Zero-Signal DC Collector Current□	−0.05	amp
Zero-Signal DC Base-to-Emitter Voltage	−0.13	volt
Peak Collector Current□	−2	amp
Max.-Signal DC Collector Current□	−0.64	amp
Signal-Source Impedance (per base)	10	ohms
Load Impedance (Per collector)	6	ohms
Power Gain●	30	db
Max.-Signal Power Output●	12	watts
Total Harmonic Distortion (At Power Output of 12 watts)	5% max.	
Circuit Efficiency (At Power Output of 12 watts)●	67	%
Collector Dissipation (Per Transistor at Power Output of 12 watts)	3	watts

● Measured at the primary of the output transformer.
□ Per transistor.



B : 14.4-volt supply

C_1: 1000 μf, electrolytic, 25 volts

R_1: Thermistor, 28.25 ohms at 0° C, 10 ohms at 25° C, 4.06 ohms at 50° C

R_2: 5.6 ohms, 0.5 watt

R_3: 270 ohms, 1 watt

T_1: Driver Transformer: Primary Impedance determined by large-signal considerations of the driver unit. Secondary Impedance = 40 ohms center tapped.

T_2: Output Transformer: Primary Impedance = 24 ohms center tapped, Secondary Impedance = voice-coil Impedance.

Fig.2 - Class B Push-Pull AF Power-Amplifier Circuit Utilizing Types 2N2869/2N301 and 2N2870/2N301A.

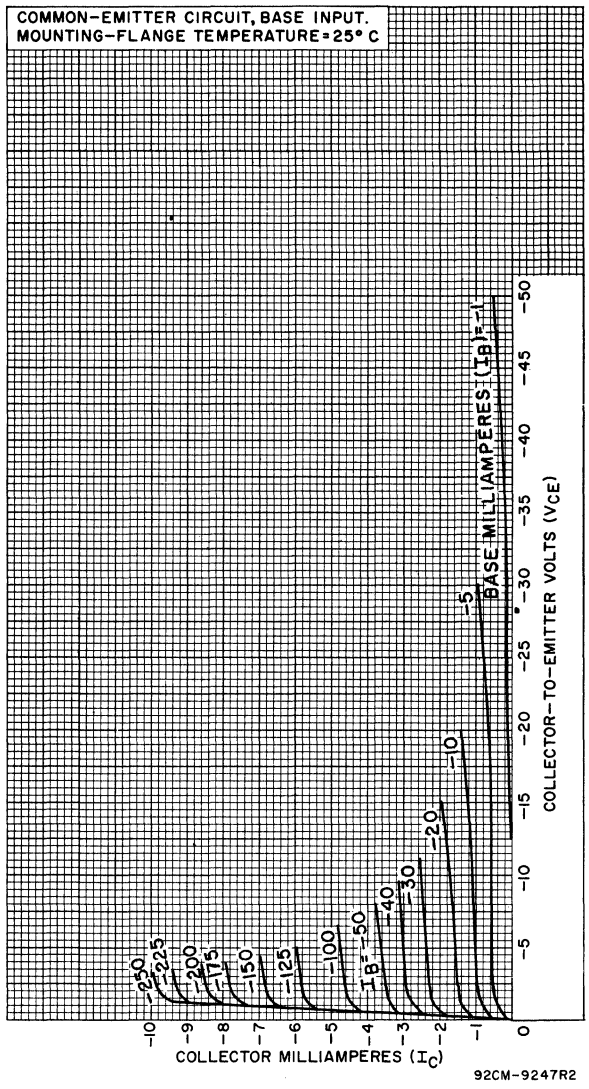
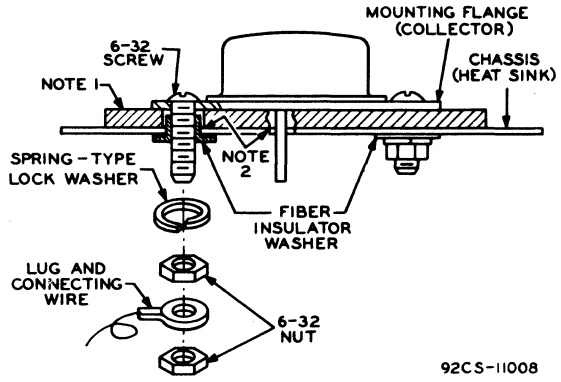


Fig.3 - Typical Collector Characteristics for Types 2N2869/2N301 and 2N2870/2N301A.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized aluminum washer having high thermal conductivity, or a 0.002" thick mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that a fibre washer be used between each bolt and the chassis as shown in Fig.7.

An insulated mounting arrangement such as that described in the preceding paragraph and shown in Fig. 7 is also necessary when Type 2N2869/2N301 or 2N2870/2N301A transistors are used in class B push-pull af-amplifier stages of the type shown in Fig. 2. In such stages the mounting flanges of the two transistors must be insulated from the chassis or heat sink and from each other to avoid short-circuiting the primary winding of the output transformer.



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

Mounting hardware items for RCA 2N2869/2N301 and 2N2870/2N301A are available from RCA Distributors under the following RCA Part Numbers:

ITEM	RCA PART No.
Mica Insulator	495320
Nylon Insulating Washer (2)	495334-7

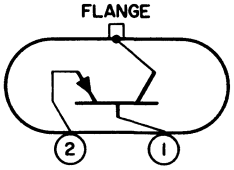
Mica insulators are also available from Reliance Mica Co., 341-351 39th St., Brooklyn, N.Y. 10032, United Mineral & Chemical Corp., 16 Hudson St., N.Y., N.Y. 10014, and other suppliers of similar components.

Insulating shoulder washers are also available from Contour Plastics, Minneapolis, Minn. and other suppliers of similar components.

Sockets for RCA-2N2869/2N301 and 2N2870/2N301A and other semiconductor devices utilizing the JEDEC TO-3 package are made by several manufacturers, and are generally available from electronic parts distributors.

Fig. 7 - Suggested Mounting Arrangement for Types 2N2869/2N301 and 2N2870/2N301A.

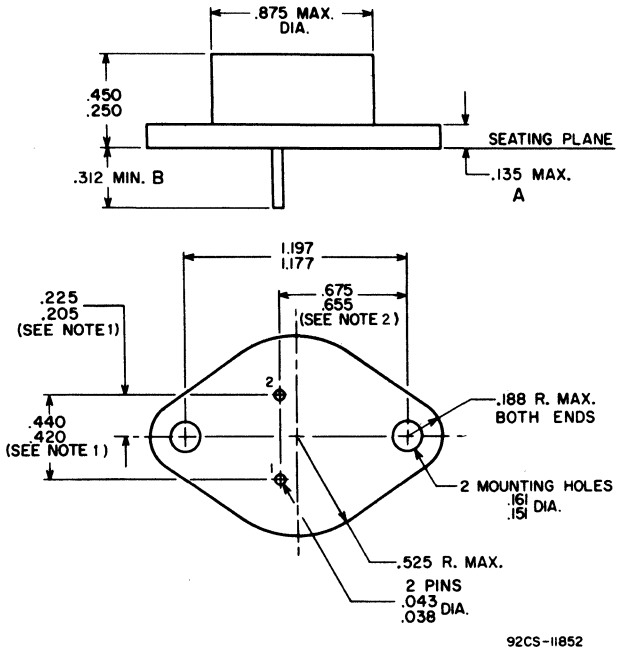
TERMINAL CONNECTIONS



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

DIMENSIONAL OUTLINE For Types 2N2869/2N301 and 2N2870/2N301A

JEDEC No. TO-3



ALL DIMENSIONS IN INCHES.

For RCA-2N2869/2N301 and 2N2870/2N301A

Mounting-Flange Thickness (A) = 0.050" max.

Pin Length (B) = 0.440" min. / 0.480" max.

NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 2: TWO LEADS.

SILICON N-P-N PLANAR TRANSISTORS

2N2895
2N2896
2N2897

File No. 143

RCA-2N2895, 2N2896, and 2N2897 are triple-diffused-junction planar transistors of the silicon n-p-n type intended for a wide variety of small-signal and low-to-medium-power applications in military and industrial equipment.

These transistors are TO-18 versions of RCA's versatile 2N2102 family of n-p-n triple-diffused silicon transistors for small-signal and medium-power military and industrial applications.

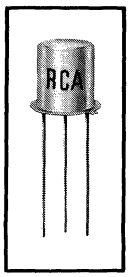
Like the 2N2102, the 2N2895 offers five levels of beta control from 0.1 ma to 0.5 ampere.

High-voltage type 2N2896 offers a BV_{CEO} of 90 volts min. and V_{CER} (sus) of 140 volts min., controlled for values of R_{BE} from 0 to 100,000 ohms.

RCA-2N2897 is an economy version offering many of the advantages of the 2N2896.

These transistors feature extremely low leakage characteristics, high pulse dc beta, high small-signal beta, very low output capacitance, and large gain-bandwidth products. Type 2N2895 also has an exceptionally low noise figure of 8 db max.

For Small-Signal and Low-to-Medium-Power Applications



JEDEC TO-18

FEATURES:

- high mimimum gain-bandwidth products –
  120 Mc for 2N2895, 2N2896
  100 Mc for 2N2897
  useful in applications from dc to 40 Mc
- planar construction – for low noise and low leakage characteristics
- operation at high junction temperatures – up to 200° C
- very low output capacitance – 15 pf max.
- high switching-speed capabilities (non-sat)

Maximum Ratings, *Absolute-Maximum Values:*

	2N2895	2N2896	2N2897	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	140	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	65	90	45 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER} (With $R_{BE} \leq$ 10 ohms)	80	140	60 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7	7 max.	volts
COLLECTOR CURRENT, I_C	1	1	1 max.	amp
TRANSISTOR DISSIPATION, P_T:				
For case temperatures up to 25° C.	1.8	1.8	1.8 max.	watts
above 25° C.	See Rating Chart (Fig. 1)			
TRANSISTOR DISSIPATION, P_T (Cont'd):				
For free-air temperatures up to 25° C.	0.5	0.5	0.5 max.	watt
above 25° C.	See Rating Chart (Fig. 1)			
TEMPERATURE RANGE:				
Storage and Operating (Junction)	-65 to +200			°C
LEAD TEMPERATURE (During Soldering): At distances ≥ 1/32 inch from lead seals for 10 seconds max.	255	255	255 max.	°C

2N2895, formerly Dev. No. TA2275
2N2896, formerly Dev. No. TA2276
2N2897, formerly Dev. No. TA2277

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N2895, 2N2896, 2N2897 6/66
Reprinted from 2N2895, 2N2896, 2N2897 7/63

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS						Units
		Case Temperature T_C	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N2895		Type 2N2896		Type 2N2897		
		°C	kc	volts	volts	volts	ma	ma	ma	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	25		90				0		-	-	-	0.01	-	-	μa
		150		90				0		-	-	-	10	-	-	μa
		25		60				0		-	0.002	-	-	-	0.05	μa
		150		60				0		-	2	-	-	-	50	μa
Emitter-Cutoff Current	I_{EBO}	25				5	0			-	0.002	-	0.01	-	0.05	μa
DC Forward-Current Transfer Ratio	h_{FE}	25			10		150[b]			40	120	60	200	50	200	
		25			10		500[b]			25	-	-	-	-	-	
		25			10		0.1			20	-	-	-	-	-	
		25			10		1			-	-	35	-	35	-	
		25			10		10			35	-	-	-	-	-	
		-55			10		10			20	-	20	-	-	-	
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0.1	0		120	-	140	-	60	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.1		7	-	7	-	7	-	volts
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$	25					100[b]		0	65	-	90	-	45	-	volts
Collector-to-Emitter Sustaining Voltage with R_{BE} = 10 ohms	$V_{CER(sus)}$	25					100[b]			80	-	140	-	60	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25					150[b]		15	-	0.6	-	0.6	-	1	volt
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25					150[b]		15	-	1.2	-	1.2	-	1.3	volts
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25	1		5		5			50	200	50	275	50	275	
		25	20 Mc		10		50			6	-	6	-	5	-	
Noise Figure: Generator resistance = 510 ohms, circuit bandwidth = 1 cps	NF	25	1		10		0.3			-	8	-	-	-	-	db
Output Capacitance	C_{ob}	25	140	10				0		-	15	-	15	-	15	pf
Input Capacitance	C_{ib}	25	140			0.5	0			-	80	-	80	-	80	pf
Thermal Resistance: Junction-to-Base	$\theta_{J\text{-}C}$	-								-	97	-	97	-	97	°C/watt
Junction-to-Free Air	$\theta_{J\text{-}FA}$	-								-	350	-	350	-	350	°C/watt

[b] Pulse test: Pulse duration = 300 μsec; duty factor = 1.8%.

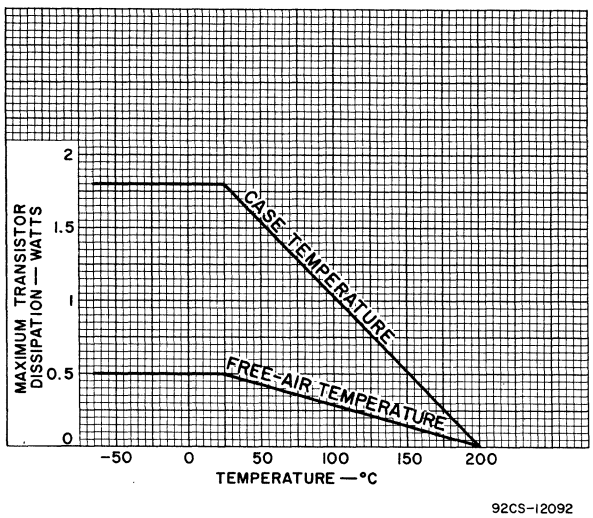


Fig. 1 - Rating Chart for Types 2N2895 2N2896, and 2N2897

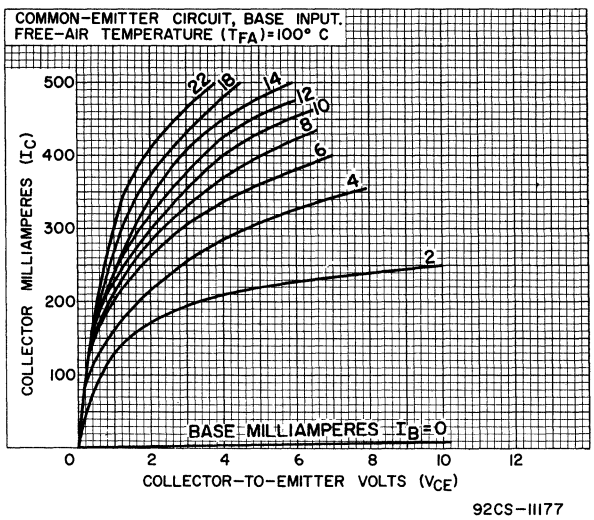


Fig. 2 - Typical Collector Characteristics at 100° C for Type 2N2895

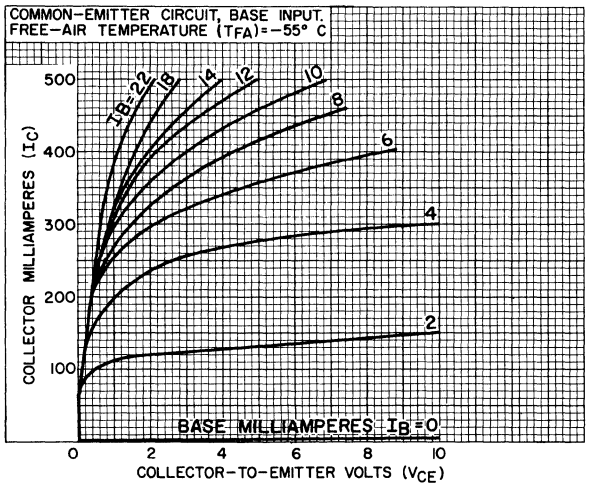


Fig. 9 - Typical Collector Characteristics at -55° C for Type 2N2895.

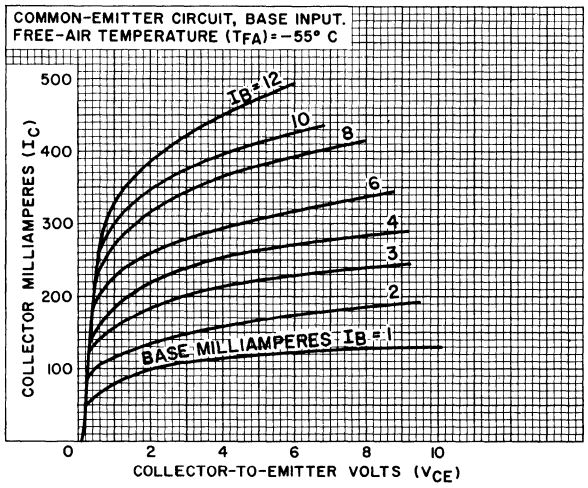


Fig. 10 - Typical Collector Characteristics at -55° C for Types 2N2896 and 2N2897.

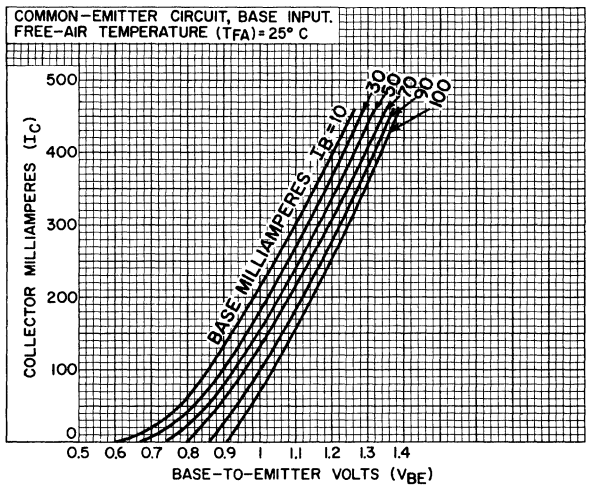


Fig. 11 - Typical Transfer Characteristics for Types 2N2895 and 2N2896.

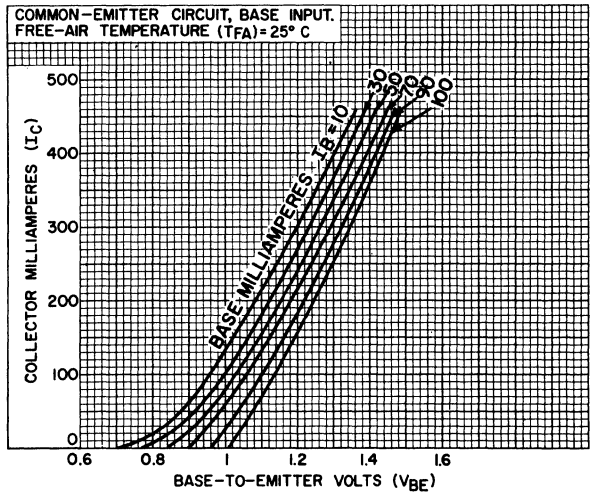


Fig. 12 - Typical Transfer Characteristics for Type 2N2897.

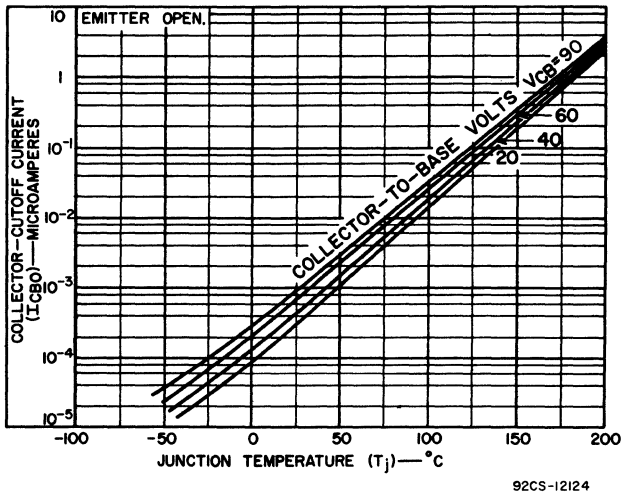


Fig. 13 - Typical Collector-Cutoff-Current Characteristics for Types 2N2895 and 2N2896.

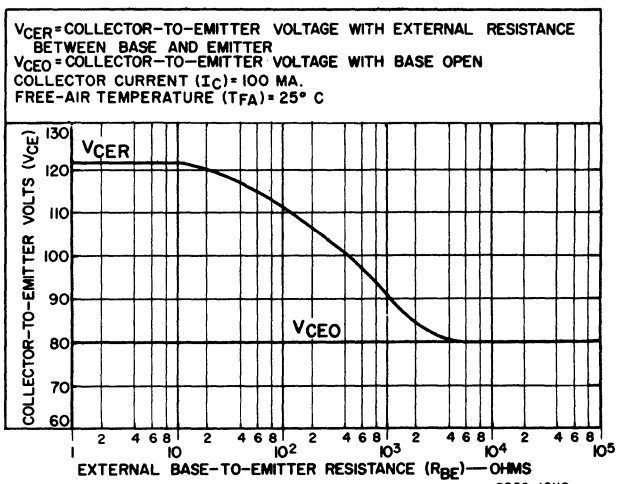


Fig. 14 - Typical Collector-to-Emitter-Voltage Characteristic for Type 2N2895.

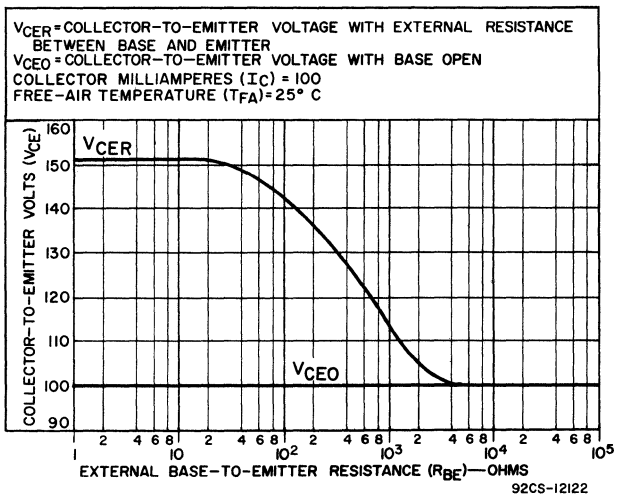


Fig. 15 - Typical Collector-to-Emitter-Voltage Characteristic for Type 2N2896.

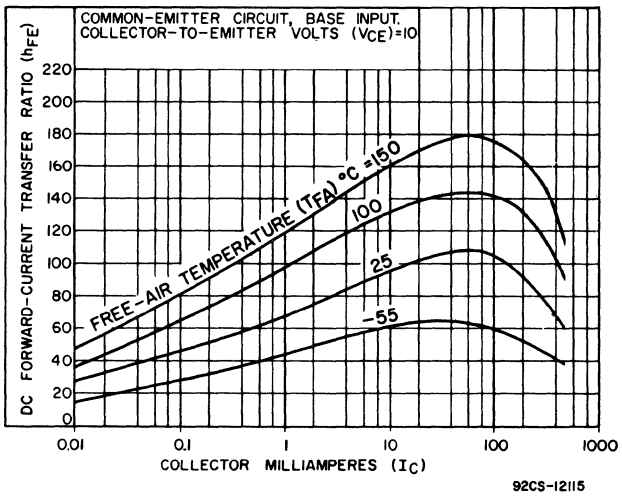


Fig. 16 - Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N2895.

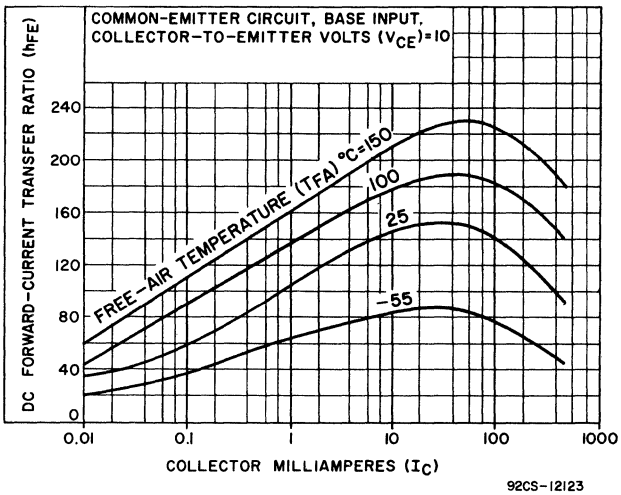


Fig. 17 - Typical DC-Forward-Current Transfer-Ratio Characteristics for Types 2N2896 and 2N2897.

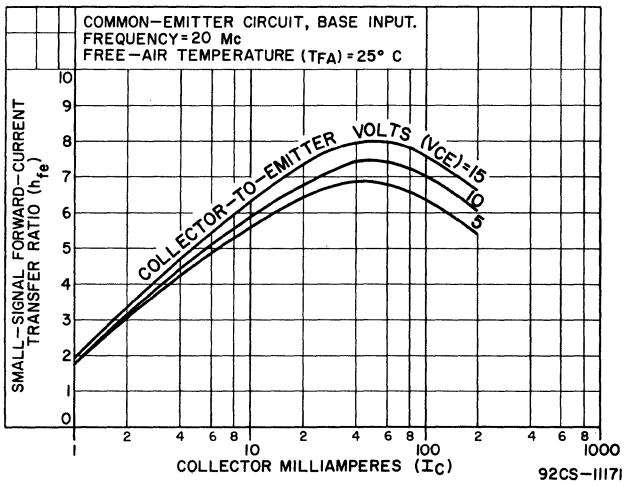


Fig. 18 - Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Types 2N2895, 2N2896 and 2N2897 .

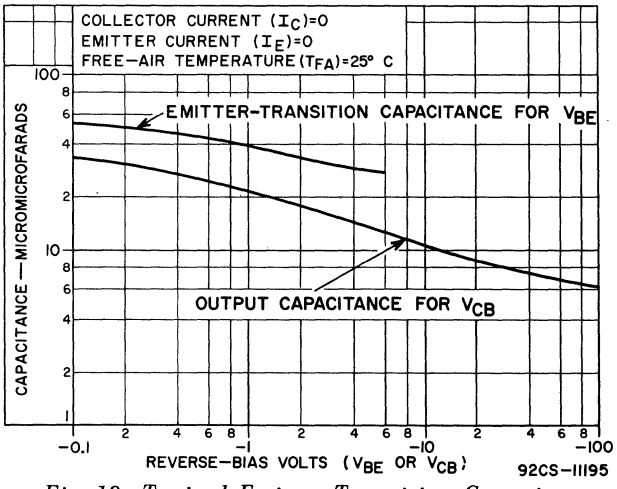


Fig. 19 - Typical Emitter-Transition-Capacitance and Output-Capacitance Characteristics for Types 2N2895, 2N2896 and 2N2897.

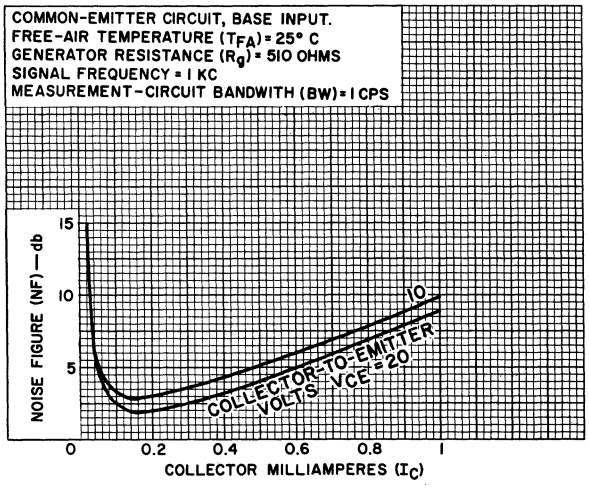


Fig. 20 - Typical AF-Noise-Figure Characteristics for Type 2N2895.

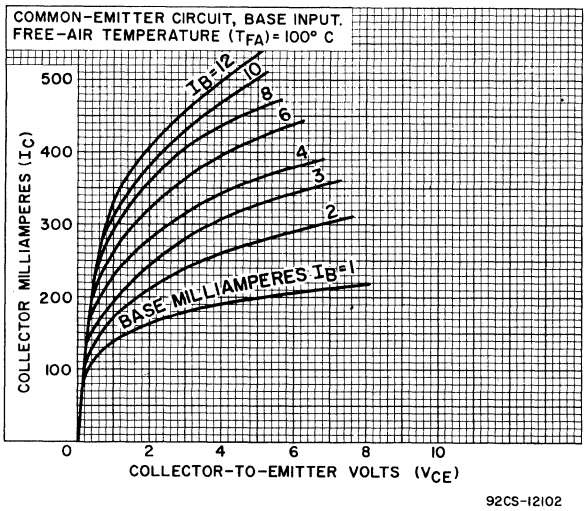


Fig. 3 - Typical Collector Characteristics at 100° C for Types 2N2896 and 2N2897.

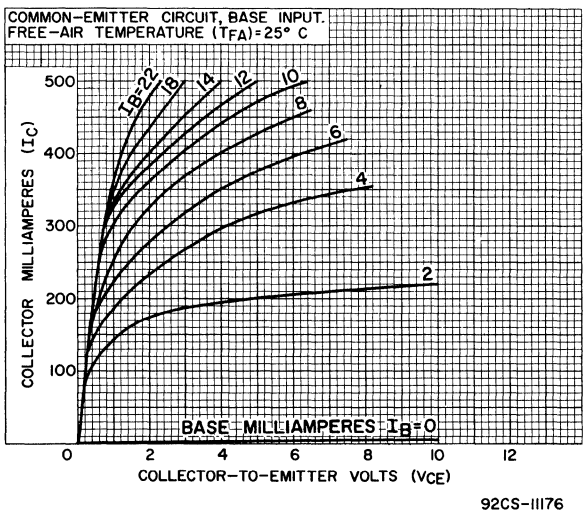


Fig. 4 - Typical Collector Characteristics at 25° C for Type 2N2895.

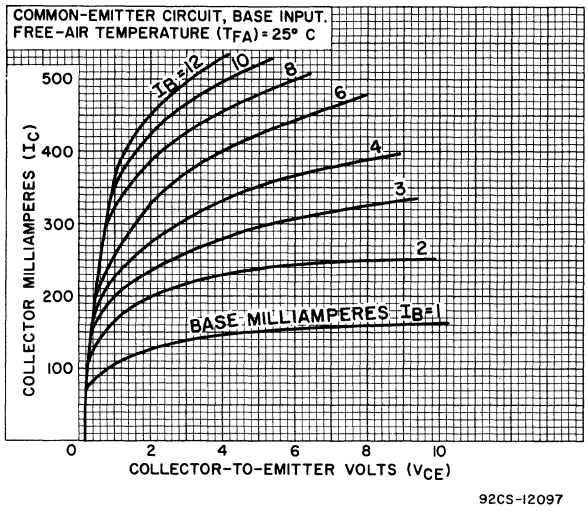


Fig. 5 - Typical Collector Characteristics at 25° C for Types 2N2896 and 2N2897.

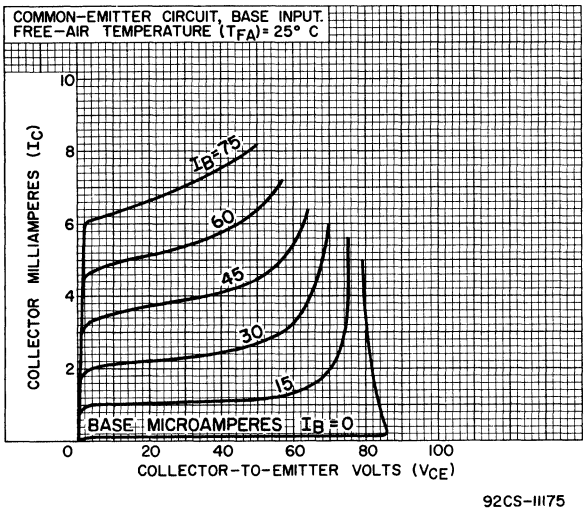


Fig. 6 - Typical Collector Characteristics at 25° C for Type 2N2895.

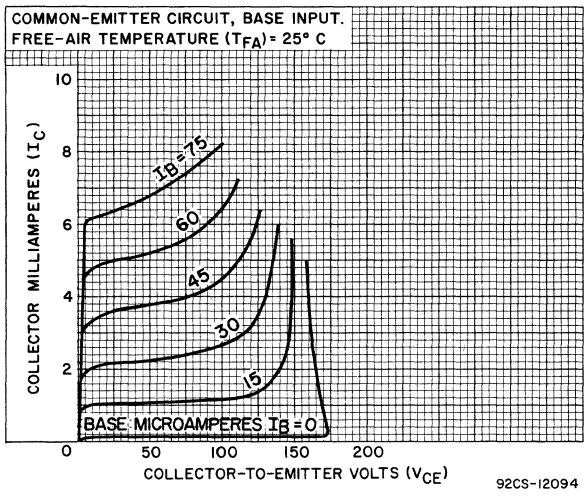


Fig. 7 - Typical Collector Characteristics at 25° C for Type 2N2896.

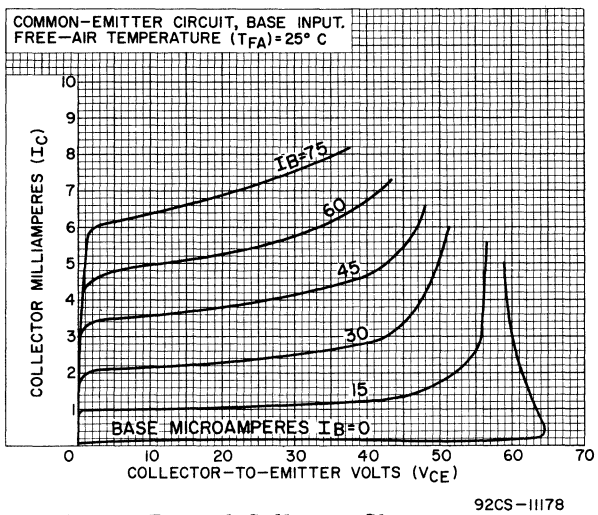
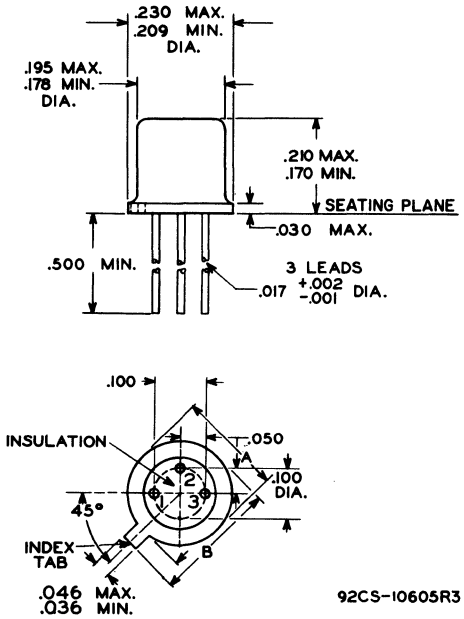
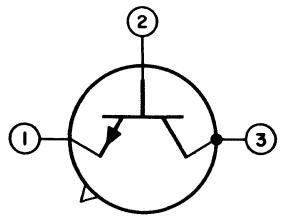


Fig. 8 - Typical Collector Characteristics at 25° C for Type 2N2897.

2N2895, 2N2896, and 2N2897
DIMENSIONAL OUTLINE
JEDEC No. TO-18



TERMINAL DIAGRAM
(Bottom View)
For All Types

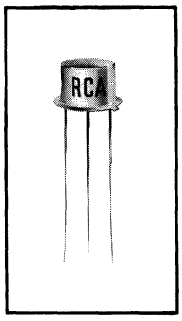


LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR, CASE

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SILICON N-P-N HIGH-SPEED TRANSISTOR

Planar Epitaxial Type For Switching Applications In Military and Commercial Data-Processing Equipment



JEDEC TO-52

RCA-2N2938▲ is a double-diffused planar epitaxial transistor of the silicon n-p-n type especially suitable for high-speed saturated switching applications in industrial and military equipment. The 2N2938 features a special internal design which provides an exceptionally high ratio of emitter periphery to area. This design makes it possible to achieve both high beta and high switching speed at high values of collector current. In addition, the planar epitaxial construction results in low base and collector cutoff currents, low saturation voltages at high values of collector current, and exceptional stability of characteristics.

The 2N2938 also features very low input and output capacitances, and utilizes a hermetically sealed JEDEC TO-52 miniature package.

- low saturation voltages:
  $V_{CE}(sat)$ = 0.22 volt typ. at I_C = 50 ma
  $V_{BE}(sat)$ = 0.85 volt typ. at I_C = 50 ma
- low cutoff currents:
  I_{CEV} = 2.7 na typ., 25 na max.
  I_{BEV} = -2.7 na typ., -25 na max.
- very low input and output capacitances:
  C_{ib} = 3.3 pf typ., 5 pf max.
  C_{ob} = 3.5 pf typ., 4 pf max.
- high pulse dc beta at high collector current:
  h_{FE} = 60 typ., 10 min. at I_C = 200 ma
- high small-signal beta —
  h_{fe} = 6.9 typ., 5 min. at 100 Mc
- wide operating-temperature range —
  -65 to +175 °C

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	13 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5 max.	volts
COLLECTOR CURRENT, I_C	500 max.	ma
TRANSISTOR DISSIPATION, P_T:		
For case temperatures[a] up to 25° C	1 max.	watt
For case temperatures[a] above 25° C	See *Fig. 1*	
For free-air temperatures up to 25° C	0.3 max.	watt
For free-air temperatures above 25° C	See *Fig. 1*	
TEMPERATURE RANGE:		
Storage	-65 to +200	°C
Operating	-65 to +175	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32" from seating surface for 10 seconds max.	300 max.	°C

[a] Measured at center of seating surface.

▲ Formerly developmental No. TA2090A

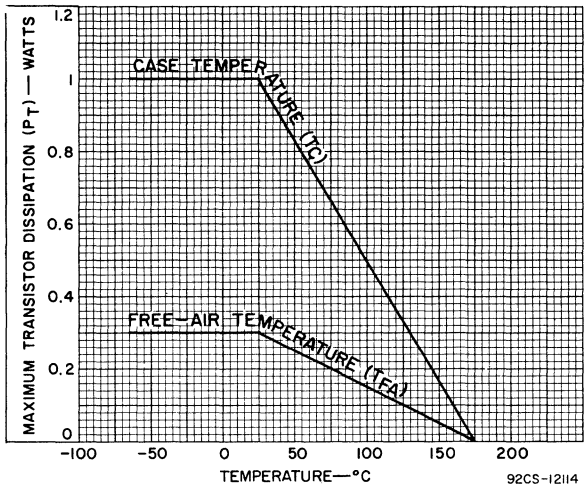


Fig. 1 - Rating Chart for Type 2N2938.

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2N2938 7-66
Reprinted from issue dated 4-64

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS			Units
		Free-Air Temperature T_{FA}	Frequency f	DC Collector-to-Emitter Voltage V_{CE}	DC Collector-to-Base Voltage V_{CB}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N2938			
		°C	Mc	volts	volts	volts	ma	ma	ma	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CEV}	25 150		20 20		0 0				- -	2.7 4.2	25 25	na μa
Base-Cutoff Current	I_{BEV}	25		20		0				-	-2.7	-25	na
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.01		25	52	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	25						10	0	13	16	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.01	0		5	8.5	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25						50	1.6	-	0.22	0.4	volt
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25						50	1.6	0.8	0.85	0.95	volt
Static Forward Current-Transfer Ratio	h_{FE}	25 25 25 -55		0.35 0.4 1 0.4				10 50[a] 200[a] 50[a]		25 30 10 15	125 105 60 65	- - - -	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	25	100	10				10		5	6.9	-	
Common-Base, Open-Circuit Output Capacitance	C_{ob}	25	1		5		0			-	3.5	4	pf
Common-Base, Open-Circuit Input Capacitance	C_{ib}	25	1			1		0		-	3.3	5	pf
Turn-On Time (See Fig.2)	t_{on}	25	**Values for Circuit Shown in Fig.2** Collector-Supply Voltage (V_{CC}) = +6 volts Base-Supply Voltage (V_{BB}) = V_{BE}(off) = -1 volt "Turn-On" Base Current (I_{B1}) = +2.5 ma "On" Collector Current (I_C) = +50 ma							-	24	30	nsec
Turn-Off Time (See Fig.2)	t_{off}	25	**Values for Circuit Shown in Fig.2** Collector-Supply Voltage (V_{CC}) = +6 volts "On" Base Current (I_{B1}) = +2.5 ma "On" Collector Current (I_C) = +50 ma "Turn-Off" Base Current (I_{B2}) = -2.5 ma							-	24	30	nsec
Storage Time (See Fig.3)	t_s	25	**Values for Circuit Shown in Fig.3** Collector-Supply Voltage (V_{CC}) = +10 volts "On" Base Current (I_{B1}) = +10 ma "On" Collector Current (I_C) = +10 ma "Turn-Off" Base Current (I_{B2}) = -10 ma							-	11	15	nsec

[a] Pulse Test: Pulse Duration = 50 μsec; Duty Factor $\leq$ 0.02.

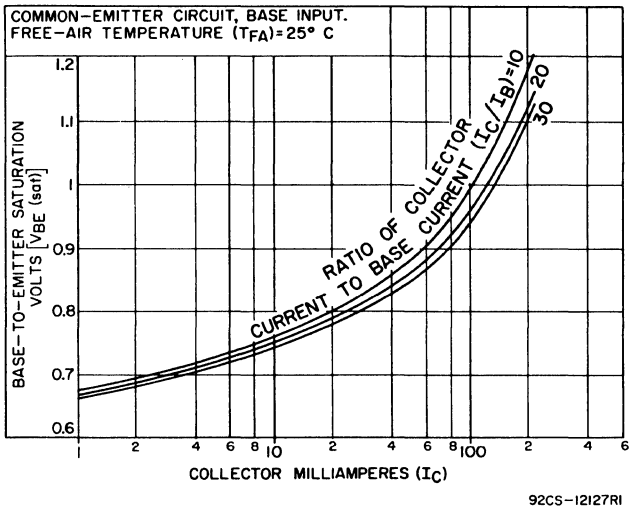


Fig. 6 - Typical V_{BE} (sat) Characteristics for Type 2N2938.

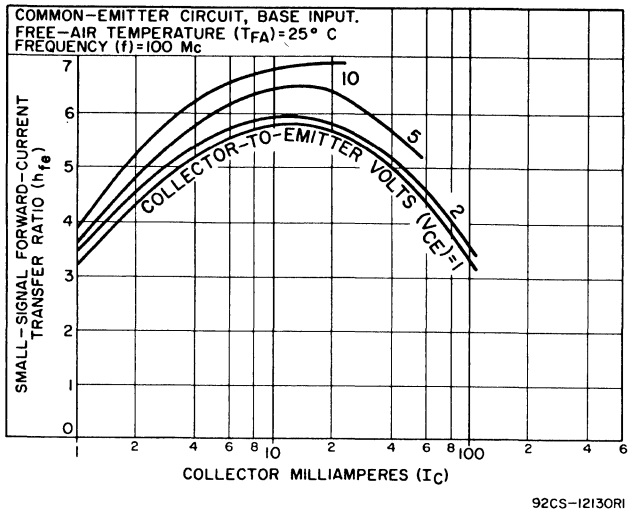


Fig. 7 - Typical 100-Mc h_{fe} Characteristics for Type 2N2938.

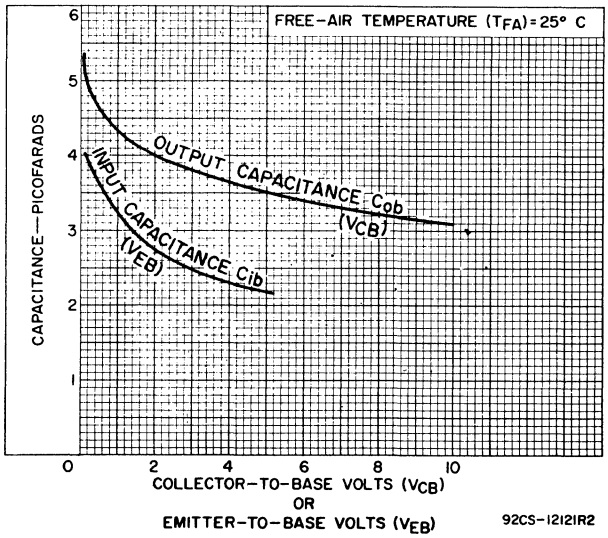


Fig. 8 - Typical C_{ob} and C_{ib} Characteristics for Type 2N2938.

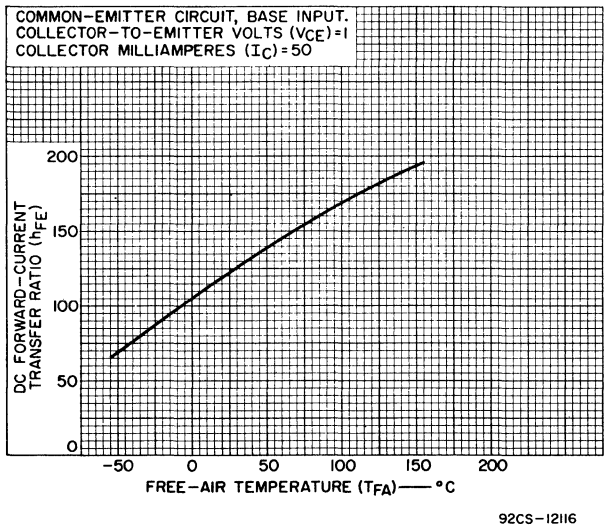


Fig. 9 - Typical h_{FE} vs. Temperature Characteristic for Type 2N2938.

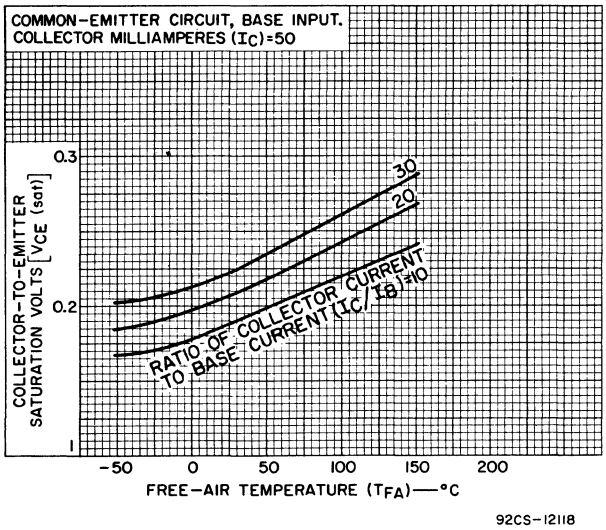


Fig. 10 - Typical V_{CE} (sat) vs. Temperature Characteristics for Type 2N2938.

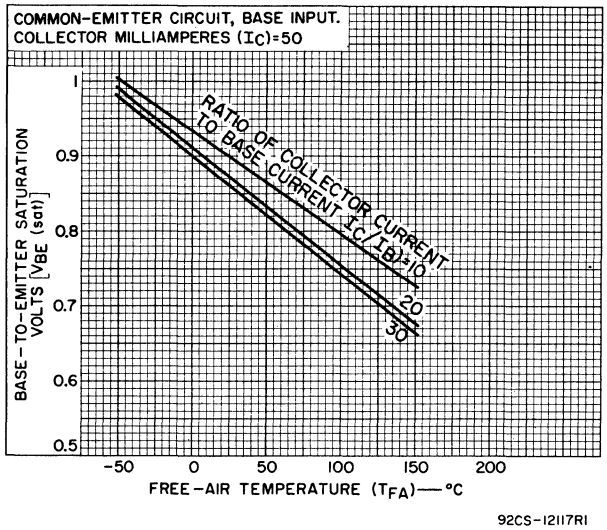


Fig. 11 - Typical V_{BE} (sat) vs. Temperature Characteristics for Type 2N2938.

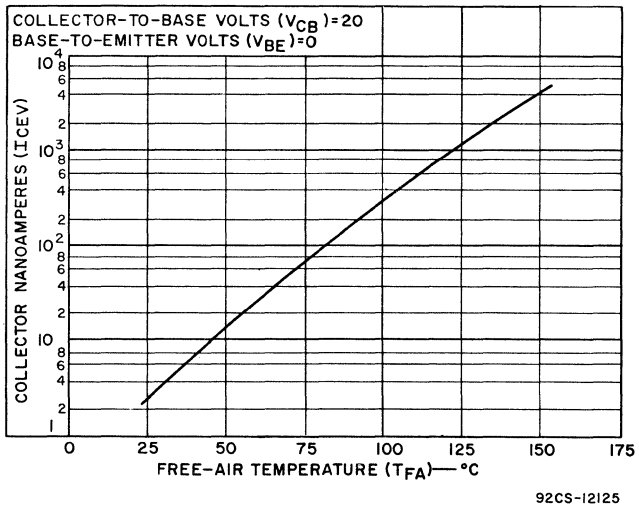


Fig. 12 - Typical I_{CEV} vs. Temperature Characteristic for Type 2N2938.

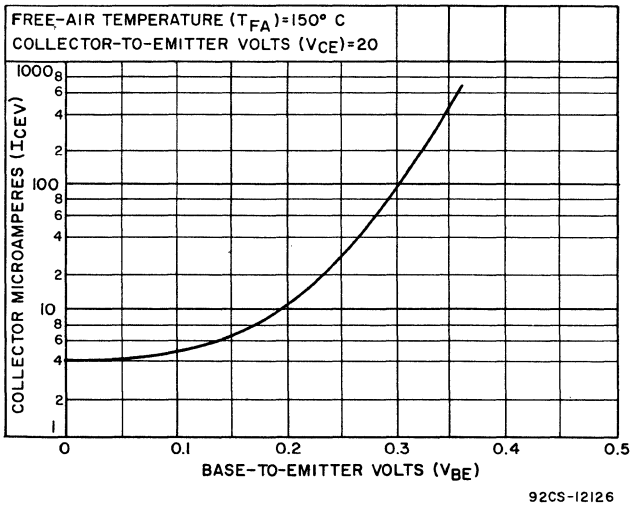


Fig. 13 - Typical I_{CEV} vs. Forward Bias Characteristic for Type 2N2938.

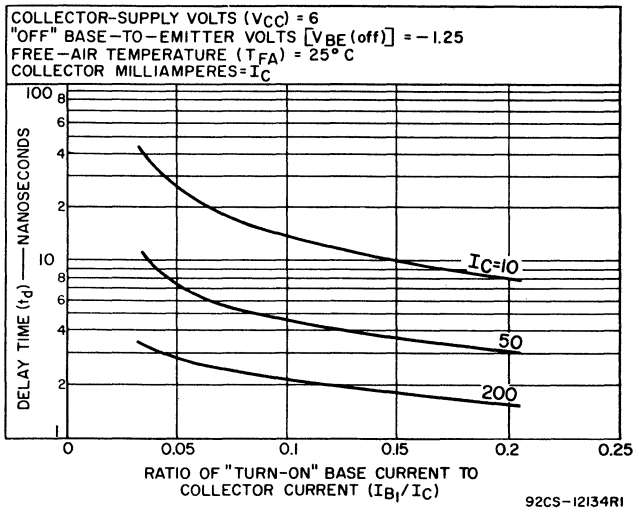


Fig. 14 - Typical t_d Characteristics for Type 2N2938.

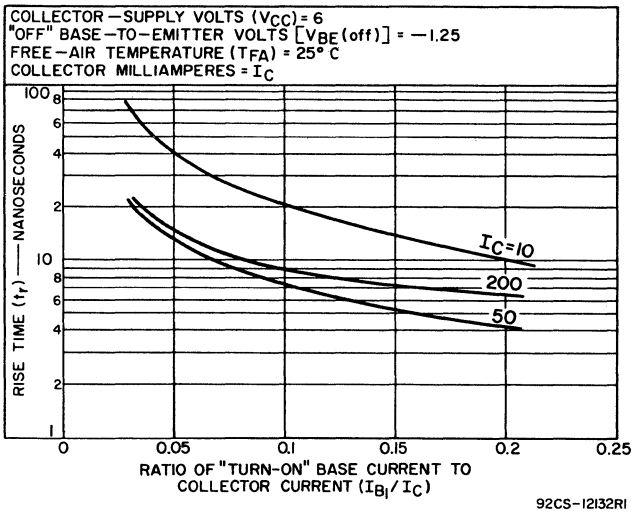


Fig. 15 - Typical t_r Characteristics for Type 2N2938.

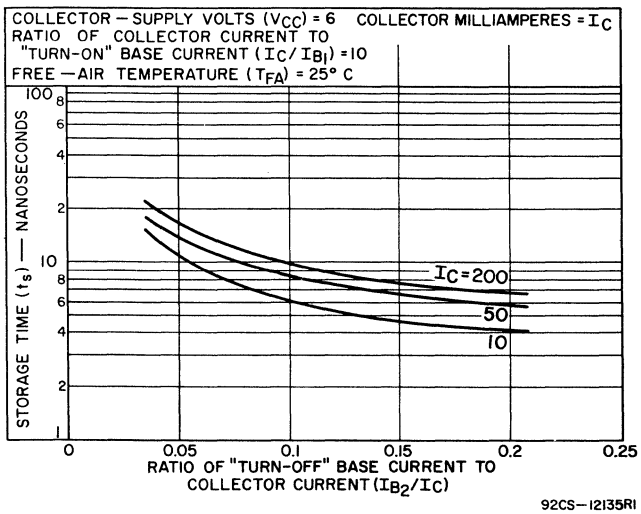


Fig. 16 - Typical t_s Characteristics for Type 2N2938.

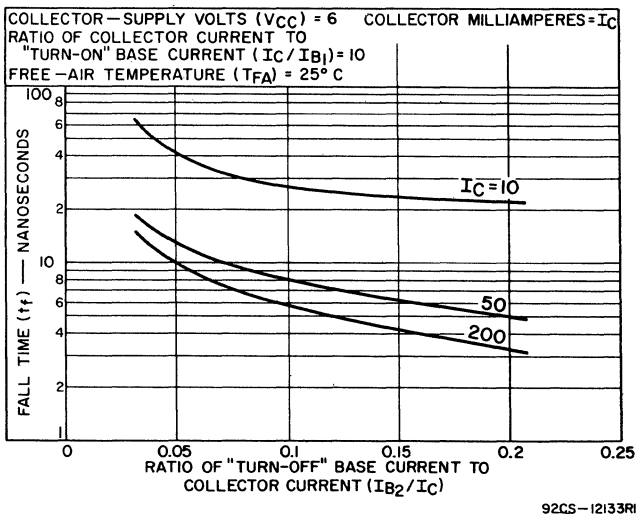
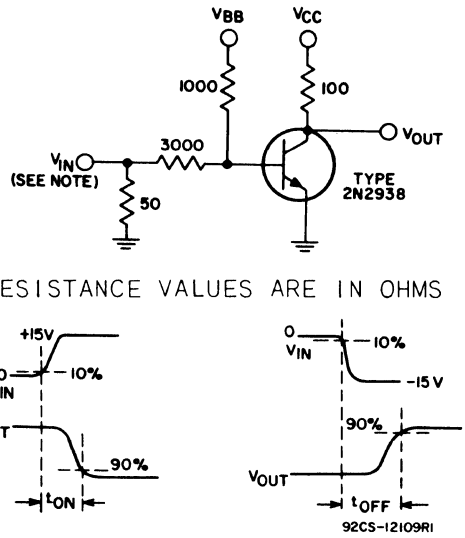
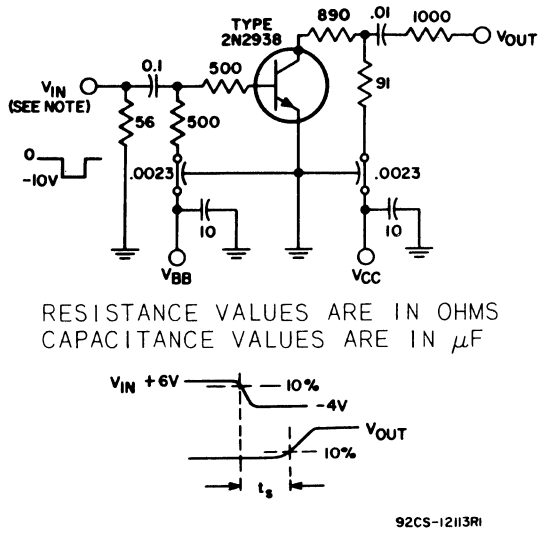


Fig. 17 - Typical t_f Characteristics for Type 2N2938.



NOTE: VIN RISE TIME ≤ 1 NSEC, PULSE DURATION ≥ 300 NSEC, DUTY FACTOR ≤ 0.02.

Fig. 2 - Turn On/Turn Off Time Test Circuit and Waveforms for Type 2N2938.



NOTE: VIN RISE TIME ≤ 1 NSEC, PULSE DURATION ≥ 300 NSEC, DUTY FACTOR ≤ 0.02.

Fig. 3 - Storage Time Test Circuit and Waveforms for Type 2N2938.

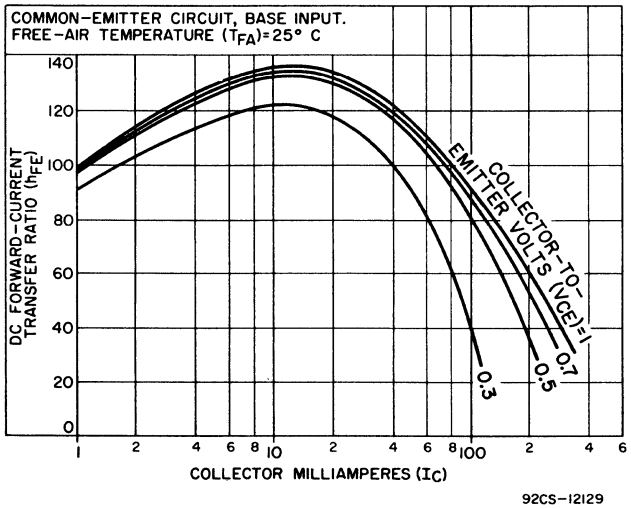


Fig. 4 - Typical h_{FE} Characteristics for Type 2N2938.

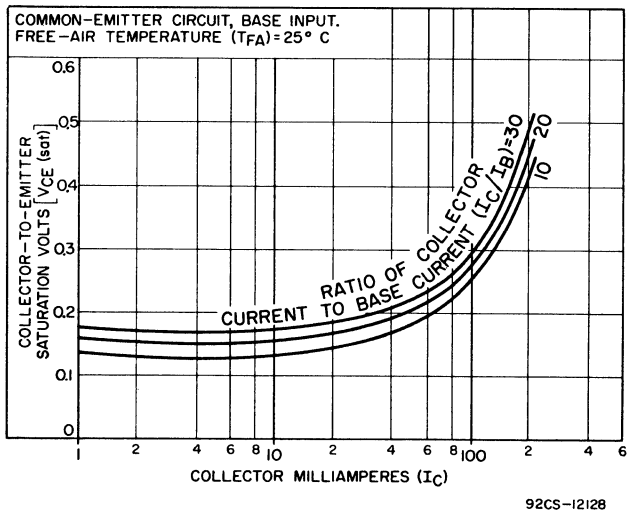
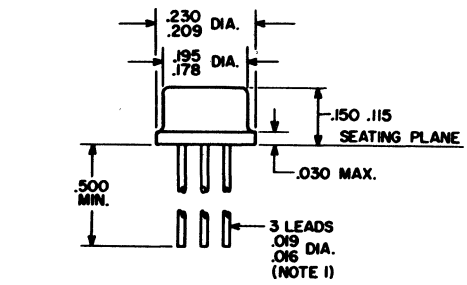
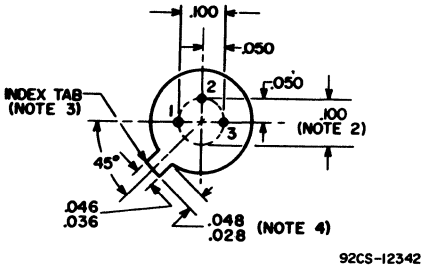


Fig. 5 - Typical V_{CE} (sat) Characteristics for Type 2N2938.

DIMENSIONAL OUTLINE

JEDEC No. TO-52





92CS-12342

Dimensions in Inches

Note 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 0.500 INCH OF THE LEAD, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: LEADS HAVING MAXIMUM DIAMETER (0.019 INCH) MEASURED IN GAUGING PLANE 0.054 INCH + 0.001 INCH–0.000 INCH BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007 INCH OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM–WIDTH TAB.

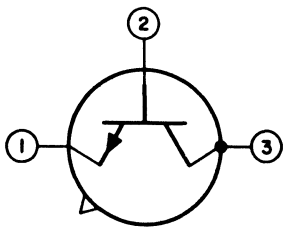
NOTE 3: INDEX TAB FOR VISUAL ORIENTATION ONLY.

NOTE 4: MEASURED FROM MAXIMUM DIAMETER OF ACTUAL DEVICE.

TERMINAL DIAGRAM

Bottom View

LEAD 2 – BASE

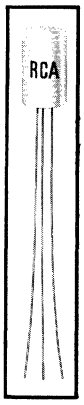


LEAD 1 – EMITTER

LEAD 3 – COLLECTOR, CASE

GERMANIUM P-N-P TRANSISTOR

For AF-Driver-Amplifier Applications in Consumer-Product and Industrial Equipment



JEDEC TO-1

RCA-2N2953▲ is an alloy-junction transistor of the germanium p-n-p type, with characteristics which make it extremely desirable for use in driver stages of transistor af power amplifiers. The 2N2953 has high gain under the operating conditions usually employed for transistor driver stages, high cutoff frequency, excellent linearity of both small-signal beta (h_{fe}) and dc beta (h_{FE}) over its entire collector-current range, and uniform gain characteristics over the audio-frequency spectrum.

When used with a practical heat sink the 2N2953 can provide a minimum power gain of 43 db and deliver a maximum power output of 100 mw.

This amount of af power is sufficient to drive to full output a power-amplifier stage having a 25-watt (rms) power output capability and a minimum power gain of 24 db.

The 2N2953 utilizes a hermetically sealed JEDEC TO-1 package, and has all leads insulated from the case to permit use of the equipment chassis as a heat sink.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}. .	-30 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CER} ($R_{BE} \leq$ 10000 ohms).	-25 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}. . .	25 max.	volts
COLLECTOR CURRENT, I_C.	-150 max.	ma
EMITTER CURRENT, I_E.	150 max.	ma
TRANSISTOR DISSIPATION, P_T:		
In free air, at temperatures: up to 55° C. . . .	120 max.	mw
In free air, at temperatures: above 55° C. . . .	See Fig. 1	
In an infinite heat sink, at case temperatures*: up to 55° C. . . .	300 max.	mw
In an infinite heat sink, at case temperatures*: above 55° C. . . .	See Fig. 2	
In a practical heat sink (thermal resistance ≤ 50° C/watt) at free-air temperatures: up to 55° C. . .	225 max.	mw
In a practical heat sink (thermal resistance ≤ 50° C/watt) at free-air temperatures: above 55° C. . .	See Fig. 2	
TEMPERATURE RANGE:		
Storage and operating (junction)	-65 to +100	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32" from seating surface for 10 seconds max.	255 max.	°C

▲ Formerly Developmental No. TA-2404.

* For region of measurement see DIMENSIONAL OUTLINE.

FEATURES

- high small-signal beta — h_{fe} = 200 min. at V_{CE} = -10 volts, I_C = -10 ma
- high cutoff frequency — f_{hfb} = 10 Mc typ.
- excellent linearity of h_{fe} and h_{FE} over entire range of I_C
- uniform gain over entire af spectrum
- low leakage currents — I_{CBO} = -5 μa max. at V_{CB} = -20 volts; I_{EBO} = -7.5 μa max. at V_{EB} = -20 volts
- high power gain — 43 db min. at V_{CE} = -10 volts, I_C = -10 ma, R_L = 1600 ohms
- hermetically sealed JEDEC TO-1 package

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N2953 6-66

Reprinted from Issue dated 4-64

ELECTRICAL CHARACTERISTICS, *at a Free-Air Temperature (T_{FA}) of 25° C*

Characteristics	Symbols	TEST CONDITIONS						LIMITS			Units
		DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	Type 2N2953			
		volts	volts	volts	ma	ma	ma	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-20				0		-	-	-5	μa
Emitter-Cutoff Current	I_{EBO}			-20	0			-	-	-7.5	μa
Collector-to-Emitter Breakdown Voltage (R_{BE} = 10000 ohms)	BV_{CER}				-1			-25	-	-	volts
Collector-to-Base Breakdown Voltage	BV_{CBV}			-2	-0.05			-30	-	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}					-0.05		-25	-	-	volts
Small-Signal Forward-Current Transfer Ratio (Measured at 1 Kc)	h_{fe}		-10		-10			200	350	-	
Extrinsic Base-Lead Resistance (Measured at 20 Mc)	$r_{bb'}$		-10		-10			-	300	-	ohms
Collector-to-Base Feedback Capacitance	$C_{b'c}$		-12		-1			-	6.5	-	pf
Small-Signal Forward-Current Transfer-Ratio Cutoff Frequency (Common-Base)	f_{hfb}	-12			-1			-	10	-	Mc

OPERATING CONSIDERATIONS

The 2N2953 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

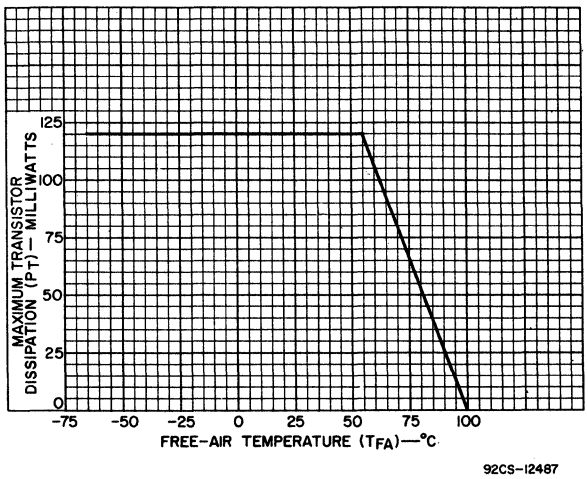


Fig. 1 - Rating Chart for Type 2N2953.

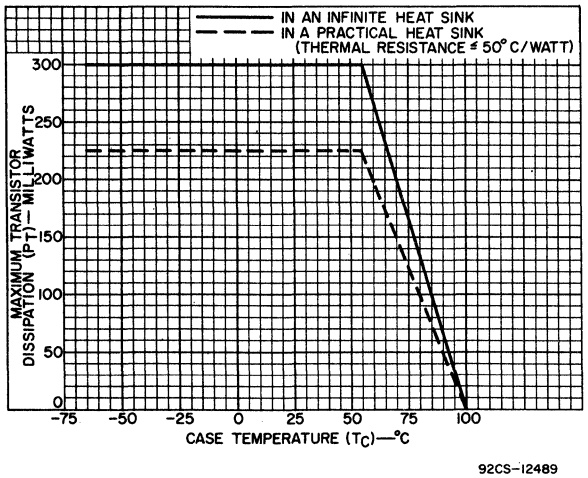


Fig. 2 - Rating Chart for Type 2N2953.

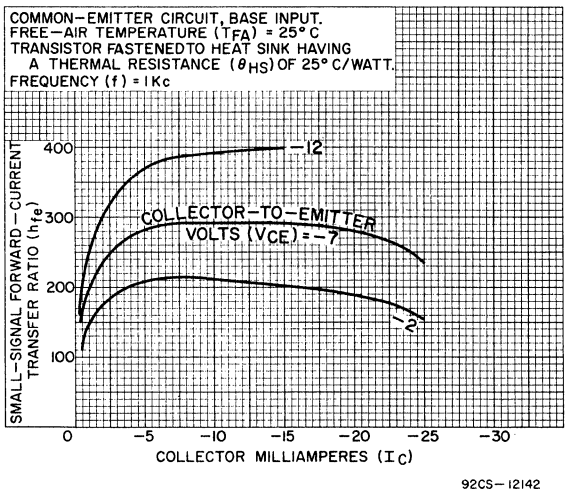


Fig. 3 - Typical Small-Signal-Beta Characteristics for Type 2N2953.

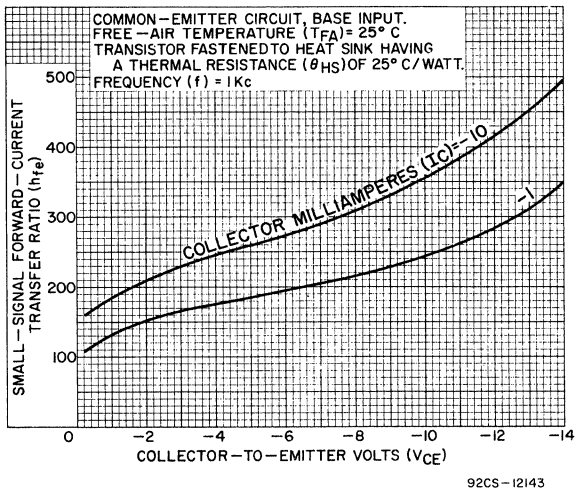


Fig. 4 - Typical Small-Signal-Beta Characteristics for Type 2N2953.

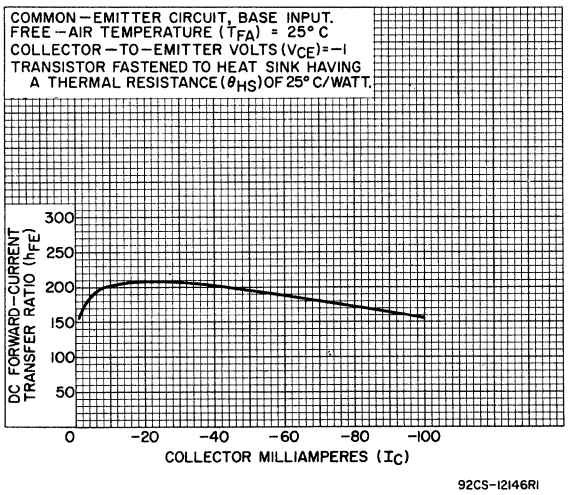


Fig. 5 - Typical DC Beta (h_{FE}) vs. Collector Current (I_C) Characteristic for Type 2N2953.

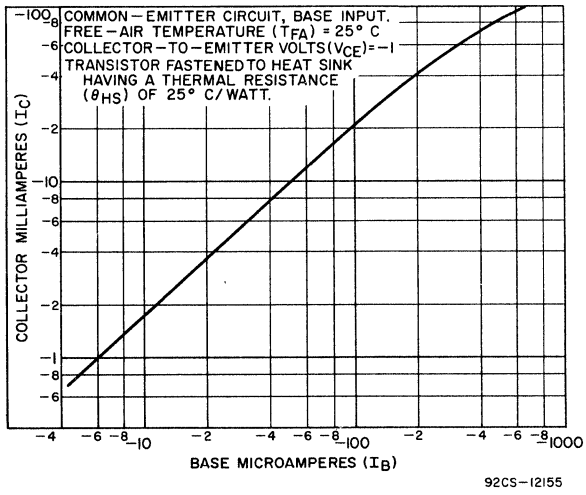


Fig. 6 - Typical Current-Transfer Characteristic for Type 2N2953.

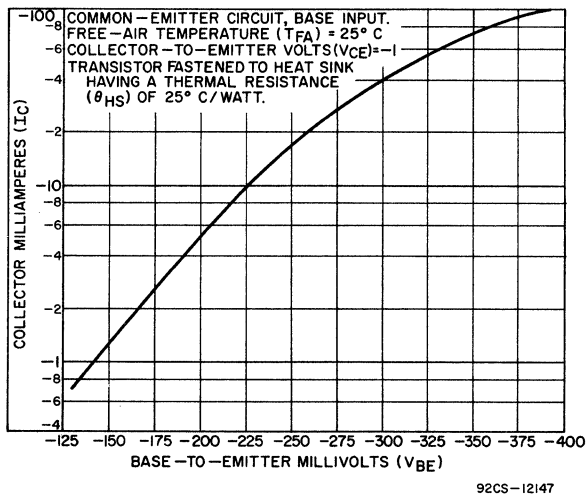


Fig. 7 - Typical Transfer Characteristic for Type 2N2953.

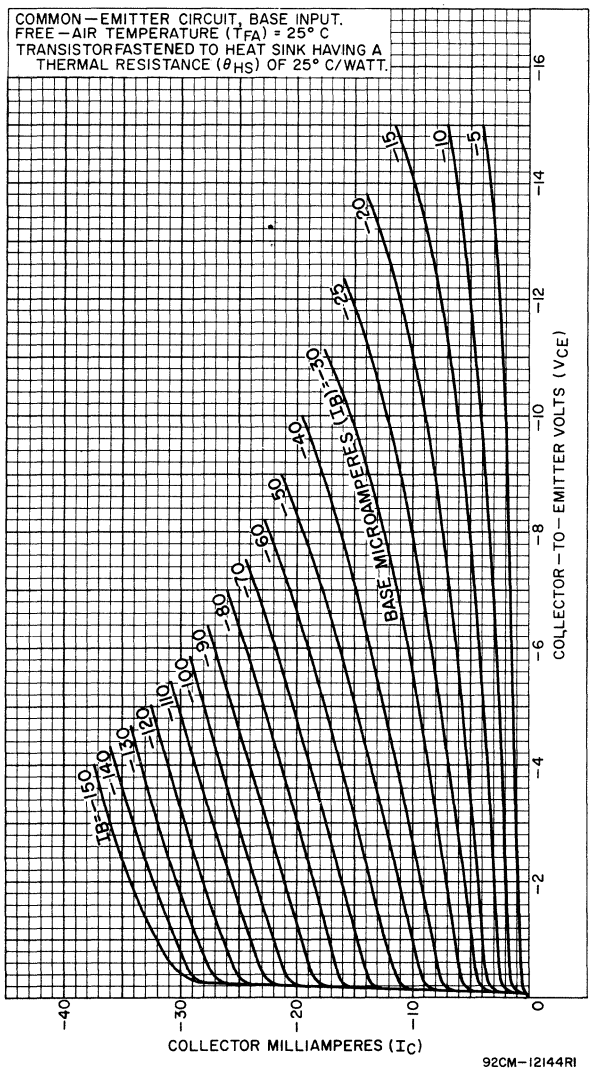


Fig. 8 - Typical Collector Characteristics for Type 2N2953.

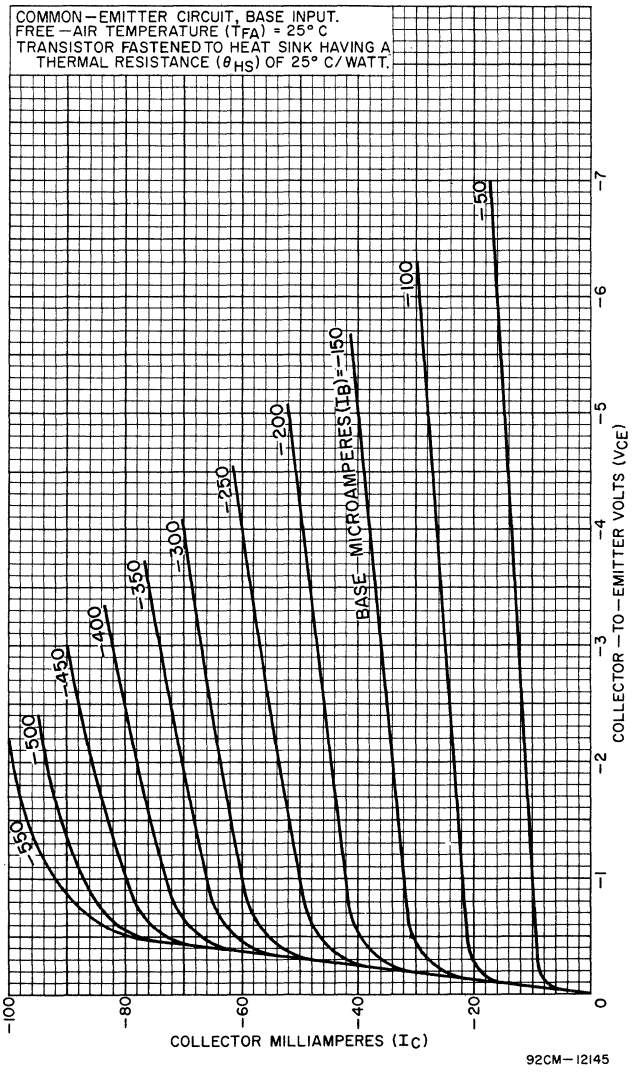
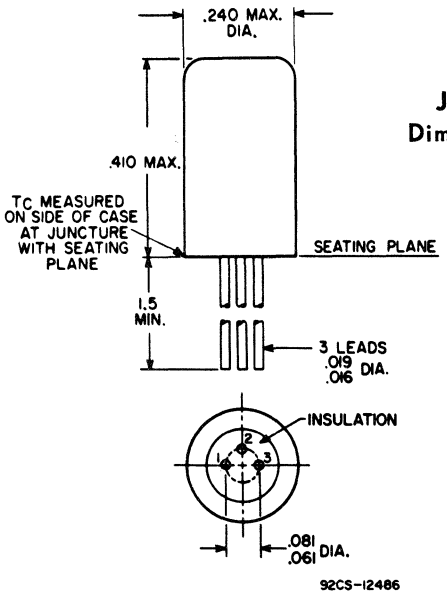


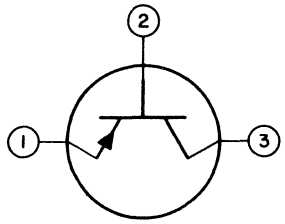
Fig. 9 - Typical Collector Characteristics for Type 2N2953.



JEDEC No. TO-1
Dimensions in Inches

TERMINAL DIAGRAM

LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR



NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 1.5 INCHES, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RCA POWER TRANSISTORS

2N3053 2N3054
2N3055
Including
40372 40389 40392

File No. 145

RCA-2N3053, 2N3054* , and 2N3055* are silicon n-p-n transistors intended for a wide variety of medium to high-power applications.

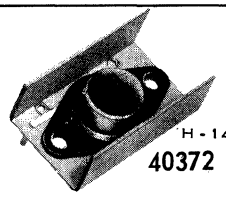
The 2N3053 is a triple-diffused planar type useful up to 20MHz in small-signal, medium-power applications.

The 2N3054 and 2N3055 are **Hometaxial-base**** types useful for power-switching circuits, for series- and shunt-regulator driver and output stages, and for high-fidelity amplifiers.

* Formerly Dev. Type Nos. TA2402A and TA2403A, respectively.

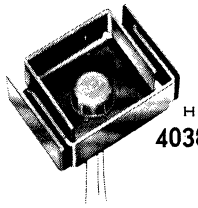
**"Hometaxial" was coined by RCA from "homogeneous" and "axial" to describe a single-diffused transistor with a base region of homogeneous-resistivity silicon in the axial direction (emitter-to-collector).

ALSO AVAILABLE. . .



40372

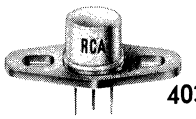
Type 40372 is a 2N3054 with a factory-attached heat radiator.



40389

Type 40389 is a 2N3053 with a factory-attached heat radiator.

Types 40372 and 40389 are intended for printed-circuit-board applications.



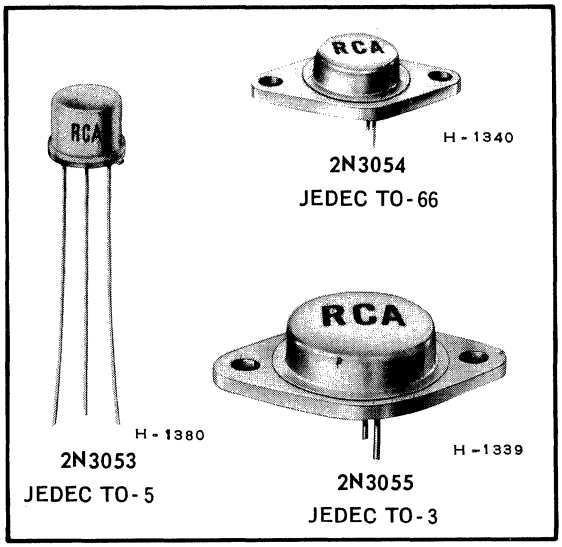
40392

Type 40392 is a 2N3053 with a factory-attached diamond-shaped mounting flange.

MAXIMUM RATINGS

Absolute-Maximum Values:		2N3053 40389, 40392	2N3054 40372	2N3055	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	90	100	V
COLLECTOR-TO-EMITTER VOLTAGE: With −1.5 V (V_{BE}) of reverse bias.	V_{CEV}(sus)	60	90	100	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω.	V_{CER}(sus)	50	—	—	V
= 100 Ω	V_{CER}(sus)	—	60	70	V
With base open	V_{CEO}(sus)	40	55	60	V
EMITTER-TO-BASE VOLTAGE.	V_{EBO}	5	7	7	V
COLLECTOR CURRENT	I_C	0.7	4	15	A
BASE CURRENT	I_B	—	2	7	A
TRANSISTOR DISSIPATION:.	P_T				
At case temperatures up to 25°C.		5(2N3053)	29(2N3054)	115	W
		7(40392)	—	—	W
At free-air temperatures up to 25°C. . . .		1(2N3053)	5.8(40372)	—	W
		3.5(40389)	—	—	W
At temperatures above 25°C, See Figs. .		1, 2, & 5	2, 3, & 6	2, 4, & 6	
TEMPERATURE RANGE: Storage & Operating (Junction).		←	−65 to 200	→	°C
LEAD OR PIN TEMPERATURE (During soldering): At distance ≥ 1/32" from seating plane for 10 s max.		255	235	235	°C

SILICON N-P-N GENERAL-PURPOSE TYPES FOR INDUSTRIAL AND COMMERCIAL APPLICATIONS



- **Maximum area-of-operation curves for DC and pulse operation**
- **Now possible to determine maximum operating conditions for operation free from second breakdown**

2N3053

- **Low leakage current (I_{CBO}) and wide beta (h_{FE}) range**

2N3054

- **V_{CEV}(sus) = 90 V min.**
- **Low saturation voltage, V_{CE}(sat) = 1.0 V (at I_C = 0.5 A)**

2N3055

- **High dissipation capability -- 115 W**
- **V_{CEV}(sus) = 100 V min.**
- **Low saturation voltage, V_{CE}(sat) = 1.1 V (at I_C = 4 A)**

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3053, 40389, 40392,
2N3054, 40372, 2N3055 8/66
Supersedes issue dated 10/64

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25°C, Unless Otherwise Specified

Characteristics	Symbol	TEST CONDITIONS							LIMITS						Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current milliamperes			Types 2N3053 40389 40392		Types 2N3054 40372		Type 2N3055		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	30					0		—	0.25	—	—	—	—	μA
	I_{CEV}		90		-1.5				—	—	—	1.0	—	—	mA
			100		-1.5				—	—	—	—	—	5.0	
At T_C = 150°C	I_{CEV}		30		-1.5				—	—	—	5.0	—	—	mA
			60		-1.5				—	—	—	—	—	10.0	
Emitter-Cutoff Current	I_{EBO}			4		0			—	0.25	—	—	—	—	μA
				7		0			—	—	—	1.0	—	—	mA
				7		0			—	—	—	—	—	5.0	mA
DC Forward-Current Transfer Ratio	h_{FE}		10			150[a]			50	250	—	—	—	—	
			4			500			—	—	25	100	—	—	
			4			4 A[a]			—	—	—	—	20	70	
Collector-to-Base Breakdown Voltage	BV_{CBO}					0.1	0		60	—	—	—	—	—	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0	0.1		5	—	—	—	—	—	V
						0	1		—	—	7	—	—	—	
						0	5		—	—	—	—	7	—	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$					100[a]		0	40	—	—	—	—	—	V
						100		0	—	—	55	—	—	—	
						200		0	—	—	—	—	60	—	
With base-emitter junction reverse biased	$V_{CEV(sus)}$				-1.5	100			—	—	—	—	100	—	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER(sus)}$					100[a]			50	—	—	—	—	—	
= 100 Ω						100			—	—	60	—	—	—	V
= 100 Ω						200			—	—	—	—	70	—	
Base-to-Emitter Voltage	V_{BE}		4			500			—	—	—	1.7	—	—	V
			4			4 A[a]			—	—	—	—	—	1.8	
Base-to-Emitter Saturation Voltage						150		15	—	1.7	—	—	—	—	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					150		15	—	1.4	—	—	—	—	
						500		50	—	—	—	1.0	—	—	V
						4 A[a]		400	—	—	—	—	—	1.1	
Small-Signal, Forward Current Transfer Ratio (At 20 MHz)	h_{fe}		10			50			5	—	—	—	—	—	
Gain-Bandwidth Product	f_T					200			—	—	800	—	—	—	kHz
						1 A			—	—	—	—	800	—	
Output Capacitance	C_{ob}	10					0		—	15	—	—	—	—	pF
Input Capacitance	C_{ib}			0.5		0			—	80	—	—	—	—	pF
Power Rating Test	PRT		39			3 A			—	—	—	—	—	1[b]	s
Thermal Resistance: Junction-to-Case	$\theta_{J\text{-}C}$								35(max.) 2N3053		6(max.) 2N3054		—	1.5	°C/W
									25(max.) 40392				—		°C/W
Junction-to-Free Air	$\theta_{J\text{-}FA}$								175(max.) 2N3053		30(max.) 40372		—	—	°C/W
									50(max.) 40389				—	—	°C/W

[a]Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

[b]At 115 W.

MAXIMUM OPERATING AREAS FOR TYPE 2N3053

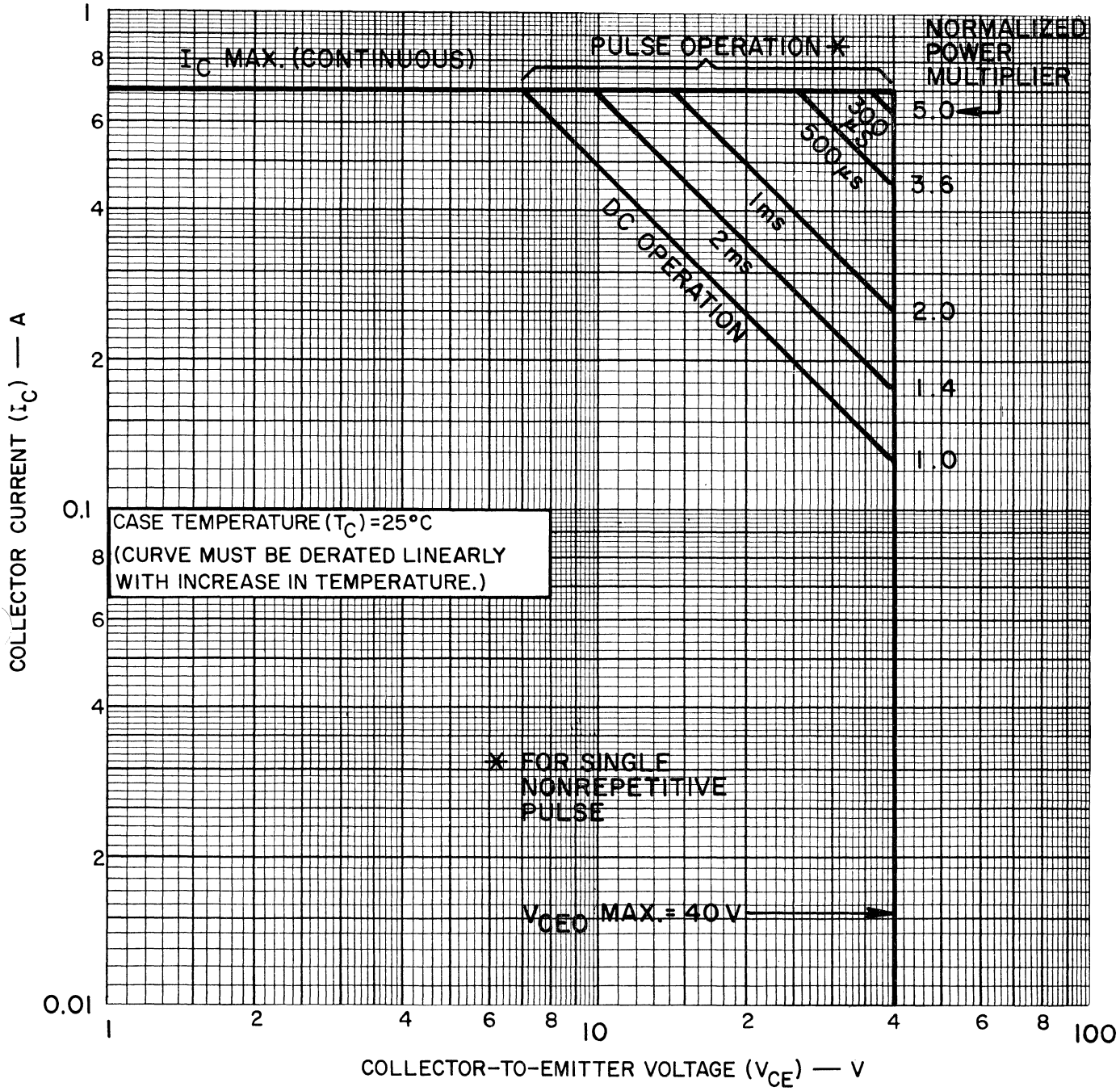


Fig. 1

MAXIMUM AREA-OF-OPERATION

2N3053

The maximum-operating-area curves shown on a log-log plot in Fig. 1 have a slope equal to -1 indicating that a thermal (dissipation) limitation exists over the entire operating region of the 2N3053. (The ratings shown are based upon a case temperature of 25°C.) All boundary lines must be derated linearly to zero at a case temperature of 200°C; see Fig. 2.

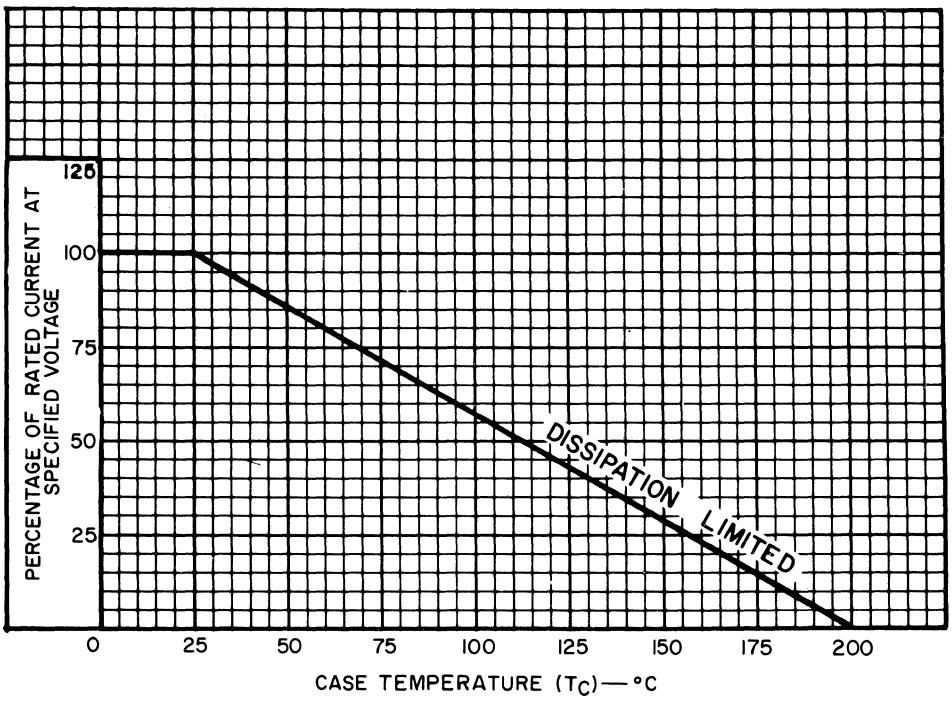
2N3054 & 2N3055

The maximum-operating-area curves shown on a log-log plot in Fig. 3 (2N3054), and Fig. 4 (2N3055) have a slope equal to -1 when a thermal (dissipation) limitation exists and -2 when a second-breakdown limitation exists (see Fig. 4).

Figs. 3 and 4 show constant-slope (constant-power) lines for pulse conditions of 1 s or less for type 2N3054, and 1 ms or less for the type 2N3055. However, for greater pulse widths for the type 2N3055, the area of operation is bounded by a line having a slope approximately equal to -2 (second-breakdown limitation); see Fig. 4. In addition to the boundary showing a second-breakdown limitation, an extension of the dissipation-limited boundary line (for derating) is shown as a dashed line.

Second breakdown limitation need not be derated with temperature. Since all ratings shown are based upon a case temperature of 25°C, all boundary lines and dashed-line extensions must be derated linearly to zero at case temperature of 200°C; see Fig. 2.

DISSIPATION DERATING CURVE FOR TYPES 2N3053, 2N3054, & 2N3055



92LS-1469

Fig. 2

MAXIMUM OPERATING AREAS FOR TYPE 2N3054

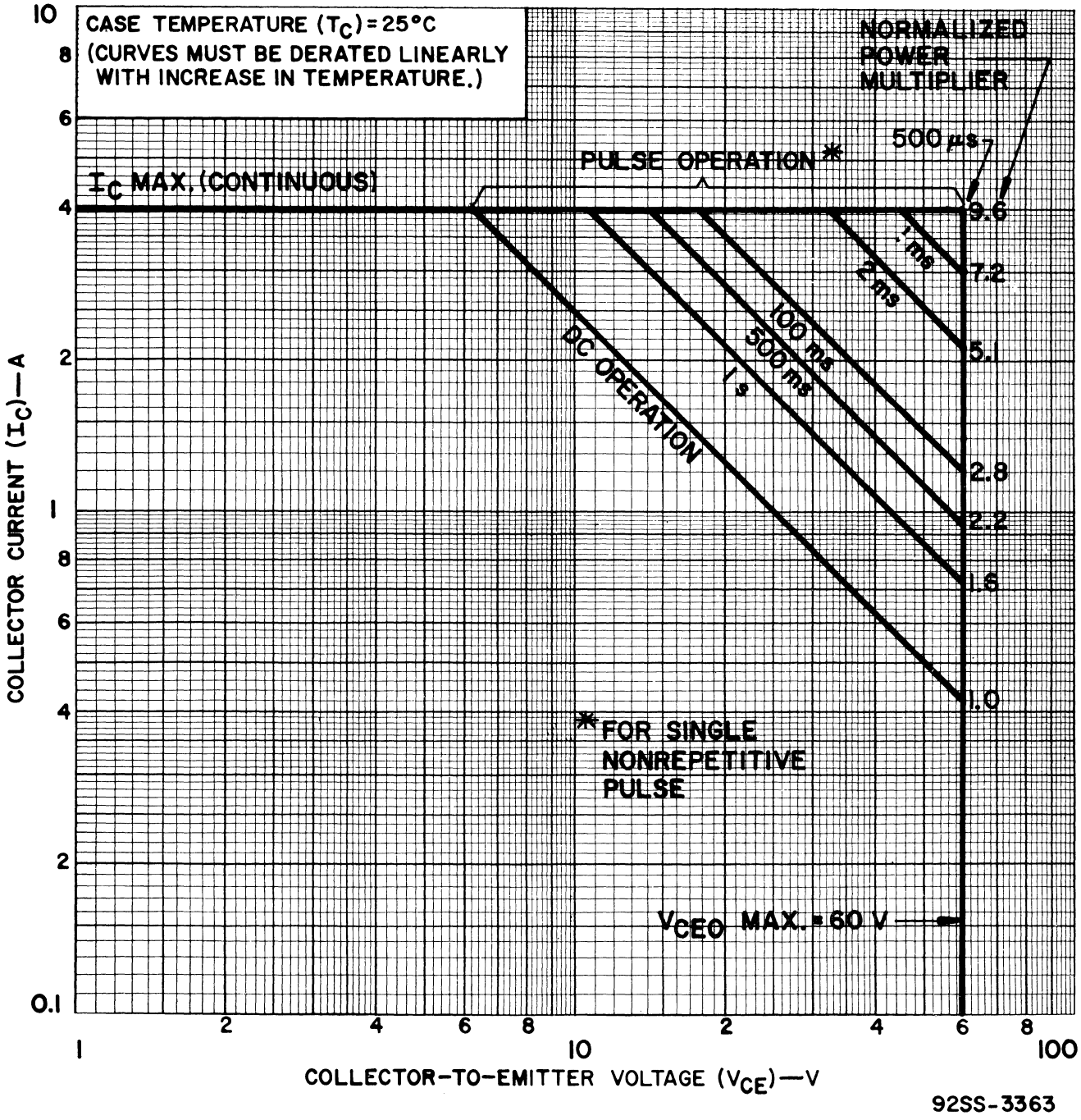


Fig. 3

MAXIMUM OPERATING AREAS FOR TYPE 2N3055

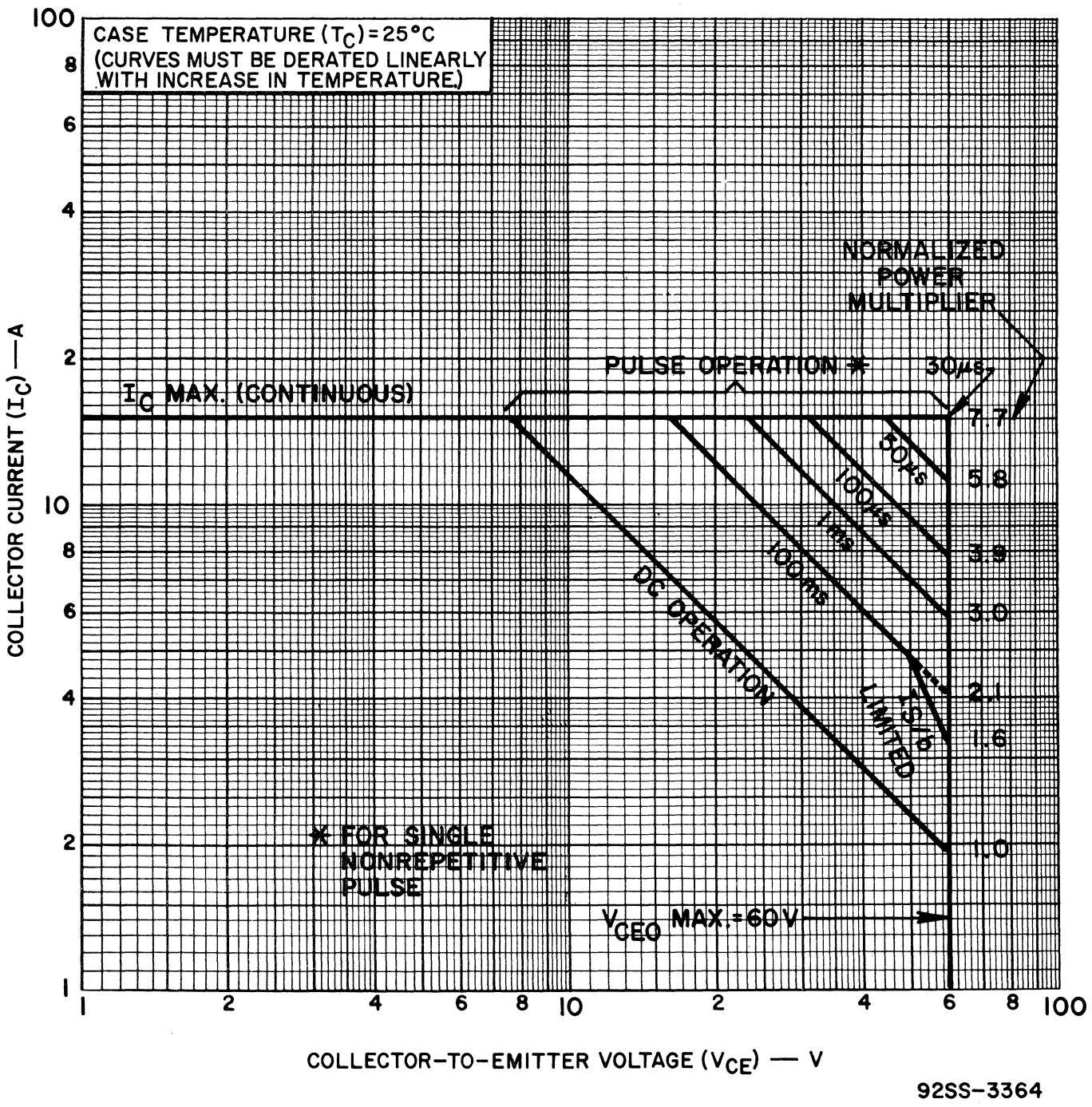


Fig. 4

DISSIPATION DERATING CURVE FOR TYPES 2N3053, 40389, & 40392

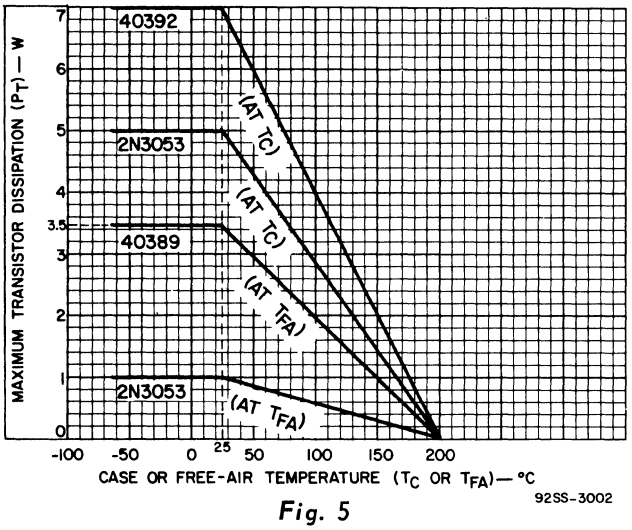


Fig. 5

DISSIPATION DERATING CURVE FOR TYPES 2N3054, 40372, & 2N3055

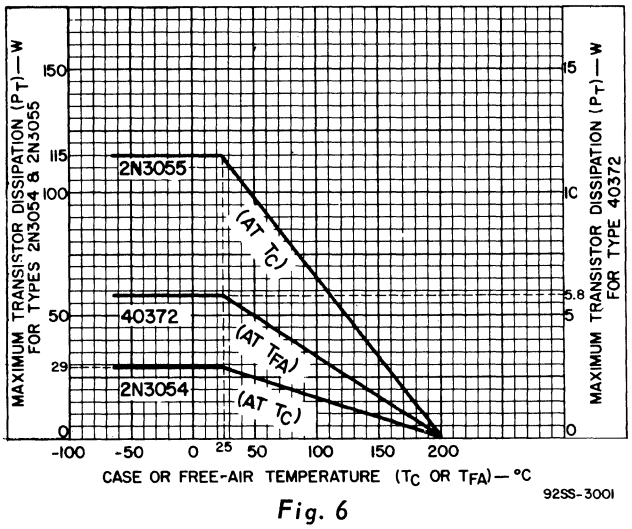


Fig. 6

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3053

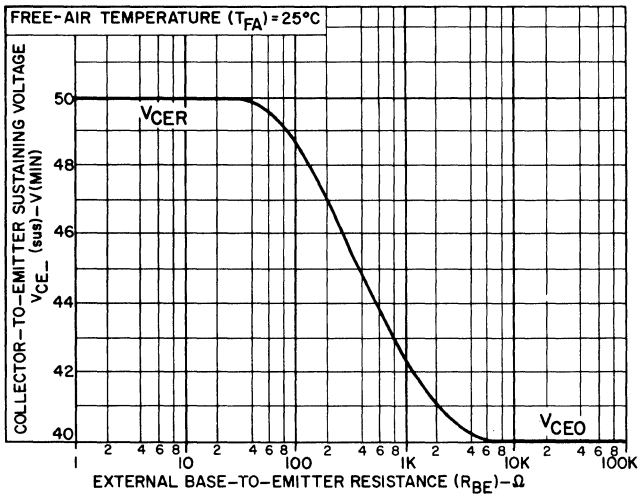


Fig. 7

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3054

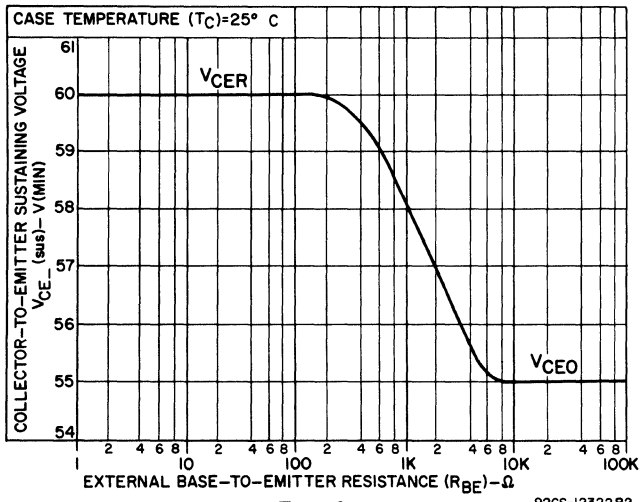


Fig. 8

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3055

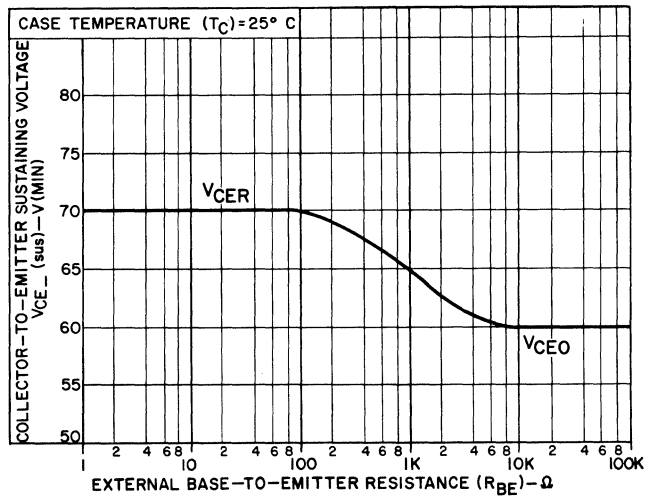


Fig. 9

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the "on" condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in Figs. 10, 11, 12, 13, and 14 should prove useful in the design of circuits having inductance loads (such as solenoid- or relay-control circuits, magnetic-circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. Also, these curves can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers.)

In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore, the allowable energy shown in the above mentioned curves (calculated from $E_{S/b} = \frac{1}{2}LI^2$, where L is a series load or leakage inductance and I is the peak collector current from the curves) will be conservative for smaller inductance loads. For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPE 2N3053

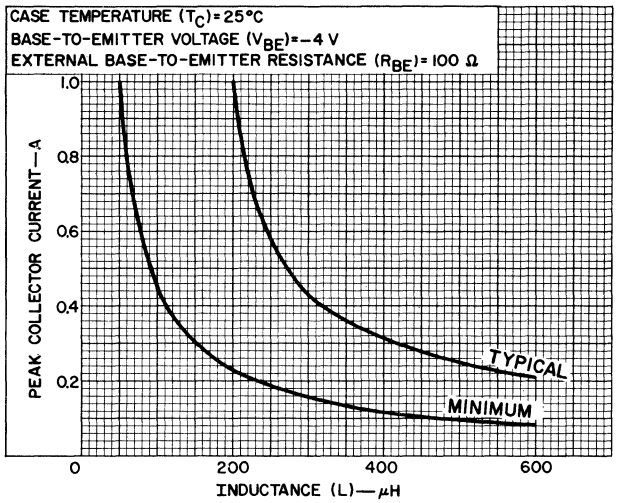


Fig. 10

92SS-3365

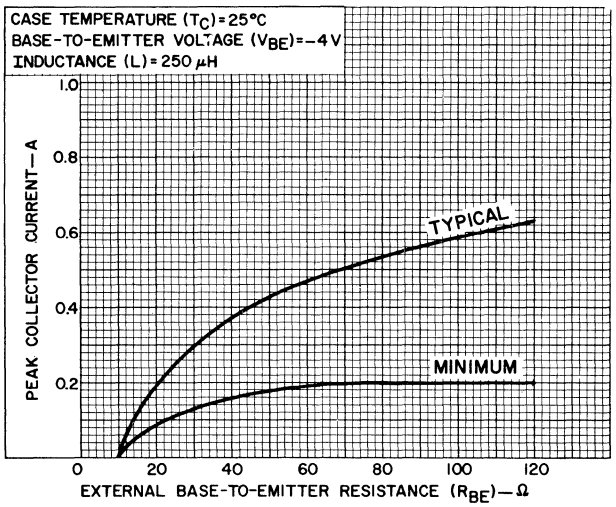


Fig. 11

92SS-3366

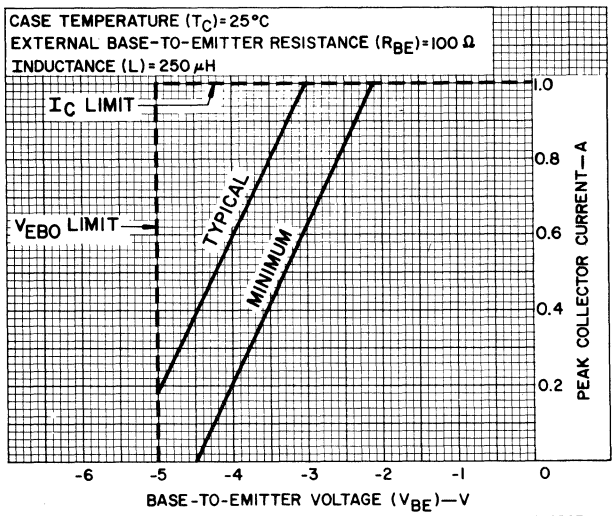


Fig. 12

92SS-3367

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPE 2N3054

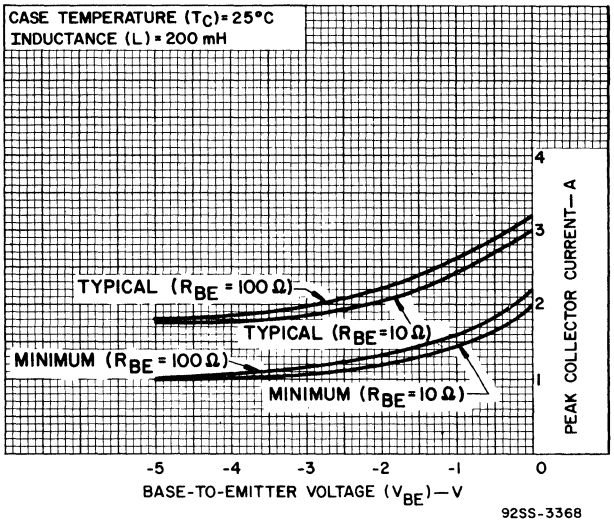


Fig. 13

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPE 2N3055

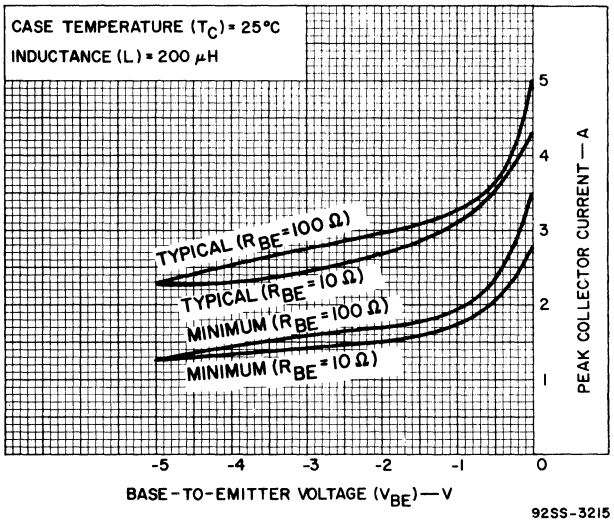


Fig. 14

TYPICAL DC-BETA CHARACTERISTICS

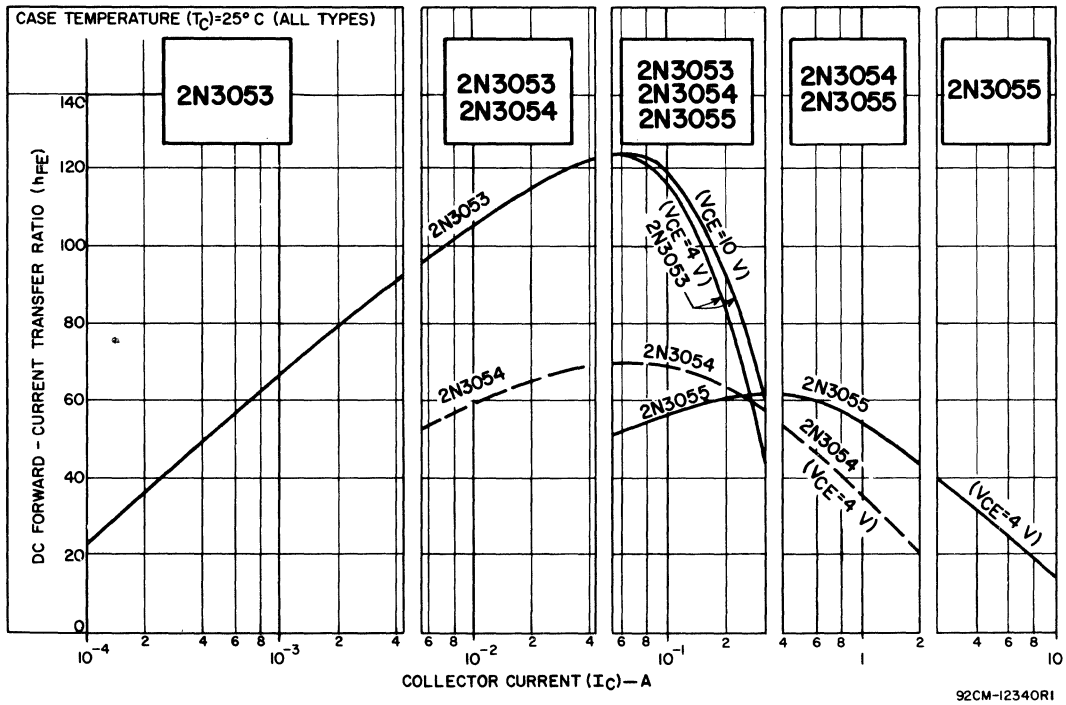


Fig. 15

TYPICAL DC-BETA CHARACTERISTICS FOR TYPE 2N3053

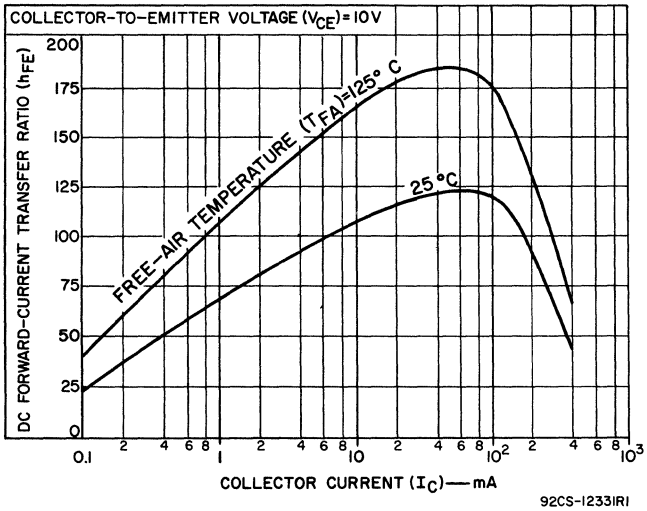


Fig. 16

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3053

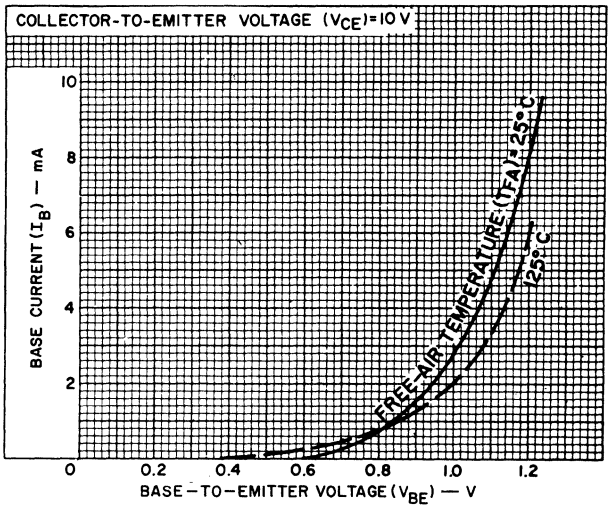


Fig. 17

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3053

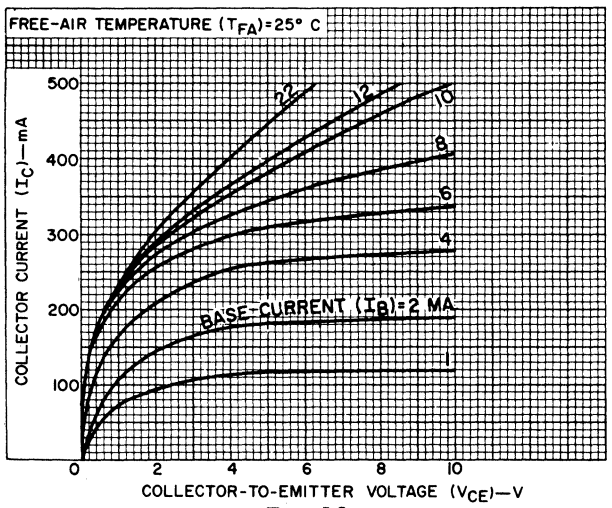


Fig. 18

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N3053

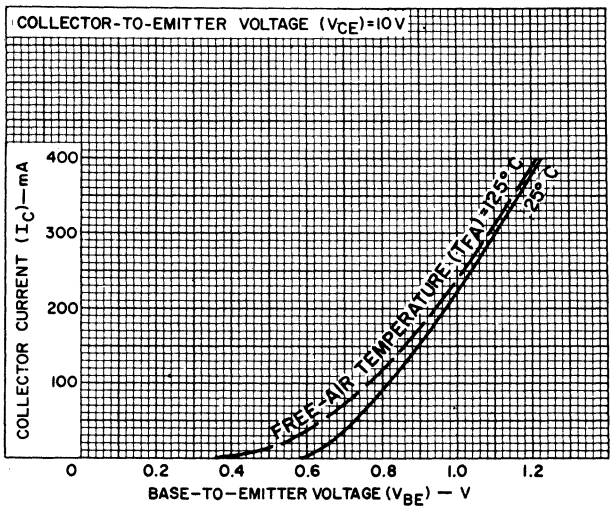


Fig. 19

TYPICAL VARIATION OF GAIN-BANDWIDTH PRODUCT WITH I_C & V_{CE} FOR TYPE 2N3053

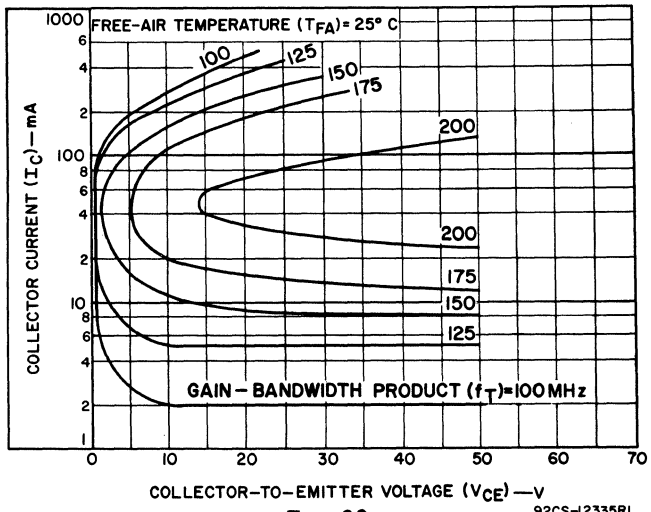


Fig. 20

TYPICAL DC-BETA CHARACTERISTICS FOR TYPE 2N3054

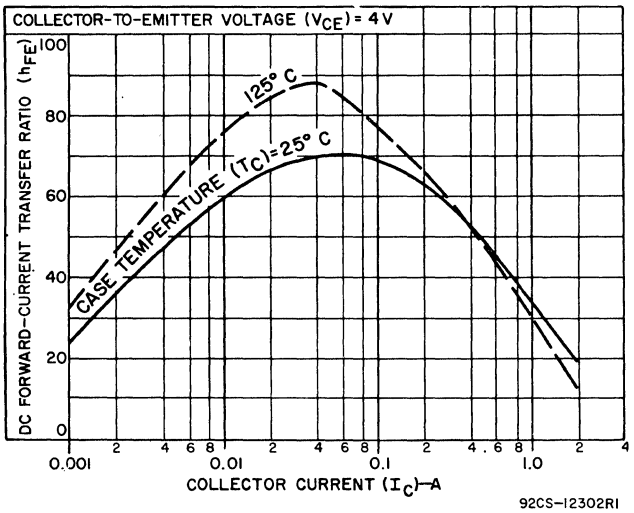


Fig. 21

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3054

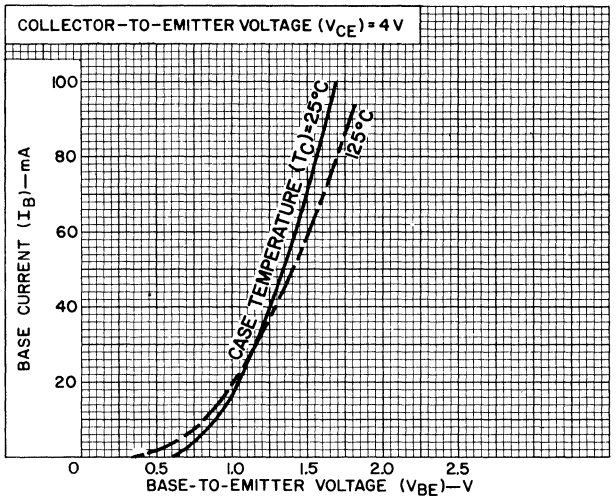


Fig. 22

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3054

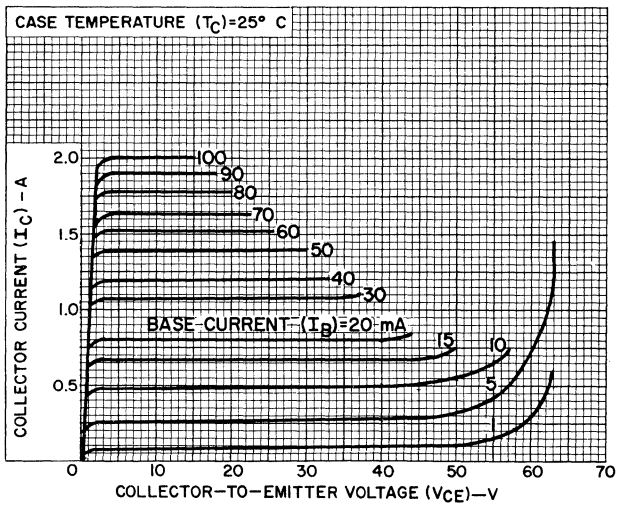


Fig. 23

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N3054

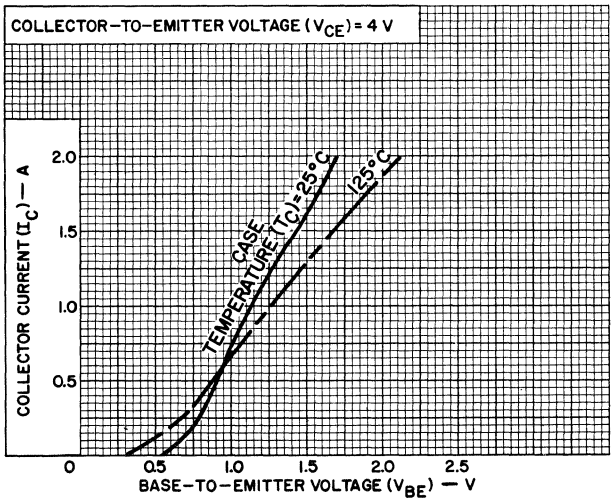


Fig. 24

TYPICAL GAIN-BANDWIDTH PRODUCT FOR TYPE 2N3054

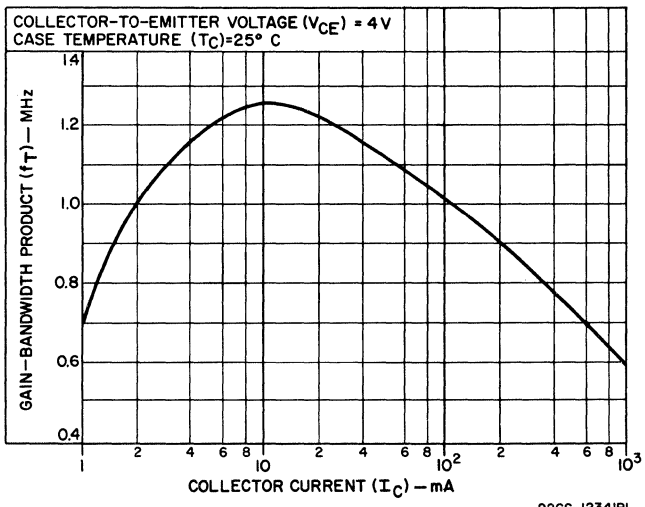


Fig. 25

TYPICAL DC-BETA CHARACTERISTICS FOR TYPE 2N3055

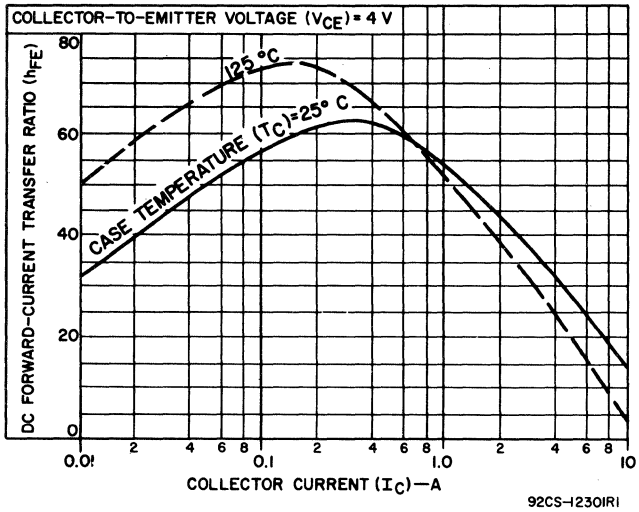


Fig. 26

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3055

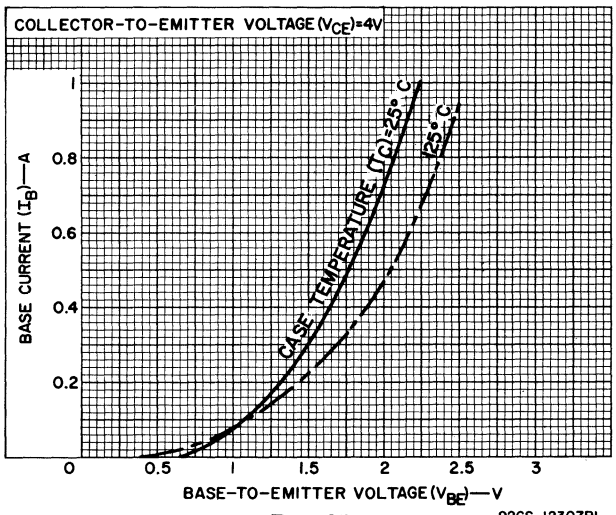


Fig. 27

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3055

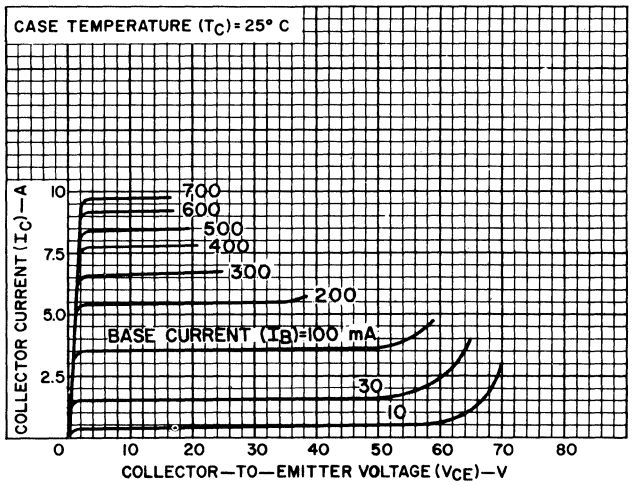


Fig. 28

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N3055

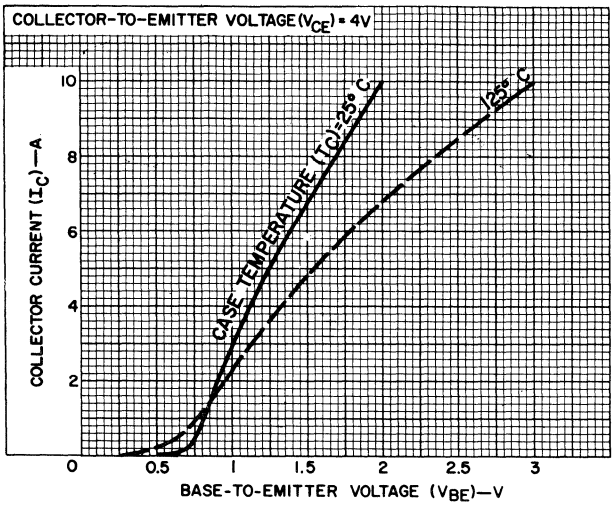


Fig. 29

TYPICAL GAIN-BANDWIDTH PRODUCT FOR TYPE 2N3055

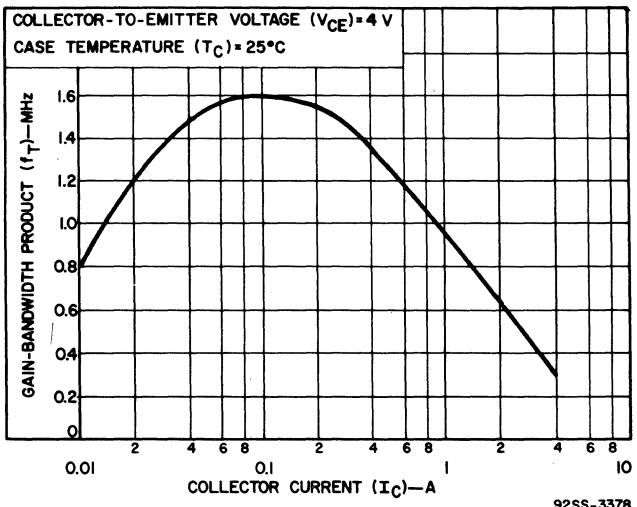
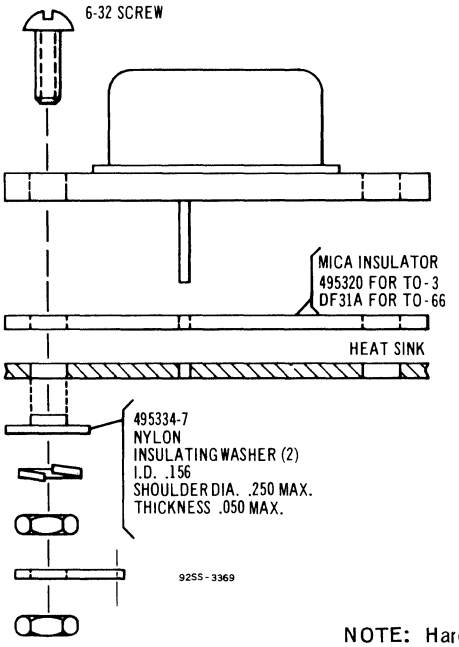


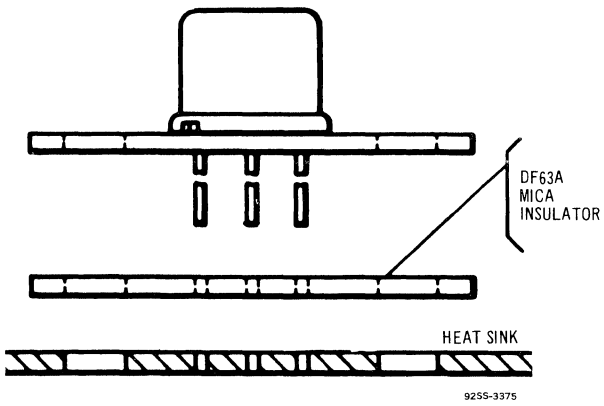
Fig. 30

SUGGESTED HARDWARE

FOR TO-3 & TO-66 PACKAGES
(2N3054 & 2N3055)

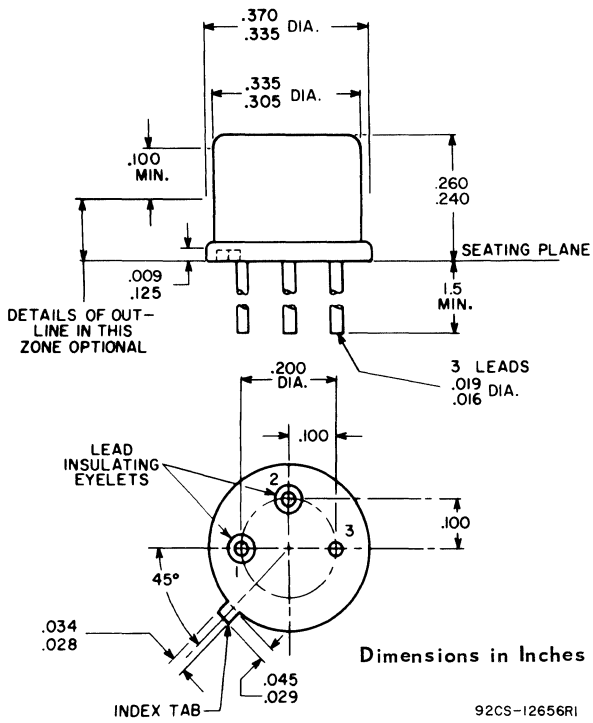


FOR FLANGE TO-5 PACKAGE
(40392)

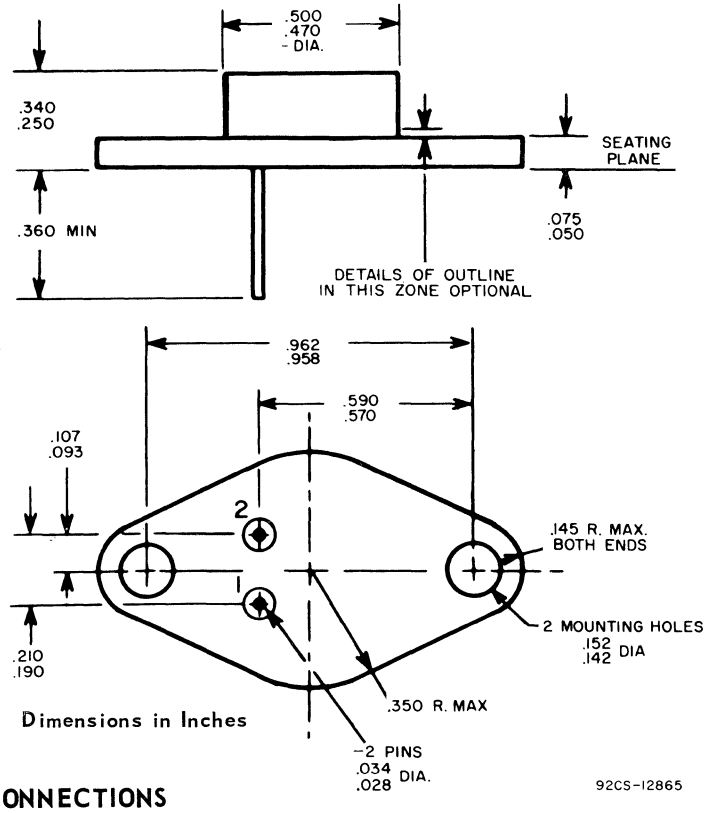


NOTE: Hardware With Part Numbers Supplied.

FOR TYPE 2N3053
JEDEC No. TO-5



FOR TYPE 2N3054
JEDEC No. TO-66

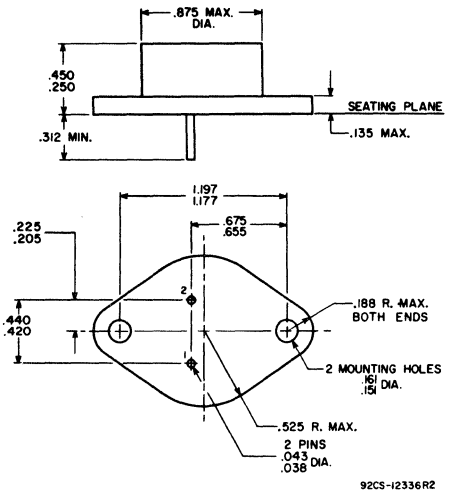


TERMINAL CONNECTIONS

FOR TYPE 2N3053	FOR TYPE 2N3054
Lead 1 - Emitter	Pin 1 - Base
Lead 2 - Base	Pin 2 - Emitter
Case, Lead 3 - Collector	Case, Flange - Collector

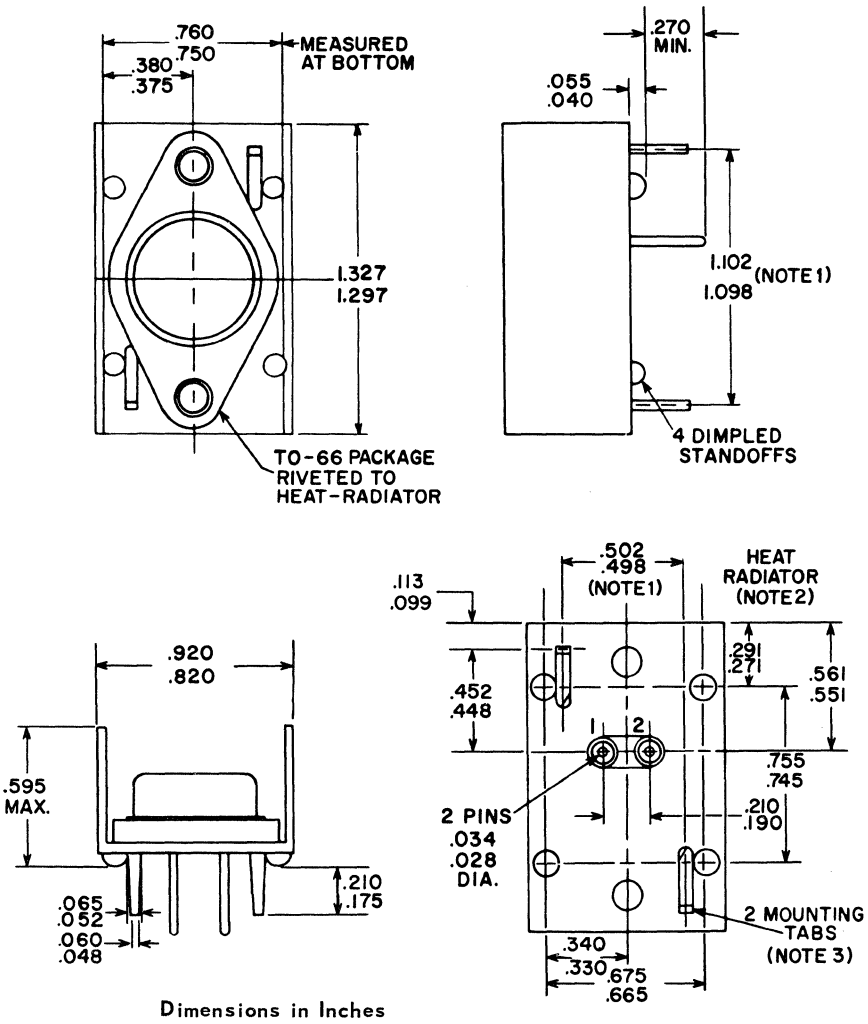
DIMENSIONAL OUTLINE

FOR TYPE 2N3055
JEDEC No. TO-3



Dimensions in Inches

FOR TYPE 40372
JEDEC No. TO-66 WITH HEAT RADIATOR



Dimensions in Inches

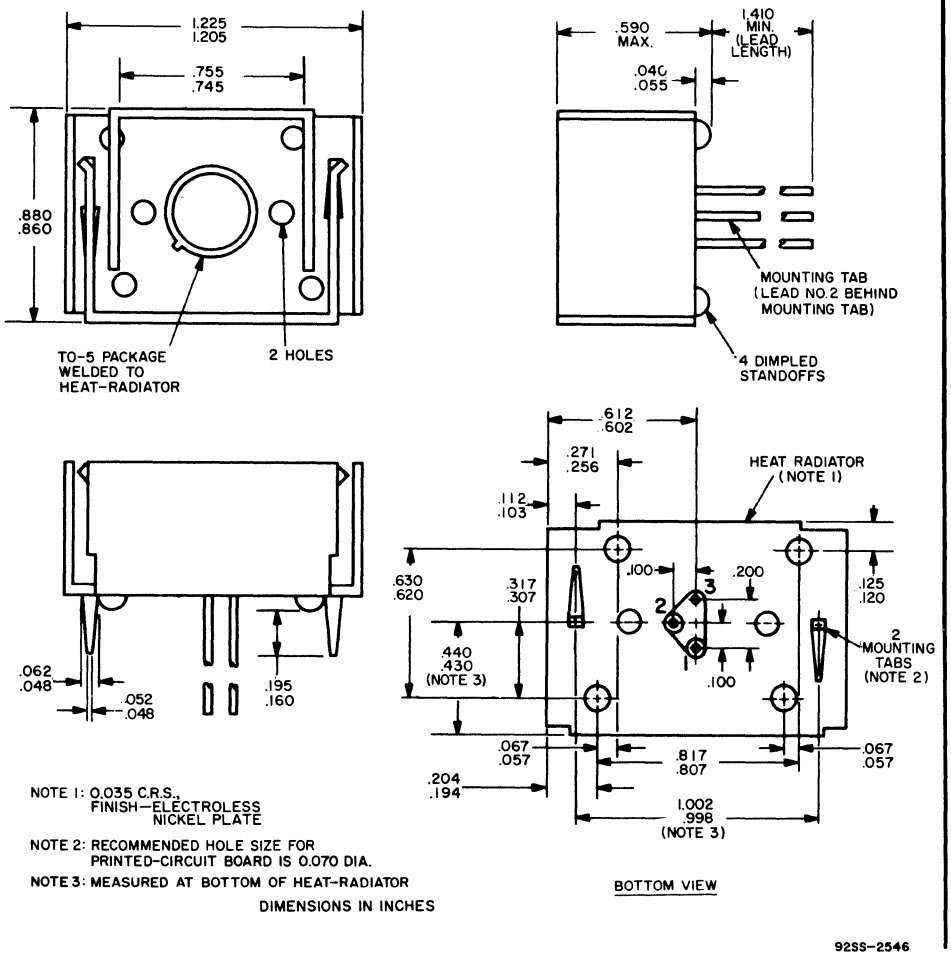
NOTE 1: Measured at bottom of heat-radiator.
NOTE 2: 0.035 C.R.S., tin plated.
NOTE 3: Recommended hole size for printed-circuit boards is 0.070 dia.

TERMINAL CONNECTIONS

FOR TYPE 2N3055	FOR TYPE 40372
Pin 1 - Base	Pin 1 - Base
Pin 2 - Emitter	Pin 2 - Emitter
Case, Flange - Collector	Heat-Radiator - Collector

DIMENSIONAL OUTLINE

FOR TYPE 40389
JEDEC TO-5 WITH HEAT RADIATOR



BOTTOM VIEW

NOTE 1: 0.035 C.R.S., FINISH—ELECTROLESS NICKEL PLATE

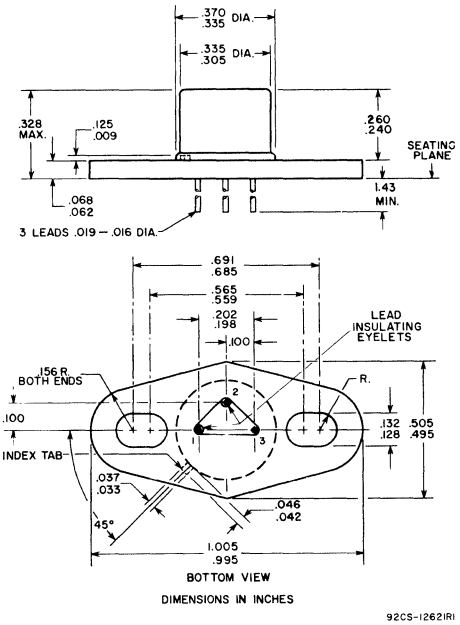
NOTE 2: RECOMMENDED HOLE SIZE FOR PRINTED-CIRCUIT BOARD IS 0.070 DIA.

NOTE 3: MEASURED AT BOTTOM OF HEAT-RADIATOR

DIMENSIONS IN INCHES

92SS-2546

FOR TYPE 40392
JEDEC TO-5 WITH FLANGE



BOTTOM VIEW

DIMENSIONS IN INCHES

92CS-12621RI

TERMINAL CONNECTIONS

FOR TYPE 40389	FOR TYPE 40392
Lead 1 - Emitter	Lead 1 - Emitter
Lead 2 - Base	Lead 2 - Base
Heat-Radiator, Lead 3 - Collector	Flange, Lead 3 - Collector

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RCA

SILICON N-P-N PLANAR TRANSISTOR

2N3118

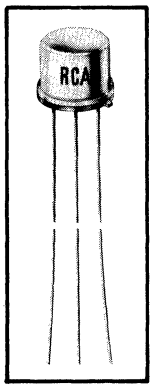
File No. 42

RCA-2N3118 is a triple-diffused planar transistor of the silicon n-p-n type intended for use in RF amplifiers in military and industrial HF and VHF communication equipment. It is designed especially for large-signal Class-C and small-signal Class-A service.

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Emitter Voltage:		
Reverse bias (V_{CEX})		
For V_{BE} = -1.5 volts.	85 max.	volts
With base open (V_{CEO})	60 max.	volts
Emitter-to-Base Voltage (V_{EBO}). .	4 max.	volts
Collector Current (I_C).	0.5 max.	ampere
Transistor Dissipation (P_T):		
At case temperatures up to 25° C	4 max.	watts
At free-air temperatures up to 25° C	1 max.	watt
At temperatures above 25° C	See *Fig.1*	
Temperature Range:		
Storage	-65 to +200	°C
Operating (Junction).	-65 to +200	°C

For Large-Signal VHF Class-C and Small-Signal VHF Class-A Amplifier Service



JEDEC TO-5

- High power dissipation — 4 watts at case temperature of 25° C
- High output power — Class-C service; 28-volt operation: 1 watt minimum at 50 Mc; 0.4 watt minimum at 150 Mc
- High collector-to-emitter voltage ratings — V_{CEX} = 85 volts; V_{CEO} = 60 volts
- High gain-bandwidth product — 380 Mc typical
- High power gain — Class-A service, neutralized: 25 db at 50 Mc, 200 mw output

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS: Case Temperature (T_C) °C	Frequency Mc	DC Collector-to-Base Voltage (volts) V_{CB}	DC Collector-to-Emitter Voltage (volts) V_{CE}	DC Emitter-to-Base Voltage (volts) V_{EB}	DC Collector Current (ma) I_C	DC Emitter Current (ma) I_E	DC Base Current (ma) I_B	LIMITS Min.	LIMITS Max.	Units
Collector-Cutoff Current	I_{CBO}	25(T_{FA})▲ 150(T_{FA})▲		30 30				0 0			0.1 100	μa μa
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.1		4		volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO}(sus)$	25					10 pulsed□		0	60		volts
Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}	25				1.5	0.1			85		volts
Feedback Capacitance	$C_{b'c}$	25	1	28			0				6	pf
$r_{bb'}$ $C_{b'c}$ Product	$r_{bb'}C_{b'c}$	25	50		28		25				60	psec
DC Forward-Current Transfer Ratio□	h_{FE}	25			28		25			50	275	
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25	50		28		25			5		
Real Part of Short-Circuit Input Impedance	$h_{ie(real)}$	25	50		28		25			25	75	ohms
Real Part of Short-Circuit Output Impedance	$1/Y_{22(real)}$	25	50		28		25			500	1000	ohms
Output Power Class-C Service P_{in} = 0.1 watt (with heat sink)	P_{OUT}	25 25	50* 150●		28 28					1.0 0.4		watt watt
Power Gain Class-A Service P_{out} = 0.2 watt (with heat sink)	PG	25	50★		28		25			18		db

▲ T_{FA} = free-air temperature □ Pulse duration, 300 μsec; duty factor, less than 1.8% * See *Fig.5* ● See *Fig.3* ★ See *Fig.13*

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N3118 5/66
Reprinted from 2N3118 11/63

RATING CHART

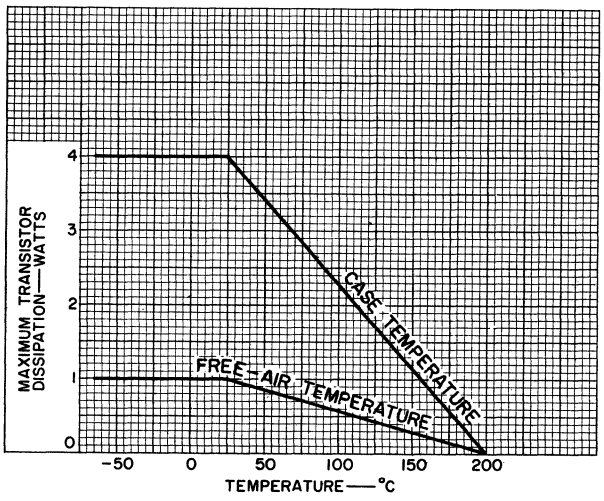


Fig.1

TYPICAL LARGE-SIGNAL OPERATION, CLASS-C SERVICE, 150 MC

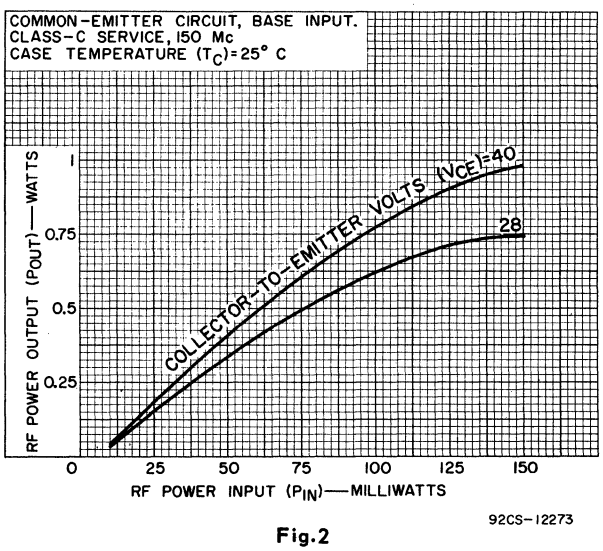
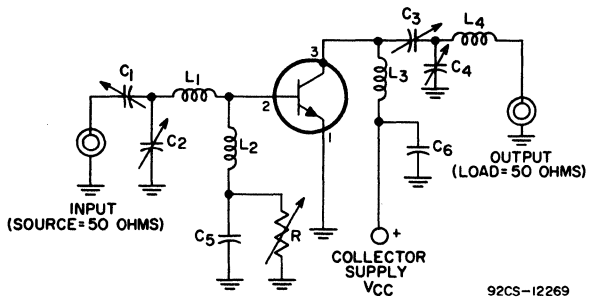


Fig.2



C_1, C_2: 1.5–20 pf
C_3: 4–40 pf
C_4: 7–100 pf
C_5: 1800 pf
C_6: 0.01 μf
R: 100 ohms, variable

L_1: 0.1 μh, 4 turns, No.18 wire, 1/4" ID, closely wound
L_2: 750-ohm ferrite choke
L_3: 0.075 μh, 4 turns, No.16 wire, 1/4" ID x 3/8" long
L_4: 0.055 μh, 3 turns, No.16 wire, 1/4" ID x 1/4" long

Fig.3

TYPICAL LARGE-SIGNAL OPERATION, CLASS-C SERVICE, 50 MC

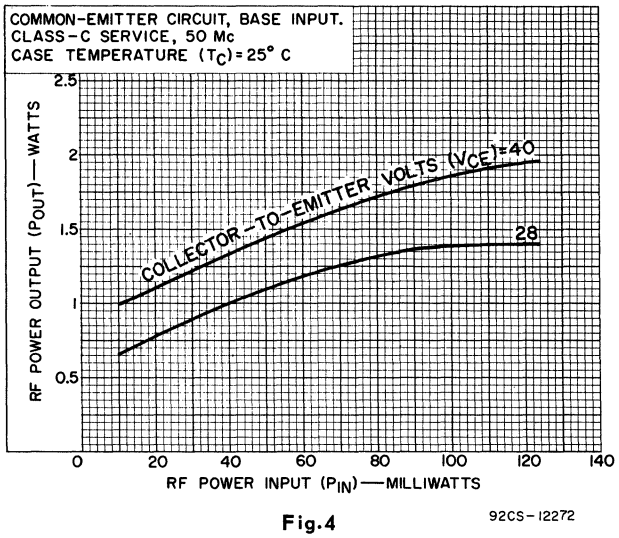
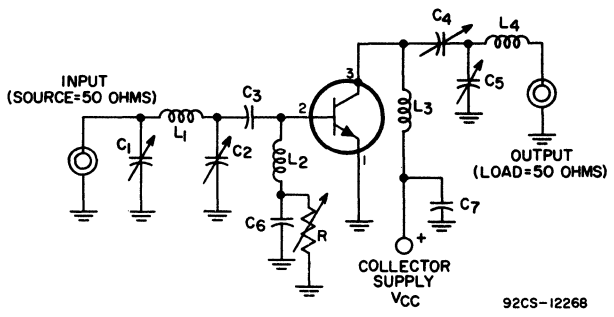


Fig.4



C_1: 70–350 pf
C_2, C_4, C_5: 7–100 pf
C_3: 0.01 μf
C_6: 0.002 μf
C_7: 0.02 μf

R: 1000 ohms, variable

L_1: 0.13 μh, 4 turns, No.18 wire, 1/4" ID, closely wound
L_2: 2.4 μh, choke, Miller Part No.4606
L_3: 0.6 μh, 10 turns, No.18 wire, 3/8" ID, closely wound
L_4: 0.6 μh, 10 turns, No.18 wire, 3/8" ID, closely wound

Fig.5

TYPICAL SMALL-SIGNAL OPERATION CHARACTERISTICS

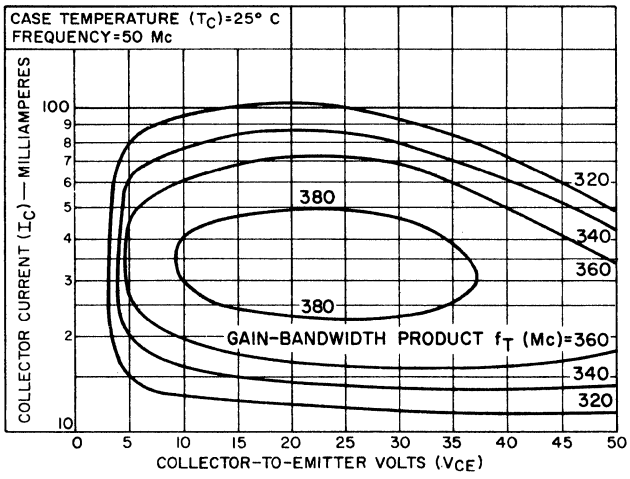


Fig.6

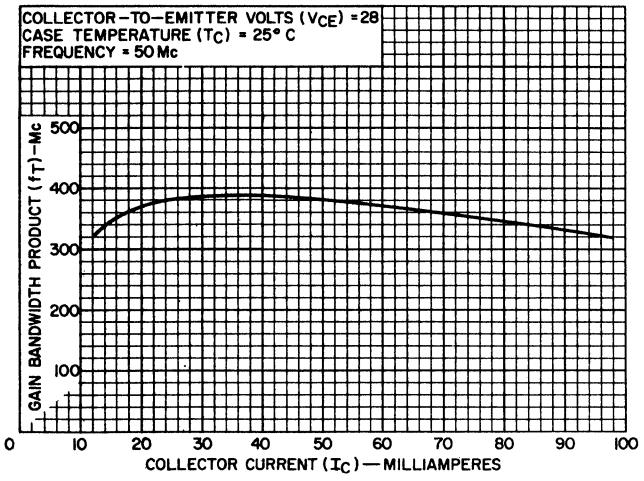


Fig.7

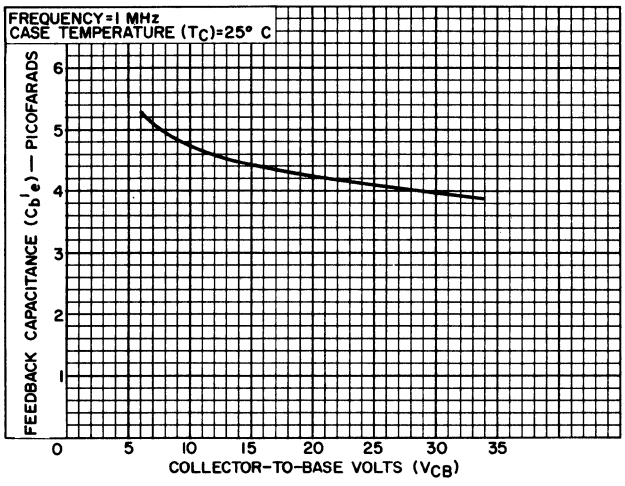


Fig.8

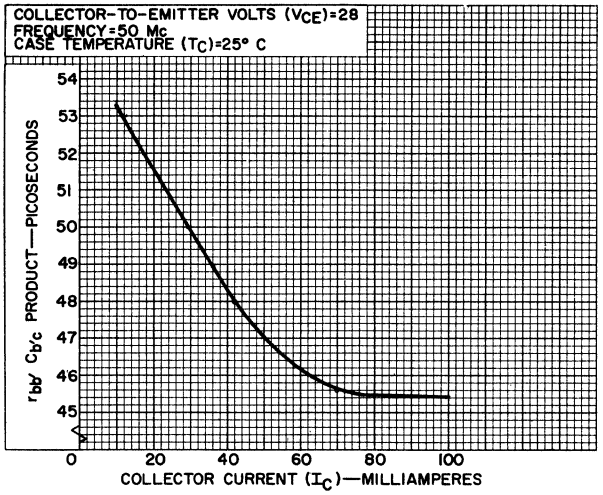


Fig.9

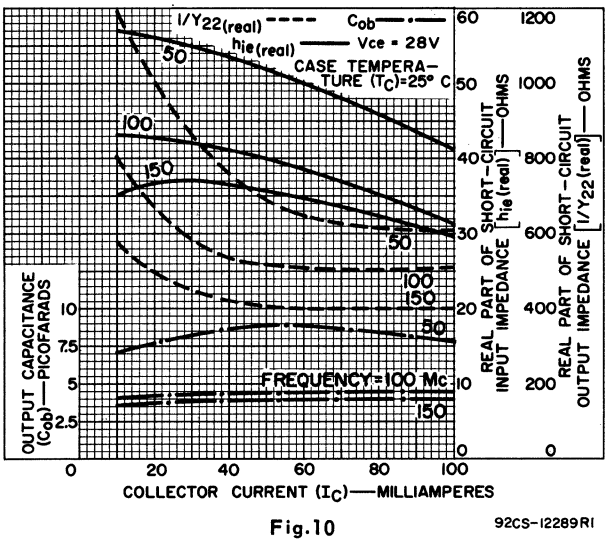


Fig.10

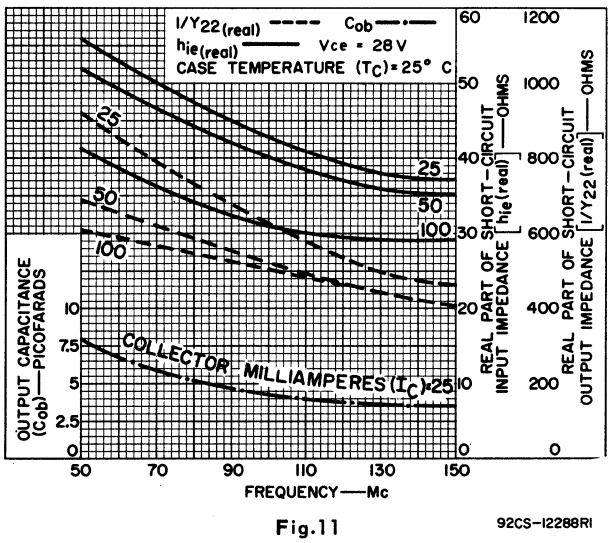


Fig.11

TYPICAL CLASS-A-SERVICE-OPERATION, 50 MC, NEUTRALIZED

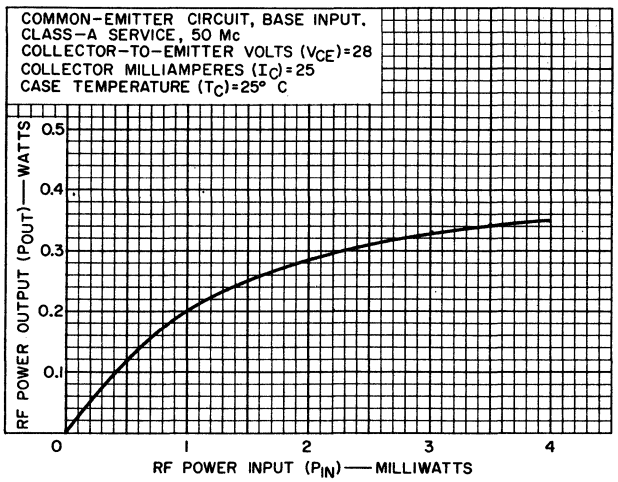
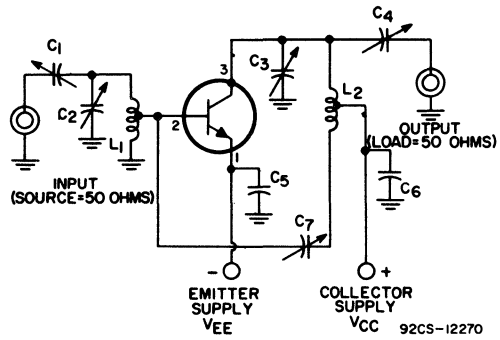


Fig.12



C_1: 7–100 pf
C_2: 8–60 pf
C_3: 14–150 pf
C_4: 6–80 pf
C_5, C_6: 0.005 μf
C_7: 0.9–7 pf

L_1: 0.12 μh, 3 turns, No.16 wire, 7/16" ID x 1/4" long, tap at 1 turn from ground

L_2: 0.23 μh, 5 turns, No.16 wire, 7/16" ID x 1/2" long, tap at 3 turns from collector terminal

Fig.13

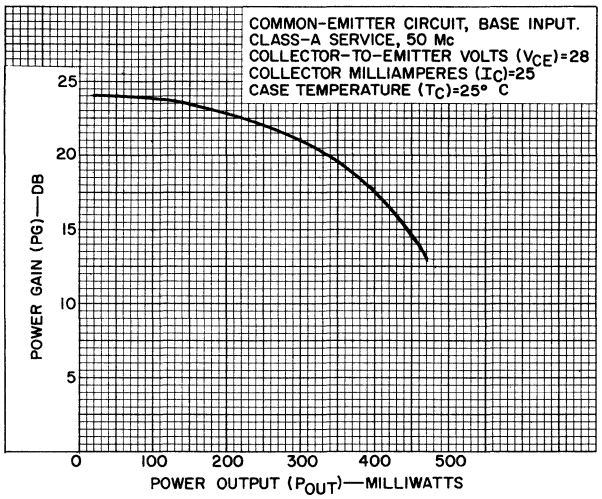


Fig.14

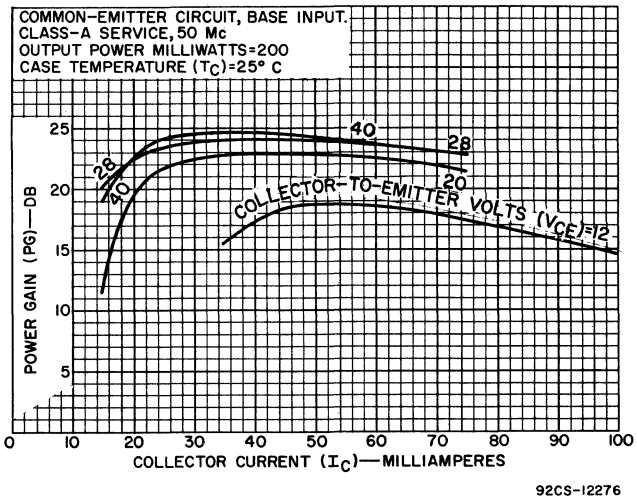
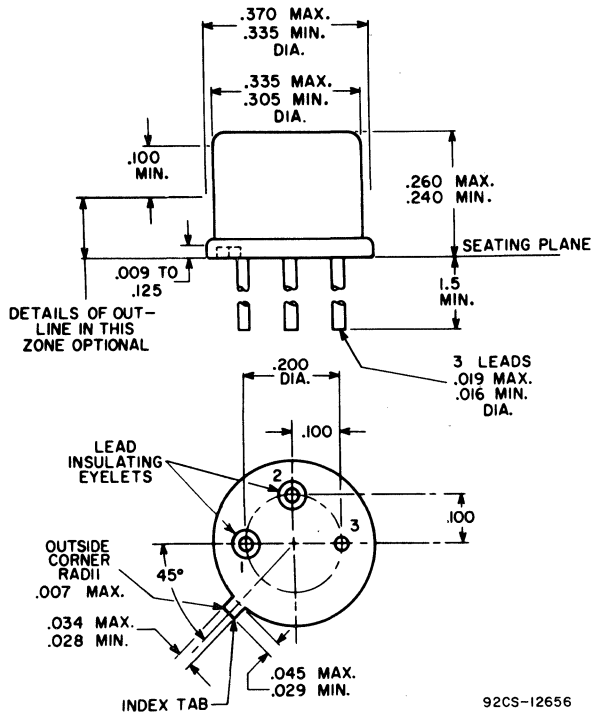


Fig.15

DIMENSIONAL OUTLINE
All Dimensions in Inches
JEDEC No.TO-5



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010.

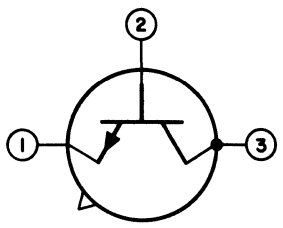
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050 AND 0.250 FROM THE SEATING PLANE. BETWEEN 0.250 AND 1.5 A MAXIMUM OF 0.021 DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019) MEASURED IN GAUGING PLANE 0.054 + 0.001 − 0.000 BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007 OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

TERMINAL DIAGRAM

LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR, CASE



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SILICON N-P-N PLANAR TRANSISTOR

2N3119

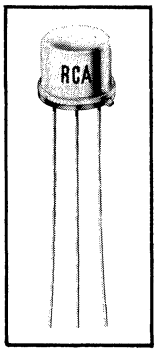
File No. 44

RCA-2N3119 is a triple-diffused planar transistor of the silicon n-p-n type intended for high-voltage, high-frequency pulse amplifiers and high-voltage saturated switches in military and industrial equipment.

For Switching and

Pulse Amplifier

Applications



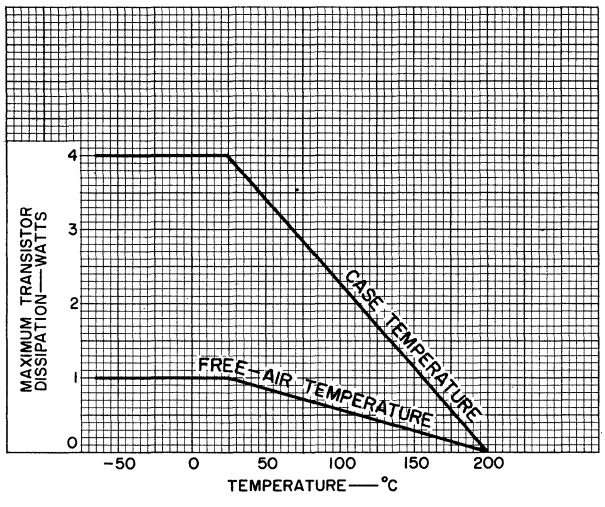
JEDEC TO-5

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage (V_{CBO})	100 max.	volts
Collector-to-Emitter Voltage:		
With 1.5 volts of reverse bias (V_{CEX})	100 max.	volts
With base open (V_{CEO})	80 max.	volts
Emitter-to-Base Voltage (V_{EBO})	4 max.	volts
Collector Current (I_C)	0.5 max.	ampere
Transistor Dissipation (P_T):		
At case temperatures up to 25° C	4 max.	watts
At free-air temperatures up to 25° C	1 max.	watt
At temperatures above 25° C	See *Fig.1*	
Temperature Range:		
Storage	-65 to +200	°C
Operating (Junction)	-65 to +200	°C
Lead Temperature:		
1/16" ± 1/32" from seating surface for 10 sec. max.	255	°C

- High collector-to-emitter voltage ratings —
  V_{CEX} = 100 volts
  V_{CEO} = 80 volts
- Fast rise time —
  50-volt pulse (1,000-ohm load) with 10 nsec rise time
- High power dissipation —
  4 watts at case temperature of 25° C

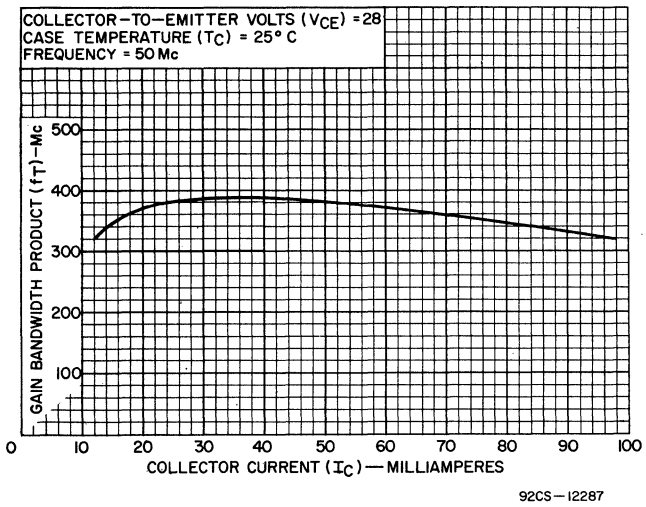
RATING CHART



92CS-12281

Fig.1

TYPICAL GAIN-BANDWIDTH PRODUCT CHARACTERISTIC



92CS-12287

Fig.2

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N3119 5/66
Reprinted from 2N3119 11/63

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Emitter Volts	DC Current (Milliamperes)			Min.	Max.	
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C			
Collector-Cutoff Current At T_{FA} = 25° C = 150° C	I_{CBO}	60 60			0 0			- -	50 50	na μa
Emitter-Cutoff Current (At T_{FA} = 25°C)	I_{EBO}			3			0	-	100	na
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO(sus)}$					0	10*	80	-	volts
Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}			1.5			0.10	100	-	volts
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.10	100	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.10		0	4	-	volts
DC Forward-Current Transfer Ratio	h_{FE}		10 10* 10*				10 100 250	40 50 20	- 200 -	
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					10	100	-	0.5	volt
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$					10	100	-	1.1	volts
Feedback Capacitance (At 1 Mc)	$C_{b'c}$	28					0	-	6	pf
Gain-Bandwidth Product (At 50 Mc)	f_T		28				25	250	-	Mc
Pulse-Amplifier Rise Time (See *Figs.9 & 10*)	$t_d + t_r$		V_{CC}=80				10	-	20	nsec
Sat. Switch Turn-On Time (delay time + rise time) (See *Figs.7 & 8*)	t_{on}		V_{CC}=28			I_{B_1} = 10	100	-	40	nsec
Sat. Switch Turn-Off Time (storage time + fall time) (See *Figs.7 & 8*)	t_{off}		V_{CC}=28			I_{B_2}=-10	100	-	700	nsec

* Pulsed; pulse duration = 300 μsec; duty factor = 1.8%.

TYPICAL DC BETA CHARACTERISTIC

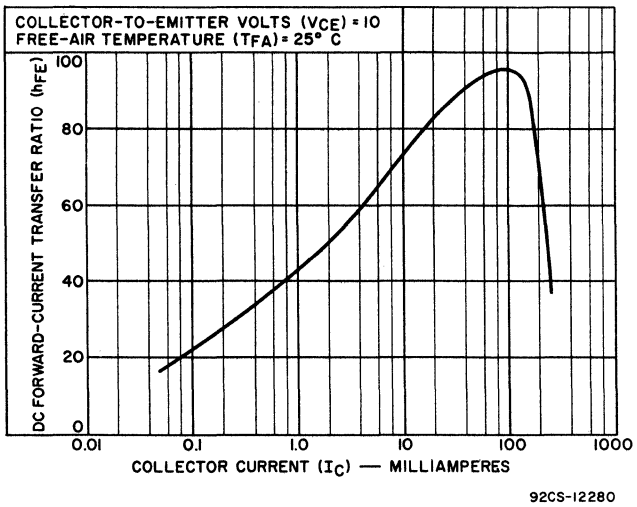


Fig.3

TYPICAL VARIATION OF f_T WITH COLLECTOR CURRENT AND COLLECTOR-TO-EMITTER VOLTAGE

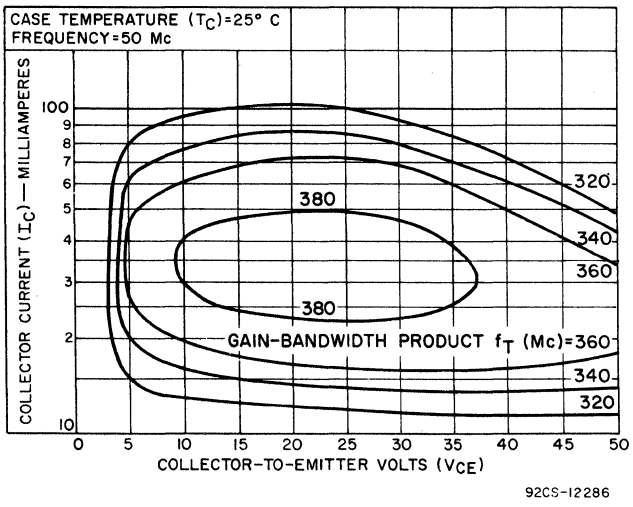


Fig.4

TYPICAL VARIATION OF OUTPUT CAPACITANCE vs. COLLECTOR-TO-BASE VOLTAGE

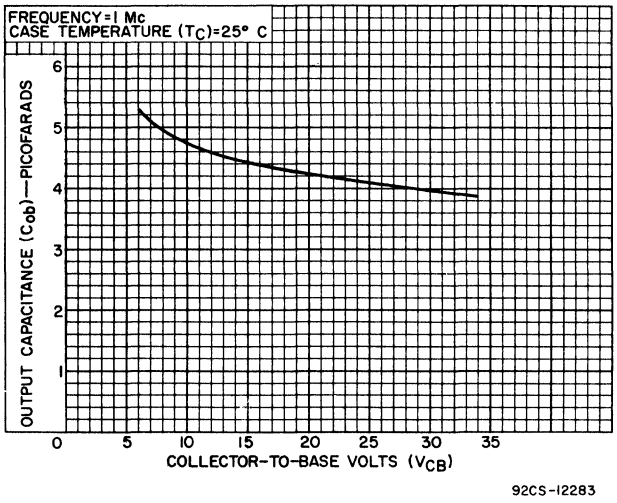


Fig.5

TYPICAL $r_{bb'}C_{b'c}$-PRODUCT vs. COLLECTOR CURRENT

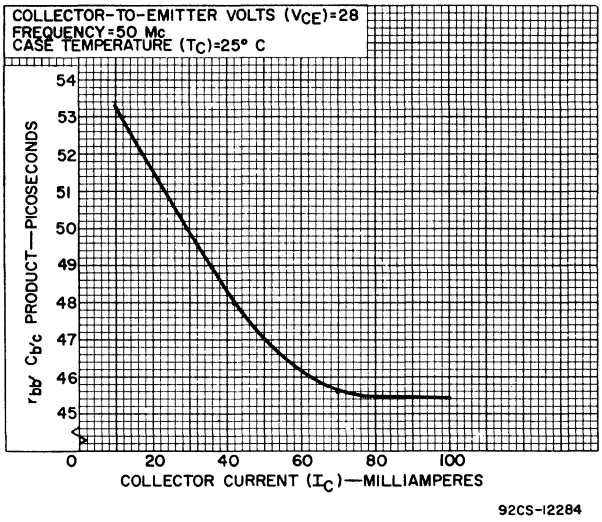
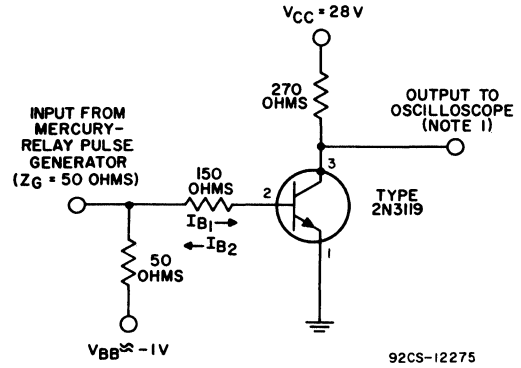


Fig.6

CIRCUIT USED TO MEASURE t_{on} AND t_{off} FOR 2N3119 OPERATING AS A SATURATED SWITCH



INPUT PULSE:

t_r < 3 nsec

t_f < 10 nsec

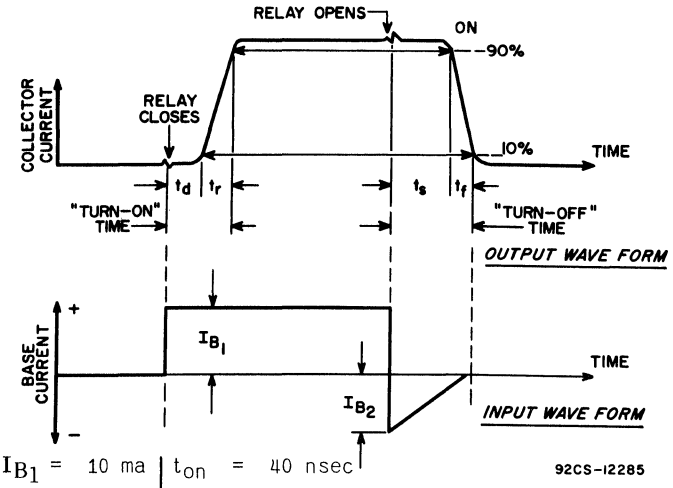
REP. RATE = 120 CPS

PULSE WIDTH = 300 μsec

NOTE 1: WITH C_{IN} < 1 pf SHUNTED BY 5,000 OHMS; t_r = 1 nsec.

Fig.7

WAVE FORMS FOR SATURATED SWITCH CIRCUIT SHOWN IN FIG. 7



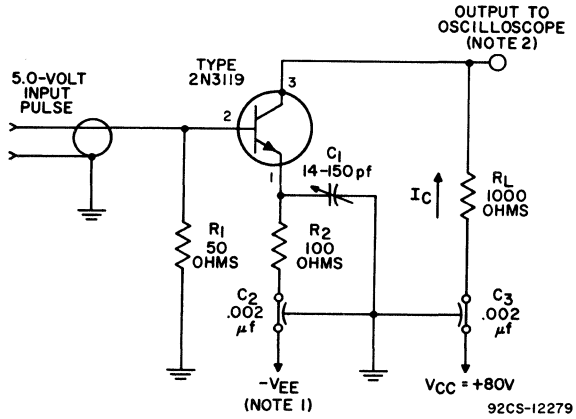
I_{B1} = 10 ma | t_{on} = 40 nsec

I_{B2} = -10 ma | t_{off} = 700 nsec

I_C = 100 ma

Fig.8

PULSE-AMPLIFIER TEST CIRCUIT



NOTE 1: V_{EE} ADJUSTED FOR I_C = 10 ma WITH NO INPUT.

NOTE 2: WITH C_{IN} < 1 pf SHUNTED BY 100,000 OHMS; t_r = 1 nsec.

Fig.9

WAVE FORMS FOR PULSE-AMPLIFIER TEST CIRCUIT SHOWN IN FIG. 9

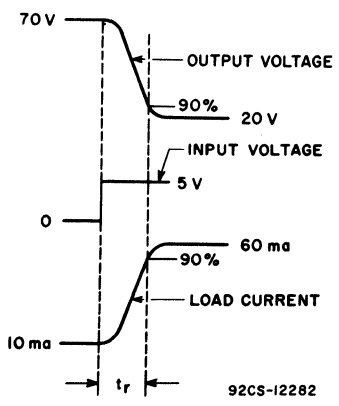
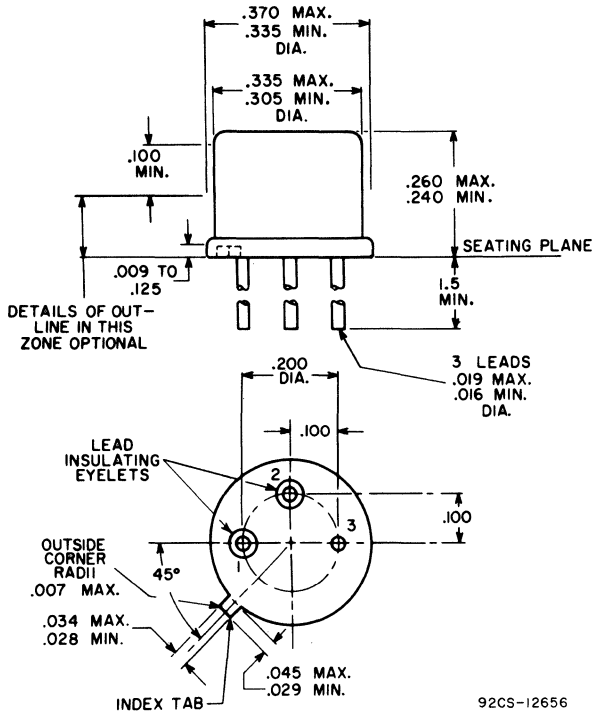


Fig.10

DIMENSIONAL OUTLINE
All Dimensions in Inches
JEDEC No.TO-5



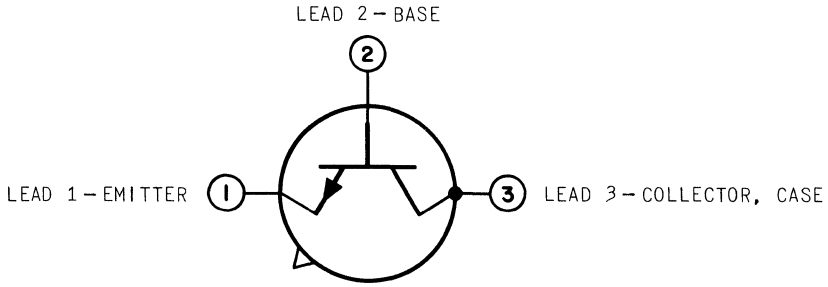
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TERMINAL DIAGRAM



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SILICON CONTROLLED-RECTIFIERS

2N3228 2N3528
2N3525 2N3529
2N4101 2N4102

File No. 114

All-Diffused SCR's for Low-Cost Power-Control and Power-Switching Applications

RCA 2N3228*, 2N3525*, 2N4101*, and 2N3528●, 2N3529●, and 2N4102● are all-diffused, three-junction, silicon controlled-rectifiers (SCR's▲) intended for use in power-control and power-switching applications.

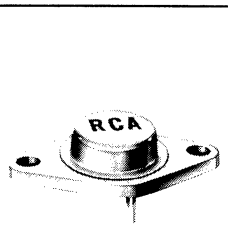
Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75°C.

Types 2N3528, 2N3529, and 2N4102 use the JEDEC TO-8 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 2 amperes (rms value) at an ambient temperature of 25°C.

* Formerly Dev. Types TA1222, TA1225, and TA2773, respectively.

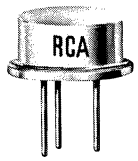
● Formerly Dev. Types TA2597, TA2617, and TA2774, respectively.

▲ The silicon controlled-rectifier is also known as a reverse-blocking triode thyristor.



2N3228
2N3525
2N4101

JEDEC TO-66



2N3528
2N3529
2N4102

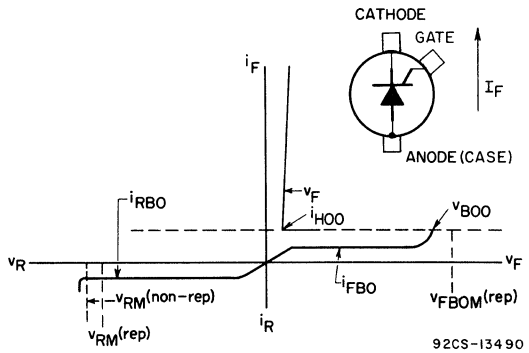
JEDEC TO-8

Current → / Voltage ↓	Average Forward Amperes 3.2	Average Forward Amperes 1.3
For 120-Volt Line Operation	2N3228	2N3528
For 240-Volt Line Operation	2N3525	2N3529
For High-Voltage Power Supplies	2N4101	2N4102

FEATURES

- Designed especially for high-volume systems
- Readily adaptable for printed-circuit boards and metal heat sinks
- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3228 5/66
Reprinted from 2N3228 2/66

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES						UNITS
	2N3228	2N3525	2N4101	2N3528	2N3529	2N4102	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)[a]	330	660	700	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)[b]	200	400	600	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)[c]	600	600	700	600	600	700	volts
Forward Current:							
For case temperature (T_C) of + 75°C, and unit mounted on heat sink–							
Average DC value at a conduction angle of 180°, I_{FAV}d	3.2	3.2	3.2	—	—	—	amperes
RMS value, I_{FRMS}e	5.0	5.0	5.0	—	—	—	amperes
For other conditions, See Fig. 8							
For free-air temperature (T_{FA}) of 25°C, and with no heat sink employed–							
Average DC value at a conduction angle of 180°, I_{FAV}d	—	—	—	1.3	1.3	1.3	amperes
RMS value, I_{FRMS}e	—	—	—	2.0	2.0	2.0	amperes
For other conditions, See Fig. 9.							
Peak Surge Current, i_{FM}(surge)[f]:							
For one cycle of applied voltage		60			60		amperes
For more than one cycle of applied voltage		See Fig. 13			See Fig. 13		
Sub-Cycle Surge (Non-Repetitive) I^2tg							
For a period of 1ms to 8.3ms		15			15		ampere^2 second
Rate of Change of Forward Current, di/dt[h]		200			200		amperes/ microsecond
V_{FB} = v_{BOO}(min. value) I_{GT} = 200mA, 0.5 μs rise time (See waveshapes of Fig. 1)							
Gate Power*:							
Peak, Forward or Reverse, for 10 μs duration, P_{GM}j (See Figs. 5 and 6)		13			13		watts
Average, P_{GAV}k		0.5			0.5		watt
Temperature:							
Storage, T_{stg}		−40 to +125			−40 to +125		°C
Operating (Case), T_C		−40 to +100			−40 to +100		°C

*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

WAVESHAPE OF di/dt RATING TEST

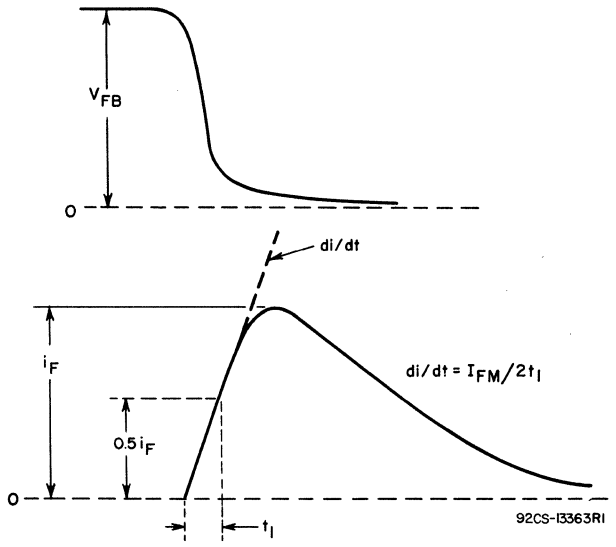


Fig. 1

WAVESHAPE OF CRITICAL dv/dt RATING TEST

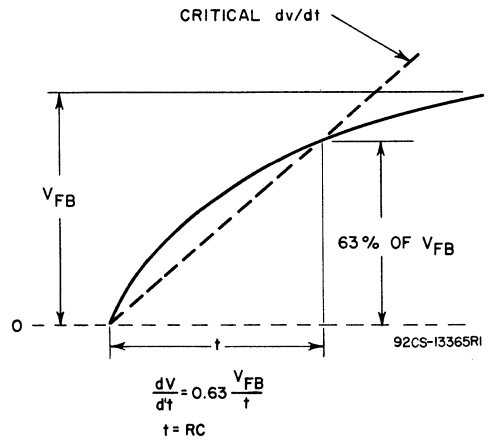


Fig. 2

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES									UNITS
	2N3228, 2N3528			2N3525, 2N3529			2N4101, 2N4102			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, v_{BOO}[m]:										
At T_C = +100°C	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at T_C = +100°C:										
Forward, I_{FBOM}[n]	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
V_{FBO}[p] = v_{BOO} (min. value)										
Reverse, I_{RBOM}[q]	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
V_{RBO}[p] = v_{RM} (rep) value										
Forward Voltage Drop, v_F[r]										
At a Forward Current of 30 amperes and a T_C = +25°C (See Fig. 11)	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, I_{GT}[s]										
At T_C = +25°C (See Fig. 5)	—	8	15	—	8	15	—	8	15	mA(dc)
Gate-Trigger Voltage, V_{GT}[t]										
At T_C = +25°C (See Fig. 5)	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts(dc)
Holding Current, i_{HOO}[u]										
At T_C = +25°C	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage,										
Critical dv/dt[v]	10	200	—	10	200	—	10	200	—	volts/ microsecond
V_{FB} = v_{BOO} (min. value), exponential rise, T_C = +100°C (See waveshape of Fig. 2)										
Turn-On Time, t_{on}[w], (Delay Time + Rise Time)	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
V_{FB} = v_{BOO} (min. value), i_F = 4.5 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C (See waveshapes of Fig. 3)										
Turn-Off Time, t_{off}[x], (Reverse Recovery Time + Gate Recovery Time)	—	15	50	—	15	50	—	15	50	microseconds
i_F = 2 amperes, 50 μs pulse width, dv_{FB}/dt = 20v/μs, di_r/dt = 30A/μs, I_{GT} = 200mA, T_C = +75°C (See waveshapes of Fig. 4)										

	2N3228, 2N3525, 2N4101			2N3528, 2N3529, 2N4102			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Thermal Resistance:							
Junction-to-case	—	—	4	—	—	—	°C/W
Junction-to-ambient	—	—	—	—	—	40	°C/W

WAVESHAPE OF t_{on} RATING TEST

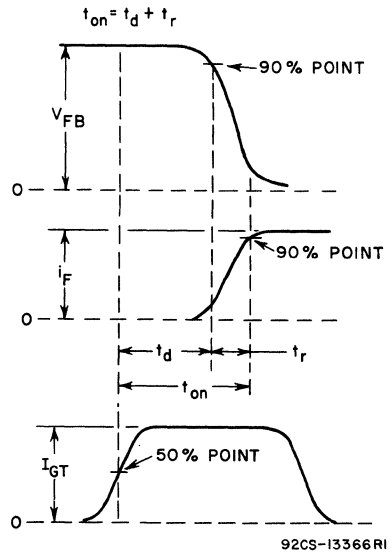


Fig. 3

WAVESHAPE OF t_{off} RATING TEST

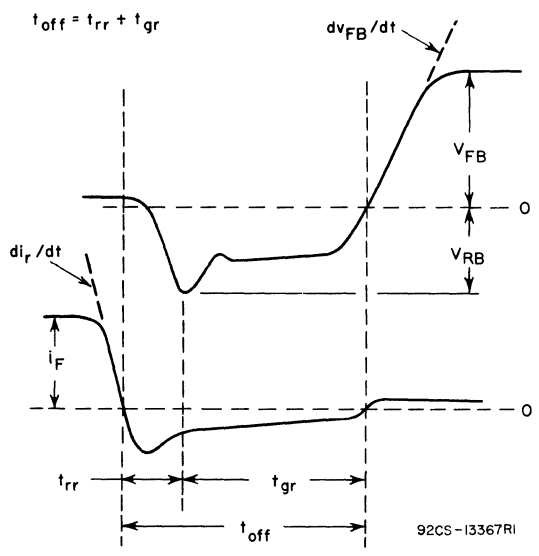


Fig. 4

FORWARD GATE CHARACTERISTICS

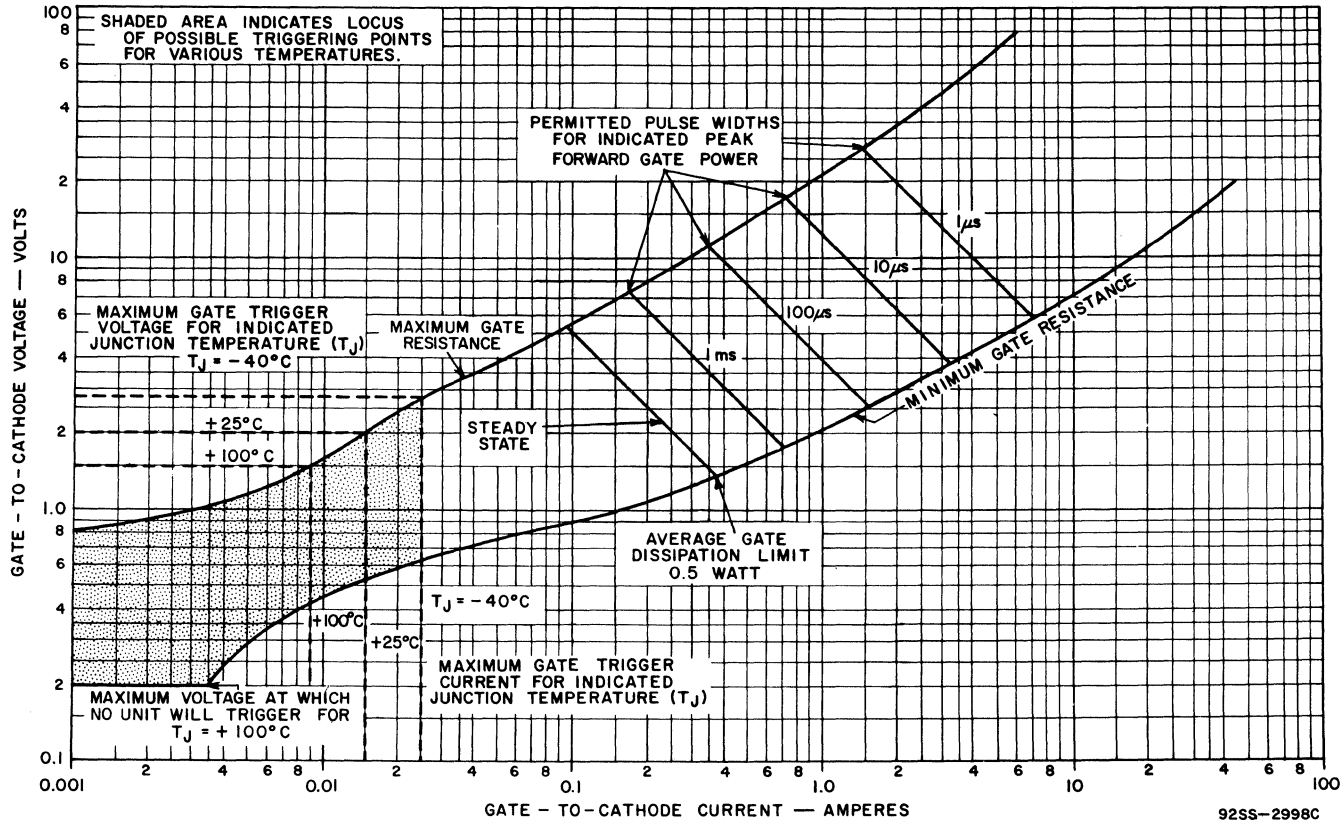


Fig. 5

REVERSE GATE CHARACTERISTICS

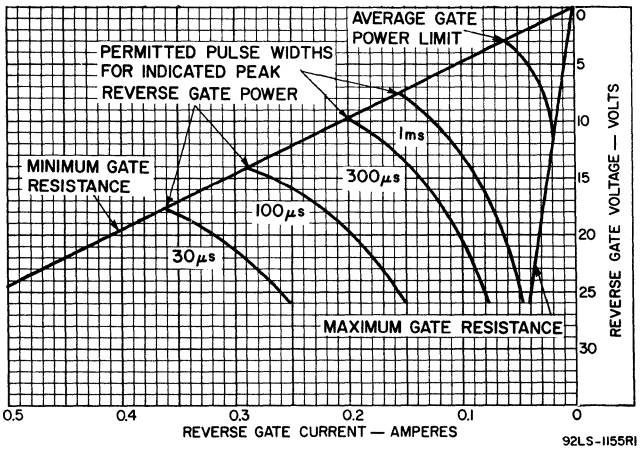


Fig. 6

TRIGGERING CONSIDERATIONS

The construction of the gate-cathode junction used in these devices provides a large periphery center gate. These devices also employ shorted-emitter construction which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown in Fig. 5. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown in Fig. 6 should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAV}) of 0.5 watt.

Turn-on times for different gate currents are shown in Fig. 7. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger pulse until the magnitude of the forward anode current has reached the latching current value. However, conservative design requires that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".

TURN-ON TIME CHARACTERISTICS

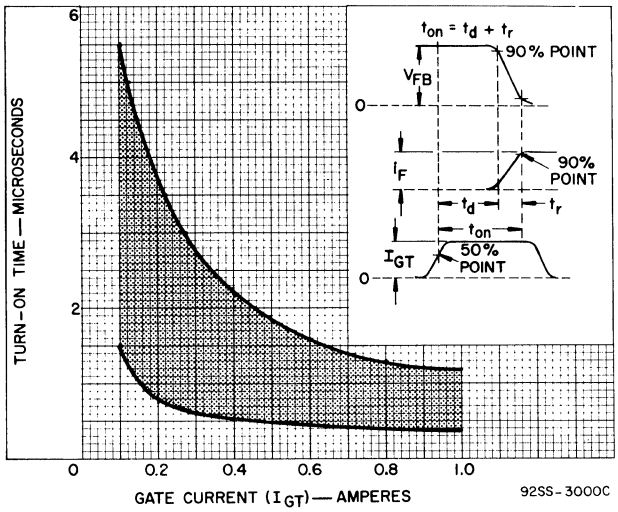


Fig. 7

RATING CHART (CASE TEMPERATURE) FOR TYPES 2N3228, 2N3525, AND 2N4101

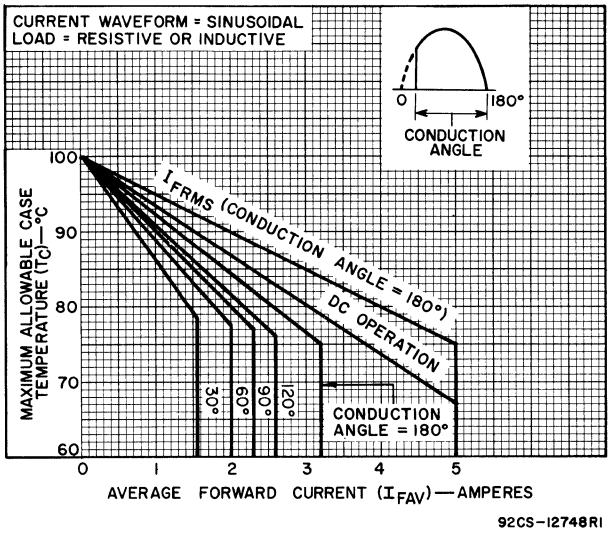


Fig. 8

RATING CHART (FREE-AIR TEMPERATURE) FOR TYPES 2N3528, 2N3529, AND 2N4102

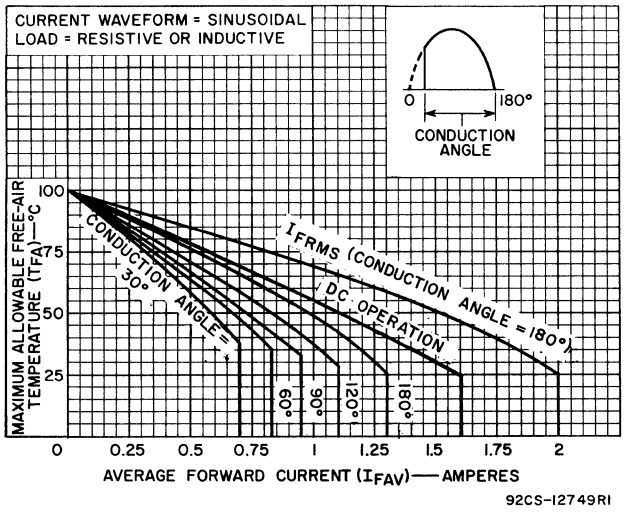


Fig. 9

POWER DISSIPATION CHART FOR ALL TYPES

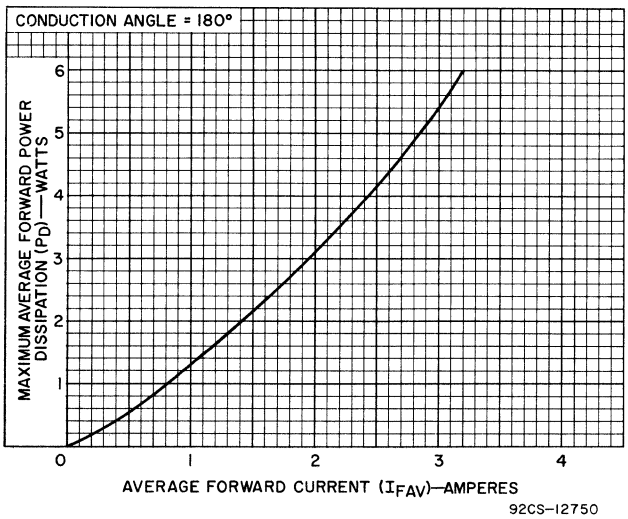


Fig. 10

FORWARD CHARACTERISTICS FOR ALL TYPES

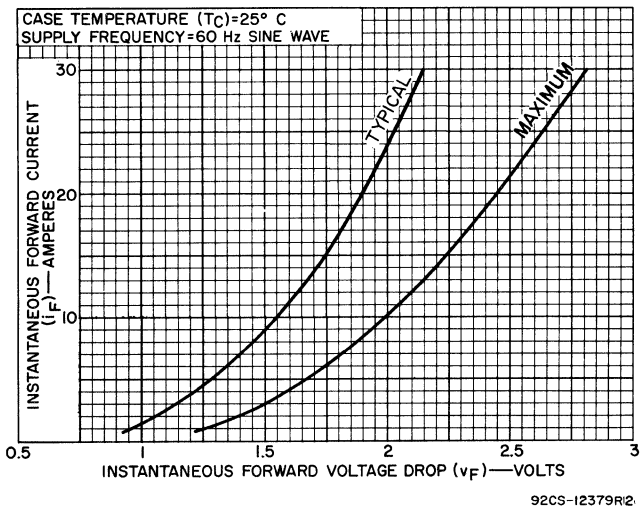


Fig. 11

OPERATION GUIDANCE CHART FOR TYPES 2N3228, 2N3525, AND 2N4101

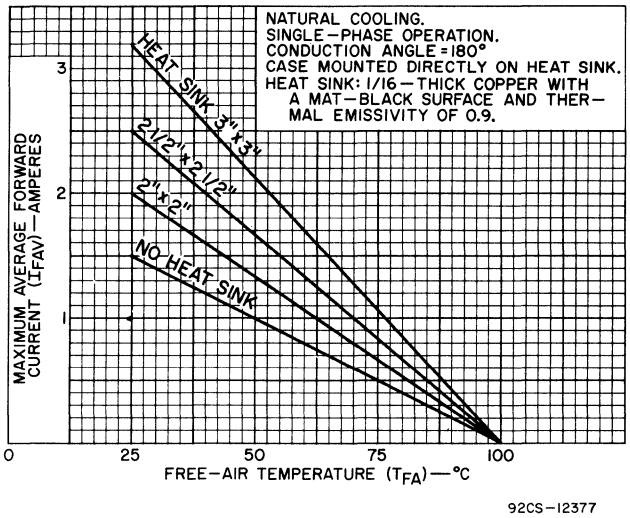


Fig. 12

SURGE CURRENT RATING CHART

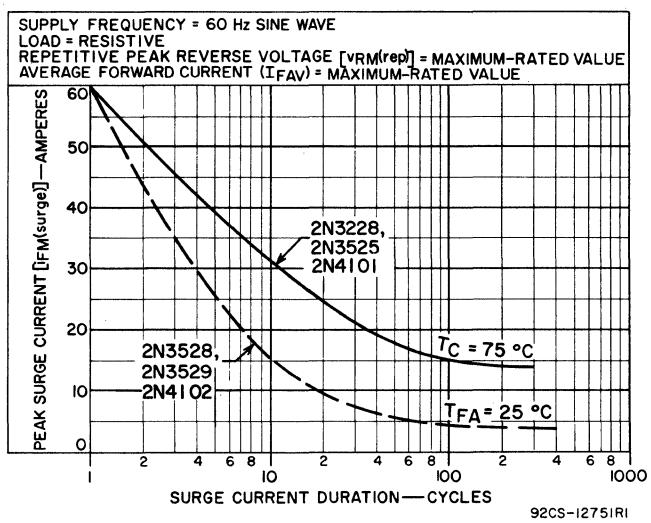


Fig. 13

CONTROLLED-RECTIFIER TERMS, SYMBOLS, AND DEFINITIONS

a **Transient Peak Reverse Voltage (Non-repetitive)** - v_{RM} (non-rep) - The maximum value of negative (reverse-blocking) voltage which may be applied between the anode and cathode for not more than 5 milliseconds when the gate is open (gate voltage is zero or negative with respect to cathode).

b **Peak Reverse Voltage (Repetitive)** - $v_{RM(rep)}$ - The maximum instantaneous value of negative (reverse-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

c **Peak Forward Blocking Voltage (Repetitive)** - $v_{FBOM(rep)}$ - The maximum instantaneous value of positive (forward-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

d **Average Forward Current** - I_{FAV} - The average (dc) value of the current flowing from anode to cathode in the device.

e **RMS Forward Current** - I_{FRMS} - The RMS value of the current flowing from anode to cathode in the device.

f **Peak Surge Current** - $i_{FM(surge)}$ - The maximum total instantaneous value of forward current which may be imposed during one forward half-cycle with the device operating within its specified maximum voltage, average-forward-current, gate-power, and temperature ratings in a single-phase circuit with 60-Hz supply and resistive load. The peak surge current may be repeated after sufficient time has elapsed for the device to return to pre-surge thermal equilibrium conditions.

g **Sub-Cycle Surge (Non-Repetitive)** I^2t - The non-recurrent surge capability of the device for sub-cycle pulses where I is RMS amperes and t is pulse duration in seconds.

h **Rate of Change of Forward Current** - di/dt - The maximum rate of change of current which may be imposed on the device immediately after turn on by the gate from a forward blocking condition.

i **Peak Forward and Reverse Gate Power** - P_{GM} - The maximum instantaneous power dissipated between gate and cathode for a specified time duration.

k **Average Forward Gate Power** - P_{GAV} - The average power dissipated between gate and cathode.

m **Forward Breakover Voltage** - v_{BOO} - The value of positive anode voltage at which a controlled rectifier may switch into the conducting state when the gate is open.

n **Peak Forward Blocking Current** - I_{FBOM} - The maximum value of the forward blocking current of a controlled rectifier with gate open.

p **Forward and Reverse Blocking Voltage** - V_{FBO}, V_{RBO} - The value of voltage applied between anode and cathode with the gate open.

q **Peak Reverse Blocking Current** - I_{RBOM} - The maximum value of the reverse blocking current of a controlled rectifier with gate open.

r **Forward Voltage Drop** - v_F - The instantaneous voltage drop across a controlled rectifier at a given instantaneous forward current i_F and under steady-state conditions.

s **Gate-Trigger Current** - I_{GT} - The gate current required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

t **Gate-Trigger Voltage** - V_{GT} - The gate-to-cathode voltage required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

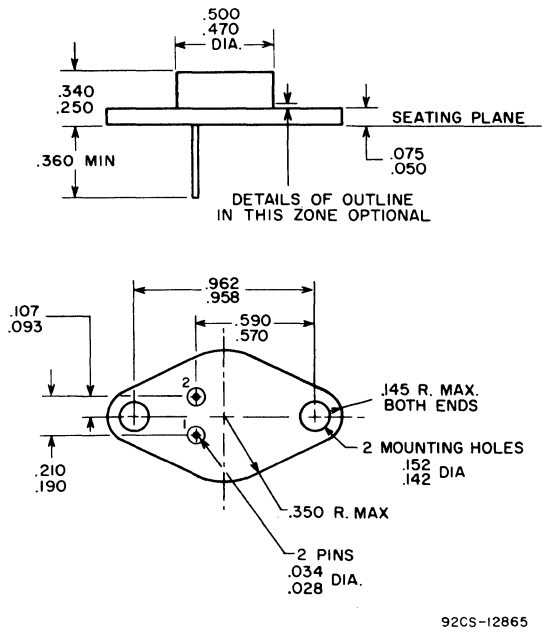
u **Holding Current** - i_{HOO} - The instantaneous value of forward current i_F below which a controlled rectifier with its gate open returns to its forward blocking state.

v **Critical Rate of Applied Forward Voltage** - Critical dv/dt - The critical rate of applied forward voltage is the minimum value of the rate of applied forward voltage which will cause switching from the off-state to the on-state under stated conditions.

w **Turn-On Time** - t_{on} - Turn-on time is the time interval between the initiation of the gate signal and the time when the resulting forward current reaches 90 per cent of its maximum value during switching from the off-state to the on-state under stated conditions.

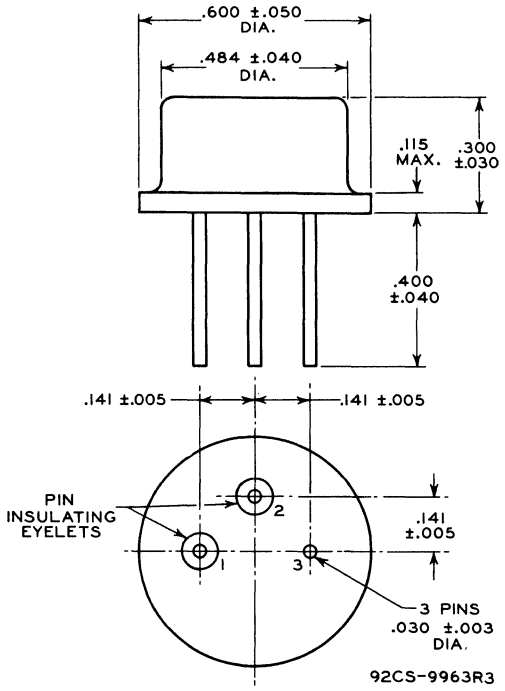
x **Turn-Off Time** - t_{off} - Turn-off time is the time interval between the time when the forward current decreases to zero and the time when the device anode voltage reaches zero and is rising to a stated value of forward blocking voltage at a stated rate of rise without turning on during switching in the external anode circuit from the on-state to the off-state under stated conditions.

DIMENSIONAL OUTLINE FOR TYPES 2N3228, 2N3525, AND 2N4101 JEDEC No. TO-66



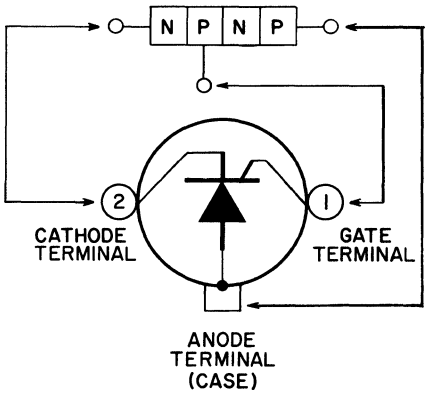
DIMENSIONS IN INCHES

DIMENSIONAL OUTLINE FOR TYPES 2N3528, 2N3529, AND 2N4102 JEDEC No. TO-8



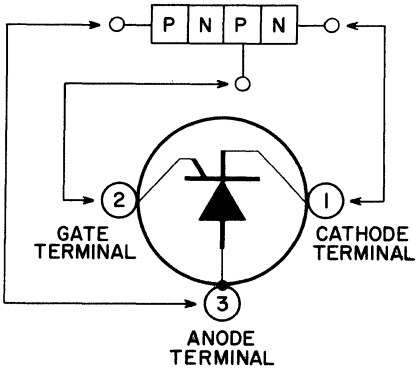
DIMENSIONS IN INCHES

TERMINAL DIAGRAM FOR TYPES 2N3228, 2N3525, AND 2N4101



PIN 1: GATE
PIN 2: CATHODE
CASE: ANODE

TERMINAL DIAGRAM FOR TYPES 2N3528, 2N3529, AND 2N4102



PIN 1: CATHODE
PIN 2: GATE
PIN 3: ANODE (CONNECTED TO CASE)

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RCA

SILICON N-P-N PLANAR TRANSISTOR

2N3229

File No. 50

RCA-2N3229 is a triple-diffused planar transistor of the silicon n-p-n type. This device is intended for applications in AM, FM, and CW service at frequencies up to 150 Mc.

The 2N3229 utilizes a new stud-mounted package which is electrically isolated from all the electrodes and is designed to provide excellent performance at very high frequencies.

RF SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	105 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With base open, V_{CEO}	60 max.	volts
With V_{BE} = -1.5 volts, V_{CEV}	105 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4 max.	volts
COLLECTOR CURRENT, I_C	2.5 max.	amperes
TRANSISTOR DISSIPATION, P_T:		
At case temperatures up to 25° C.	17.5 max.	watts
At case temperatures above 25° C.	Derate linearly 100	mw/°C
TEMPERATURE RANGE:		
Storage	-65 to 200	°C
Operating (Junction)	-65 to 200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32" from ceramic wafer for 10 sec. max.	230 max.	°C

REGION OF SAFE OPERATION (WITHOUT SECOND BREAKDOWN) IN CLASS-A SERVICE FOR TYPE 2N3229

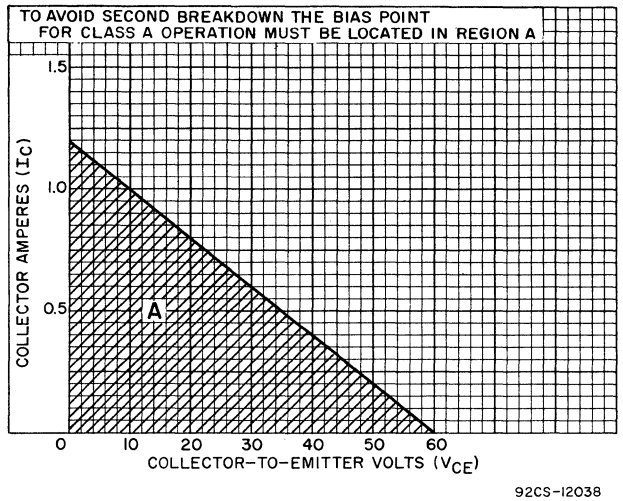
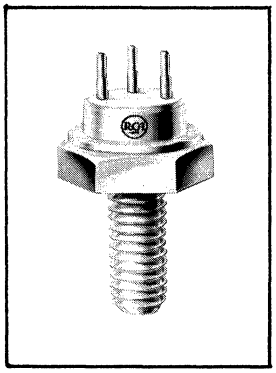


Fig. 1

For Large-Signal, High-Power, VHF Applications in Military and Industrial Communications Equipment



JEDEC TO-60

- High Power Output, Unneutralized (P_{OUT}):
  15 w min. at 50 Mc
  5 w min. at 150 Mc
- High Voltage Ratings:
  V_{CBO} = 105 volts max.
  V_{CEV} = 105 volts max.
  V_{CEO} = 60 volts max.
- 100 per cent tested to assure freedom from second breakdown in class-A operation at maximum ratings
- Low Thermal Resistance (θ_{J-C})—
  high thermal-conductivity ceramic insulation between collector and mounting stud
- Isolated Stud Package:
  all three electrodes electrically isolated from case—for design flexibility
  heavy copper mounting stud—for effective contact with heat sink
  pin terminals arranged on a .200" pin-circle diameter—fit commercially available sockets

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N3229 5/66
Reprinted from 2N3229 2/64

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C Unless Otherwise Specified

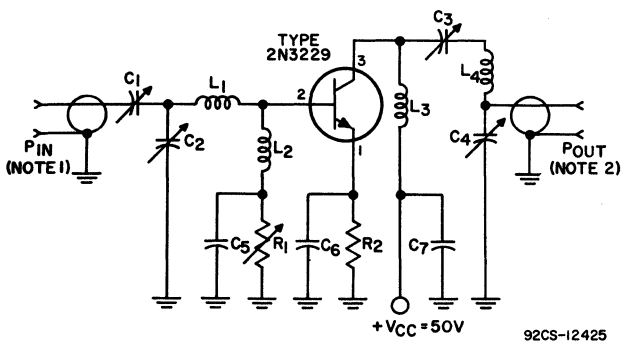
Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	30			0			-	0.1	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.5	105	-	volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO(sus)}$					0	500*	60	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			-1.5			0.1	105	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					500	2.5 amp	-	1	volt
Feedback Capacitance (Measured at 140 Kc)	$C_{b'c}$	30			0			-	20	pf
RF Power Output, Unneutralized (See *Fig. 2.*):	P_{out}									
Measured at 50 Mc			50				550	15[a]	-	watts
150 Mc			50				250	5[b]	-	watts
Gain-Bandwidth Product	f_T		28				250	200(typ.)		Mc
Base-Spreading Resistance (Measured at 400 Mc)	$r_{bb'}$		28				250	6.0(typ.)		ohms
Collector-to-Case Capacitance	C_c							-	6	pf

* Pulsed. Pulse duration $\leq$ 5 μsec; duty factor $\leq$ 1%.

[a] For P_{IN} = 2 watts

[b] For P_{IN} = 1 watt

CIRCUIT OF UNNEUTRALIZED AMPLIFIER USED TO MEASURE POWER OUTPUT OF TYPE 2N3229



NOTE 1: GENERATOR IMPEDANCE = 50 OHMS.

NOTE 2: LOAD IMPEDANCE = 50 OHMS.

For 50-Mc Operation

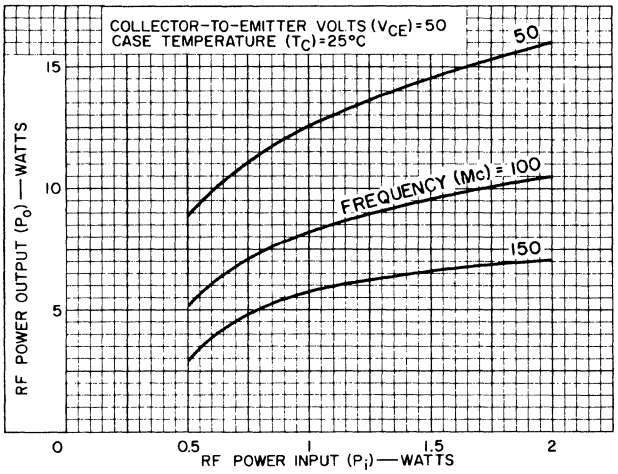
C_1: 4–40 pf
C_2, C_4: 7–100 pf
C_3: 1.5–20 pf
C_5, C_6, C_7: 0.005 μf
L_1: 5–1/2 turns No.18 wire, 1/4" ID, closely–wound
L_2: Ferrite choke, Z = 750(±20%) ohms
L_3: 6 turns No.18 wire, 3/8" ID, wire spacing = 1 wire dia. (slug–tuned)
L_4: 8 turns No.18 wire, 3/8" ID, closely–wound (slug–tuned)
R_1: 1,000 ohms
R_2: 3.9 ohms (non–inductive)

For 150-Mc Operation

C_1, C_2: 4–40 pf
C_3, C_4: 1.5–20 pf
C_5, C_7: 0.005 μf
L_1: 1–1/2 turns No.16 wire, 1/4" ID, wire spacing = 1 wire dia.
L_2: Ferrite choke, Z = 750(±20%) ohms
L_3: 2.4 μh
L_4: 6 turns No.16 wire, 3/8" ID, closely–wound
R_1: 100 ohms
R_2: = 0 (Emitter connected to ground)

Fig.2

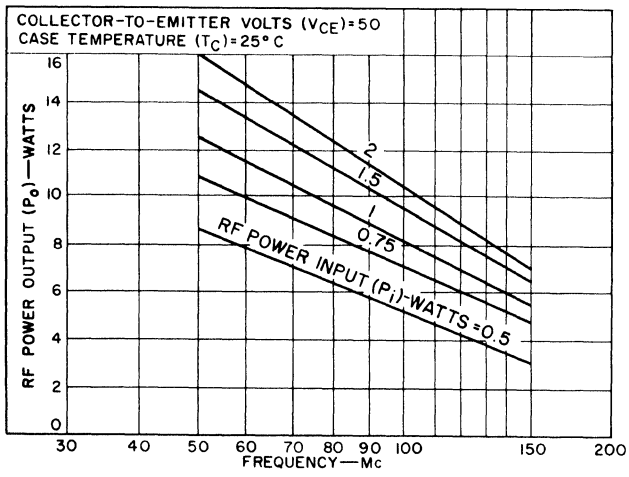
TYPICAL-OPERATION CHARACTERISTICS FOR TYPE 2N3229



92CS-12424

Fig.3

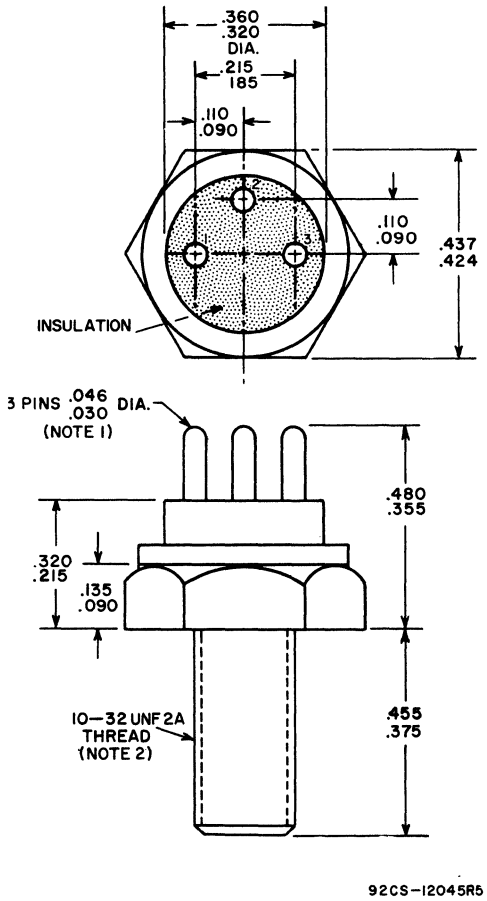
TYPICAL-OPERATION CHARACTERISTICS FOR TYPE 2N3229



92CS-12427

Fig.4

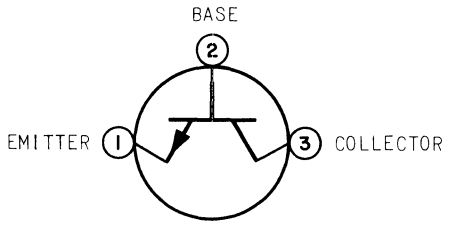
DIMENSIONAL OUTLINE



92CS-12045R5

DIMENSIONS IN INCHES

TERMINAL DIAGRAM



NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200" AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.035" MIN., 0.045" MAX.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

NOTE 3: THIS DEVICE MAY BE OPERATED IN ANY POSITION.

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RCA

RCA SILICON TRANSISTOR FAMILY

For Amplifier and Switching Applications

2N3241A 2N3242A
2N4074
40397 40398
40399 40400

HEAT-RADIATOR TYPES

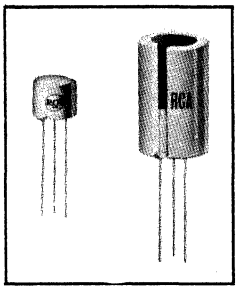
40450 40451
40452
40453 40454
40455 40456

File No. 221

SILICON N-P-N EPITAXIAL PLANAR TRANSISTORS

For High-Voltage, High-Current Amplifier Service in Commercial and Industrial Equipment

For High-Current Switching Service in Computer Equipment



RCA-2N3241A, 2N3242A, 2N4074, 40397, 40398, 40399, and 40400 are epitaxial planar transistors of the silicon npn type, with ratings and characteristics which make them highly desirable for high-voltage, high-current audio-amplifier, video amplifier, and other applications in commercial and industrial equipment.

RCA-40450, 40451, 40452, 40453, 40454, 40455, and 40456 respectively, are electrically and mechanically similar to the types listed above, but are equipped with integral heat radiators which provide 50% lower thermal resistance between junction and ambient. RCA-40450 through 40456 thus have twice the dissipation capability of their prototypes at ambient temperatures up to 25°C.

This family of related devices features low leakage currents, low saturation voltages, and exceptionally linear transfer characteristics. It also provides a choice of breakdown-voltage capabilities and small-signal characteristics to meet a wide variety of circuit-design requirements.

Type 2N3242A and its corresponding heat-radiator type (RCA-40451) have an exceptionally low noise figure (2 dB typ. at 10 kHz), which makes these types particularly suitable for critical audio- and video-amplifier applications. Both the 2N3241A and 2N3242A and their corresponding heat-radiator types (RCA-40450 and 40451) also feature a high gain-bandwidth product (175 MHz typ.), and high-speed "turn-on" and "turn-off" characteristics, features which give these devices additional utility as switching transistors in computer applications.

2N3241A, 2N3242A, Formerly Dev. Nos. TA2500F and TA2505, respectively

2N4074, Formerly Dev. No. TA2715

40397 through 40400, Formerly Dev. Nos. TA2500A, B, C, D, respectively

40450 through 40456, Formerly Dev. Nos. TA2500J, K, Q, L, M, N, P, respectively

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FEATURES

- high dissipation capabilities – P_T = {2 W at T_C to 75°C; to 1 W at T_A to 25°C}
- high current capabilites – I_C to 1 ampere
- high breakdown voltages – BV_{CEO} to 40 V
- low saturation voltages – $V_{CE(sat)}$
  as low as 0.22 V typ., 0.3 V max. at I_C = 300 mA
  as low as 0.1 V typ., 0.2 V max. at I_C = 100 mA
- high beta – h_{FE} to 165 min. at I_C = 10 mA
- hermetically sealed 3-lead metal package with index tab to simplify referencing and installation
- RCA-40450 through 40456 have integral heat radiators for reduced thermal resistance and increased dissipation capability

APPLICATIONS

- high-voltage, high-current audio and video amplifiers
- high-gain, low-noise audio and video amplifiers
- high-current switching in computer applications

For 2N3241A, 2N3242A, 40450, 40451

- high gain-bandwidth product – f_T = 175 MHz typ.
- high switching speeds – t_{on} = 75 ns max. t_{off} = 575 ns max.
- low noise – NF = 2 dB typ. at 10 kHz for 2N3242A, 40451

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Trademark(s) ® Registered
Marca(s) Registrada(s)
Printed in U.S.A.

1CE-341 9-66
Supersedes: 2N3241A, 2N3242A 7-66;
2N4074 6-66; 40397-40400 3-66

Maximum Ratings, Absolute-Maximum Values:

	2N3241A 40450	2N3242A 40451	2N4074 40452	40397 40453	40398 40454	40399 40455	40400 40456		
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	25	40	40	25	25	18	18	max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEV} (V_{BE} = -1 V)	25	40	40	25	25	18	18	max.	V
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30	40	—	—	—	—	—	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	7.5	8	8	7.5	7.5	7	7	max.	V
COLLECTOR CURRENT, I_C	Limited by Dissipation		300	200	200	200	200	max.	mA
EMITTER CURRENT, I_E	—	—	-300	-200	-200	-200	-200	max.	mA
BASE CURRENT, I_B	—	—	—	25	25	25	25	max.	mA
TEMPERATURE RANGE: Storage and operating (junction)	← -65 to +175 →								°C
LEAD TEMPERATURE (During soldering): At distances not closer than 1/32 inch to seating surface for 10 seconds max.	265	265	255	255	255	255	255	max.	°C
TRANSISTOR DISSIPATION, P_T:	2N3241A	2N3242A	2N4074	40397	40398	40399	40400		
For case temperatures up to 75°C	2	2	2	2	2	2	2	max.	W
For case temperatures above 75°C	← See Fig.1 →								
For ambient temperatures up to 25°C	0.5	0.5	0.5	0.5	0.5	0.5	0.5	max.	W
For ambient temperatures above 25°C	← See Fig.1 →								
	40450	40451	40452	40453	40454	40455	40456		
For case temperatures up to 75°C	2	2	2	2	2	2	2	max.	W
For case temperatures above 75°C	← See Fig.2 →								
For ambient temperatures up to 25°C	1	1	1	1	1	1	1	max.	W
For ambient temperatures above 25°C	← See Fig.2 →								

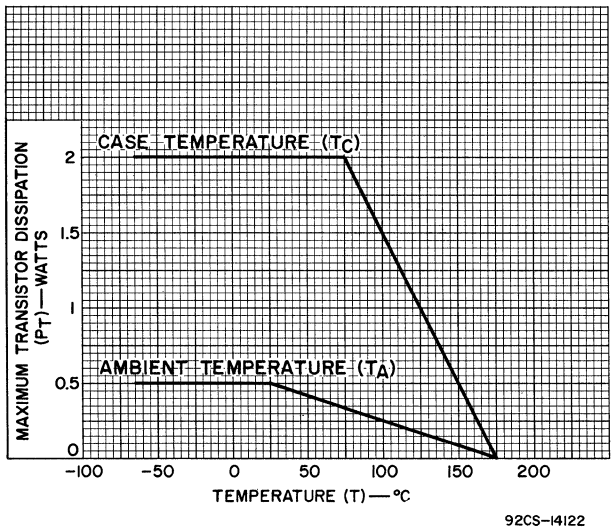


Fig.1 - Rating chart for types 2N3241A, 2N3242A, 2N4074, 40397, 40398, 40399, and 40400.

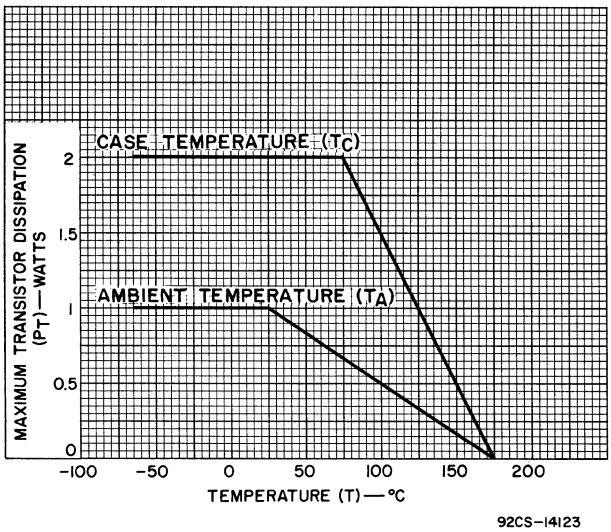


Fig.2 - Rating chart for types 40450, 40451, 40452, 40453, 40454, 40455, and 40456.

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STATIC CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS							LIMITS																		Units
		Temperature T*	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Base-to-Emitter Voltage V_{BE}	DC Base Current I_B	DC Collector Current I_C	DC Emitter Current I_E	Types 2N3241A 40450			Types 2N3242A 40451			Types 2N4074 40452			Types 40397 40453			Types 40398 40454			Types 40399 40455			Types 40400 40456			
		°C	V	V	V	mA	mA	mA	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Collector-Cutoff Current	I_{CBO}	25	25					0	-	-	100	-	-	10	-	-	10	-	-	100	-	-	100	-	-	-	-	-	-	nA
			12					0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	500	-	-	500	nA
		85	25					0	-	-	-	-	-	-	-	-	1	-	-	5	-	-	5	-	-	-	-	-	-	μA
			12					0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	10	μA
		150	25					0	-	-	10	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	μA
Collector-Cutoff Current	I_{CEV}	25		40	-1				-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	μA
				25	-1				-	-	-	-	-	-	-	-	-	-	-	10	-	-	10	-	-	-	-	-	-	μA
Emitter-Cutoff Current	I_{EBO}	25			-2.5		0		-	-	100	-	-	10	-	-	10	-	-	100	-	-	100	-	-	500	-	-	500	nA
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	25				0	10		25	-	-	40	-	-	40	-	-	25	-	-	25	-	-	18	-	-	18	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEV}	25			-1		0.01		25	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0.05	0	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V
							0.1	0	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.05	7.5	-	-	8	-	-	8	-	-	7.5	-	-	7.5	-	-	7	-	-	7	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25				15	300		-	-	-	-	0.24	0.3	-	0.22	0.3	-	-	-	-	-	-	-	-	-	-	-	-	V
						10	200		-	0.22	0.25	-	-	-	-	-	-	-	0.15	0.25	-	0.15	0.25	-	-	-	-	-	-	V
						5	100		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.2	-	0.1	0.2	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25				15	300		-	-	-	-	0.93	1.5	-	1	1.5	-	-	-	-	-	-	-	-	-	-	-	-	V
						10	200		-	0.88	1.25	-	-	-	-	-	-	-	0.8	1.3	-	0.8	1.3	-	-	-	-	-	-	V
						5	100		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.75	1.3	-	0.75	1.3	V
Static Forward Current-Transfer Ratio	h_{FE}	25		6			0.5		-	-	-	-	-	-	35	75	-	20	175	-	20	75	-	-	175	-	-	75	-	-
				10			10		100	150	200	125	200	300	75	150	300	165	300	600	75	150	300	165	300	600	75	150	300	-
				1			100		-	-	-	-	-	-	50	140	-	100	245	-	50	140	-	100	245	-	50	140	-	-

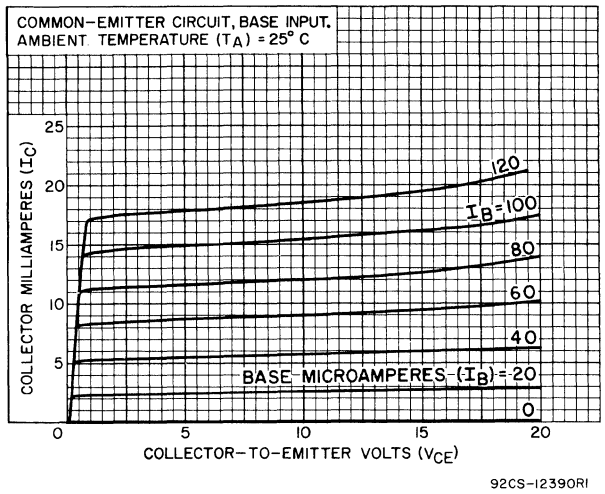
* Ambient Temperature (T_A) for Types 2N3241A, 2N3242A, 40450, 40451; Case Temperature (T_C) for all other types.

DYNAMIC CHARACTERISTICS, at T_A = 25°C for Types 2N3241A, 2N3242A, 40450, 40451; at T_C = 25°C for all other types

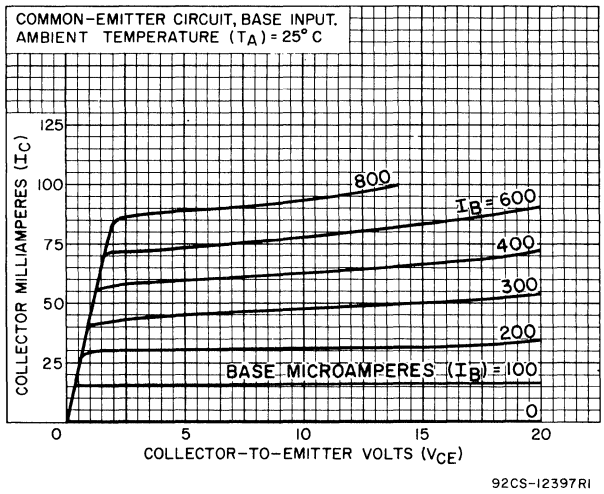
Characteristics	Symbols	TEST CONDITIONS			LIMITS																								Units
		Frequency f	DC Collector-to-Emitter Voltage V_{CE}	DC Collector Current I_C	Types 2N3241A 40450			Types 2N3242A 40451			Types 2N4074 40452			Types 40397 40453			Types 40398 40454			Types 40399 40455			Types 40400 40456						
		-	V	mA	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max				
Small-Signal Forward Current-Transfer Ratio	h_{fe}	1 kHz	12	10	100	175	250	125	200	375	75	175	-	165	375	-	75	200	-	165	375	-	75	200	-				-
Small-Signal Short-Circuit Input Impedance	h_{ie}	1 kHz	12	10	200	-	1000	250	-	1500	-	600	-	-	1200	-	-	600	-	-	1200	-	-	600	-				Ω
Small-Signal Open-Circuit Output Admittance	h_{oe}	1 kHz	12	10	30	-	350	30	-	350	-	75	-	-	120	-	-	75	-	-	120	-	-	75	-				μmho
Small-Signal Open-Circuit Reverse Voltage-Transfer Ratio	h_{re}	1 kHz	12	10	-	-	-	-	-	-	-	125 x10^{-6}	-	-	250 x10^{-6}	-	-	125 x10^{-6}	-	-	250 x10^{-6}	-	-	125 x10^{-6}	-				-
Collector-to-Base Feedback Capacitance[a]	C_{cb}	1 MHz	V_{CB} = 6 V	I_E = 0	-	-	20	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				pF
Open-Circuit Common-Base Output Capacitance	C_{obo}	1 MHz	V_{CB} = 6 V	I_E = 0	-	-	-	-	-	-	-	12	20	-	12	20	-	12	20	-	12	20	-	12	20				pF
Gain-Bandwidth Product	f_T	50 MHz	10	10	-	175	-	-	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				MHz
		100 MHz	6	1	-	-	-	-	-	-	-	50	80	-	50	80	-	50	80	-	50	80	-	50	80				MHz
Extrinsic Base-Lead Resistance	$r_{bb'}$	100 MHz	6	1	-	20	-	-	20	-	-	20	40	-	20	40	-	20	40	-	20	40	-	20	40				Ω
Magnitude of Small-Signal Forward-Current-Transfer-Ratio	$\lvert h_{fe} \rvert$	100 MHz	6	1	0.5	1	-	0.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				-
Noise Figure[b]	NF	10 kHz	6	0.1	-	2.5	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				dB
		1 kHz	6	0.5	-	8	10	-	4	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				dB
Thermal Resistance: Junction-to-Case	θ_{J-C}	-	-	-	-	-	50	-	-	50	-	-	50	-	-	50	-	-	50	-	-	50	-	-	50				°C/W
					2N3241A			2N3242A			2N4074			40397			40398			40399			40400						
Thermal Resistance: Junction-to-Ambient	θ_{J-A}	-	-	-	-	-	300	-	-	300	-	-	300	-	-	300	-	-	300	-	-	300	-	-	300				°C/W
					40450			40451			40452			40453			40454			40455			40456						
					-	-	150	-	-	150	-	-	150	-	-	150	-	-	150	-	-	150	-	-	150				°C/W

[a] Three-Terminal Measurement: Emitter Terminal Guarded.
[b] Bandwidth of Measurement Circuit = 1 Hz; Generator Resistance (R_g) = 1000 Ω.

TYPICAL COLLECTOR CHARACTERISTICS

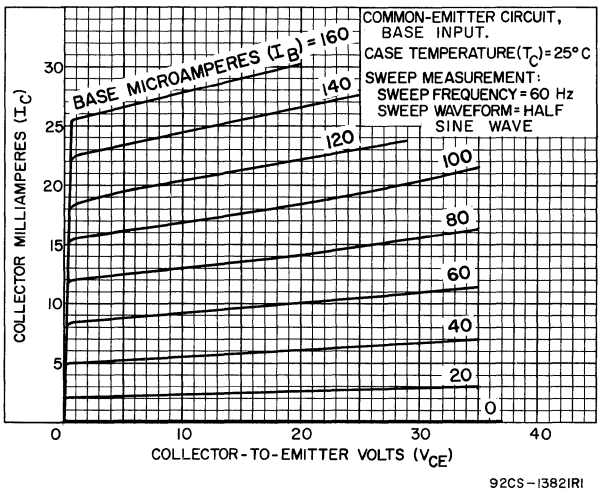


(a)

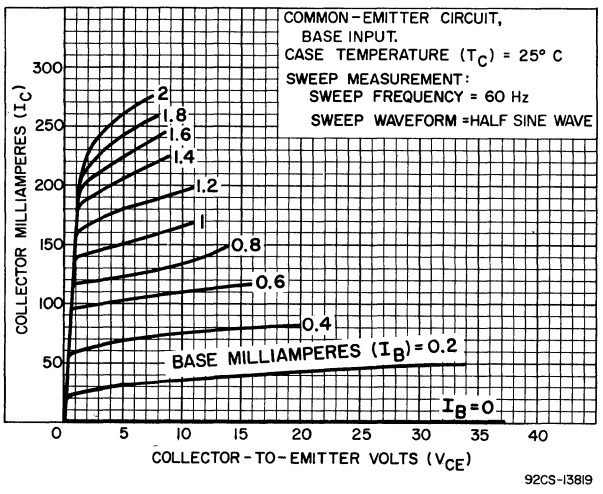


(b)

Fig.3 - I_C vs V_{CE} for 2N3241A, 2N3242A, 40450, and 40451.

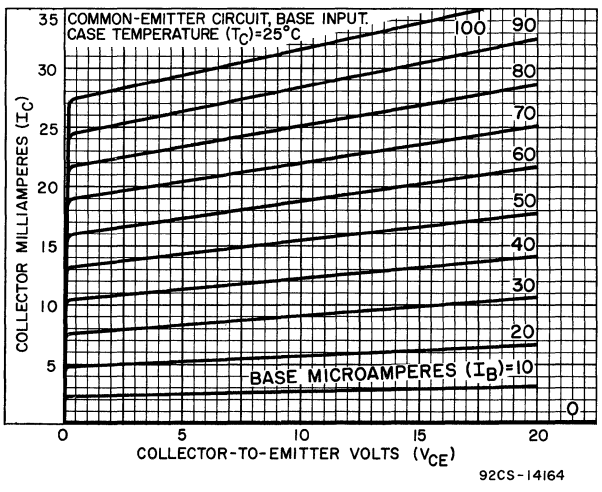


(a)

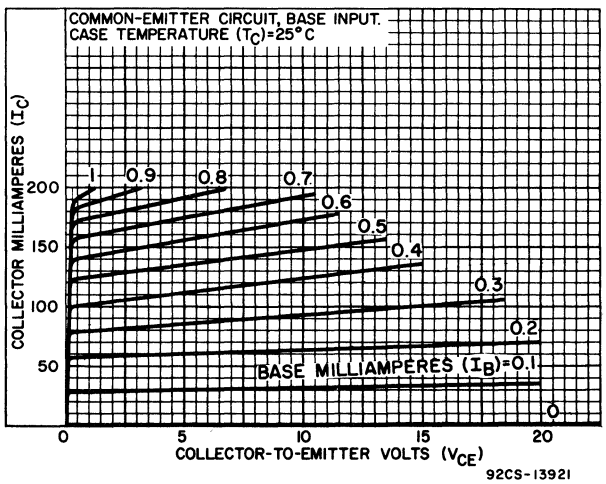


(b)

Fig.4 - I_C vs V_{CE} for 2N4074 and 40452.



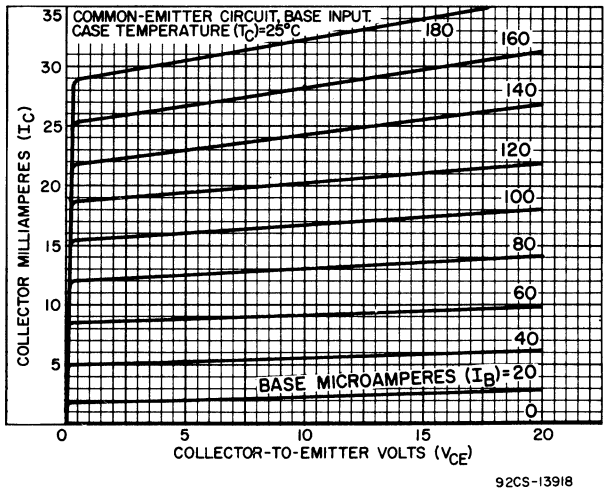
(a)



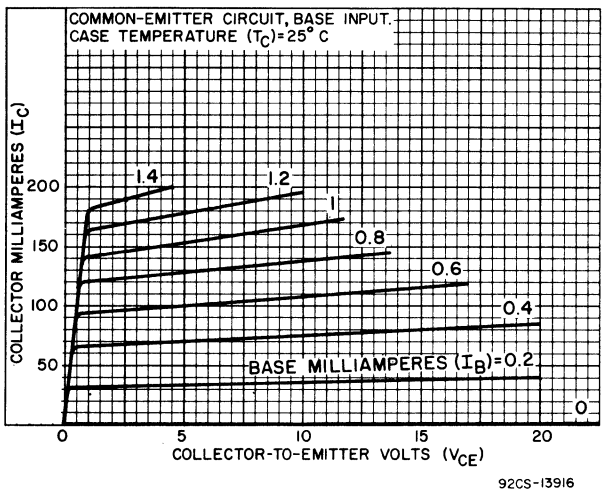
(b)

Fig.5 - I_C vs V_{CE} for 40397 and 40453.

TYPICAL COLLECTOR CHARACTERISTICS

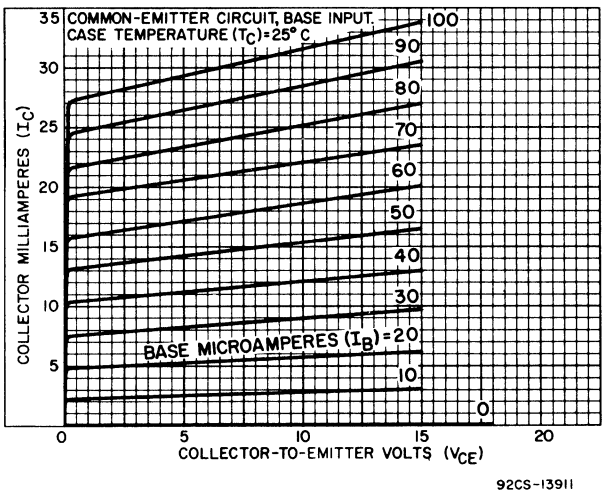


(a)

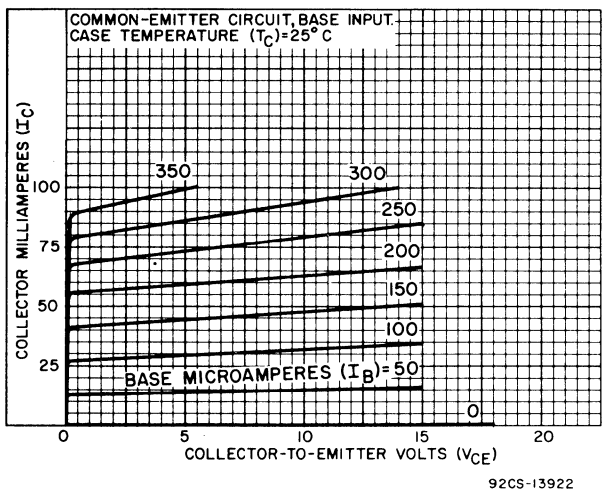


(b)

Fig.6 - I_C vs V_{CE} for 40398 and 40454.

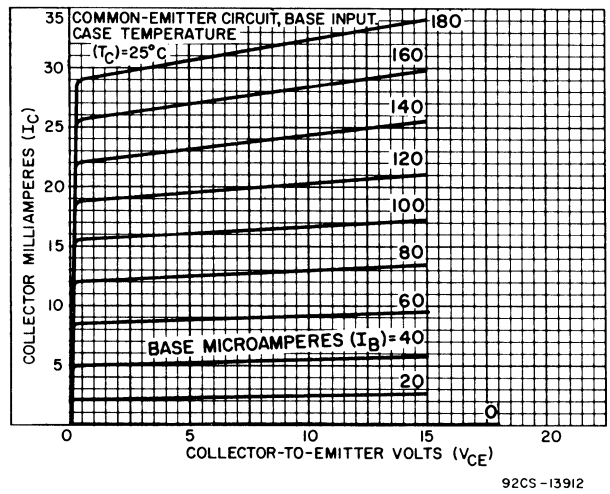


(a)

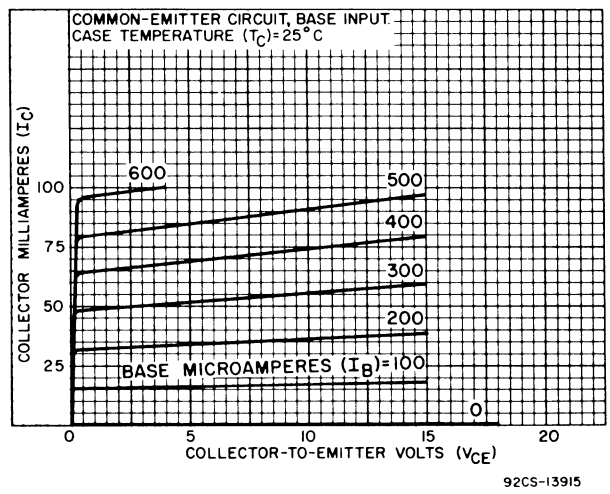


(b)

Fig.7 - I_C vs V_{CE} for 40399 and 40455.



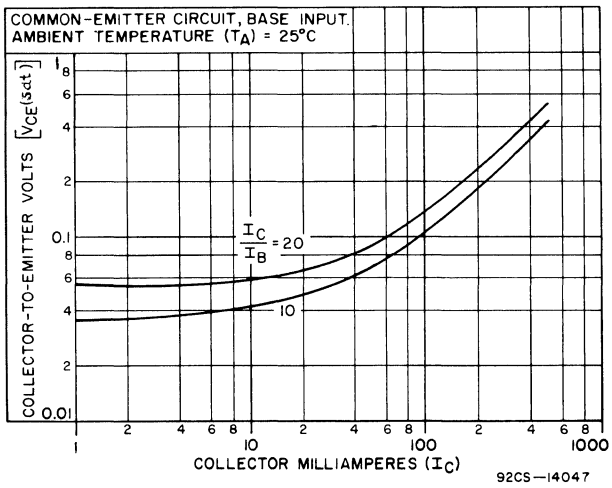
(a)



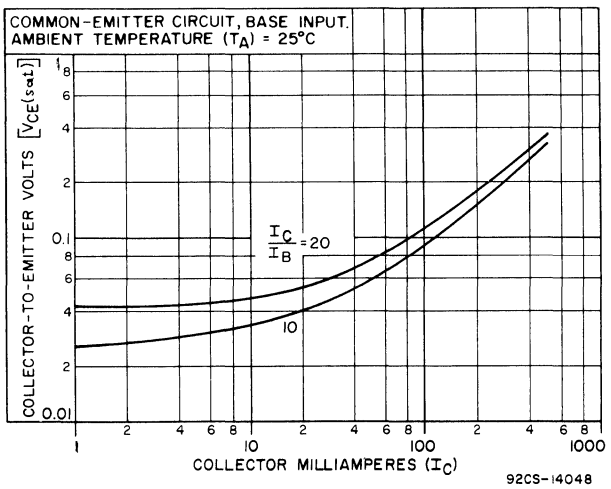
(b)

Fig.8 - I_C vs V_{CE} for 40400 and 40456.

TYPICAL CHARACTERISTICS

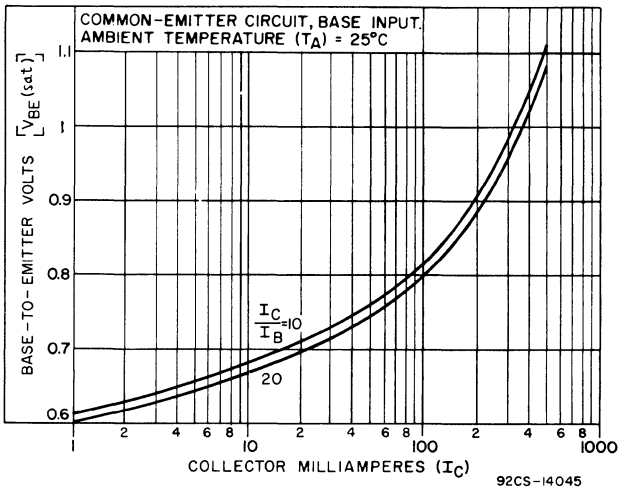


(a) $V_{CE}(sat)$ vs I_C for 2N3241A and 40450.

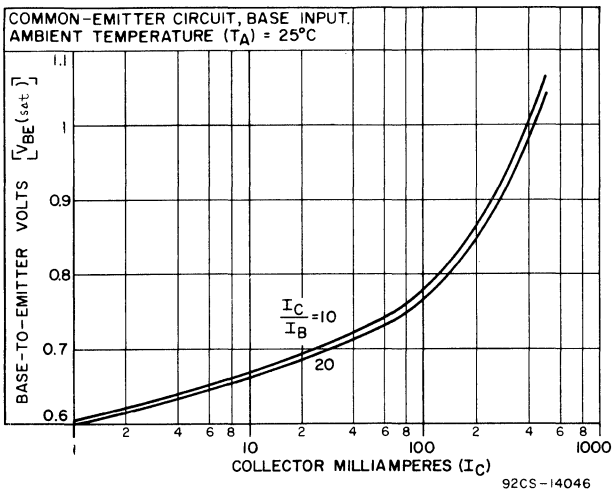


(b) $V_{CE}(sat)$ vs I_C for 2N3242A and 40451.

Fig.9 - Typical collector-saturation-voltage characteristics.



(a) $V_{BE}(sat)$ vs I_C for 2N3241A and 40450.



(b) $V_{BE}(sat)$ vs I_C for 2N3242A and 40451.

Fig.10 - Typical base-saturation-voltage characteristics.

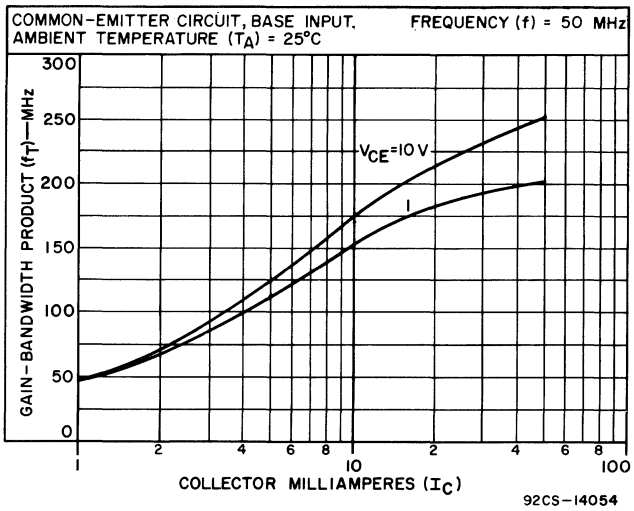
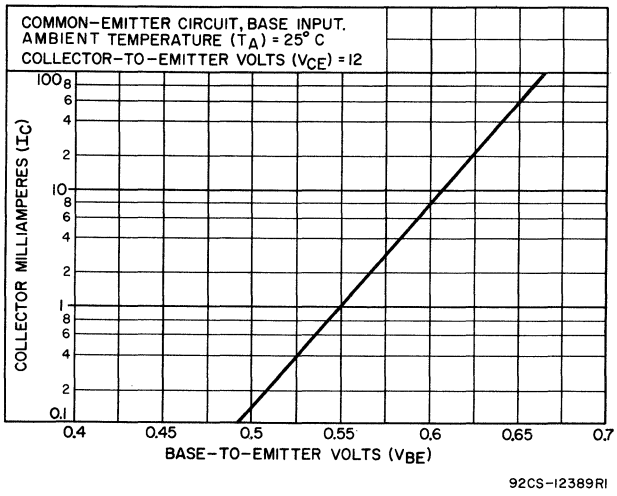
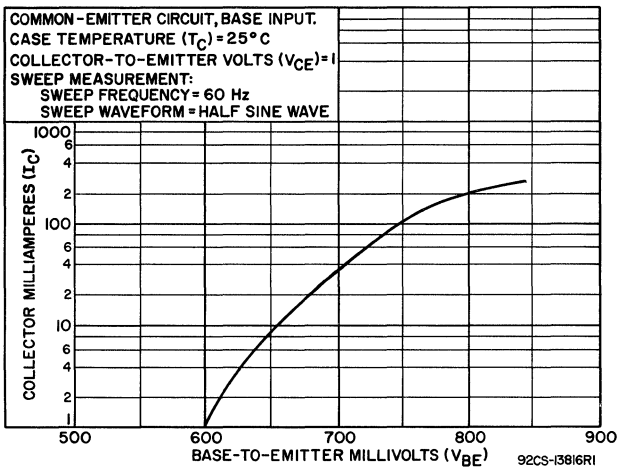


Fig.11 - Gain-bandwidth product vs collector current for types 2N3241A, 2N3242A, 40450, and 40451.

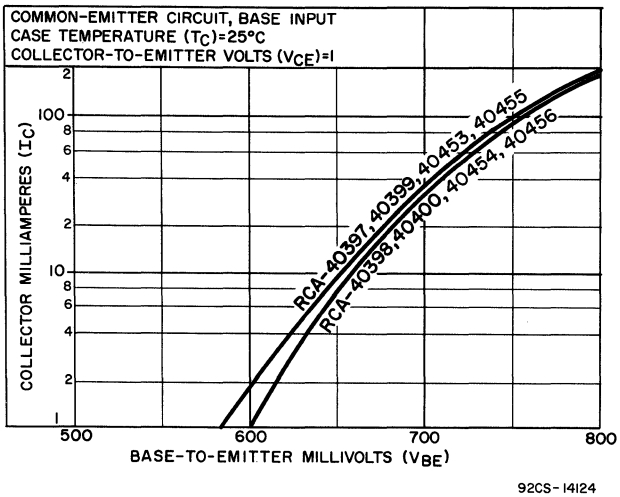
TYPICAL CHARACTERISTICS



(a) I_C vs V_{BE} for 2N3241A, 2N3242A, 40450, and 40451.

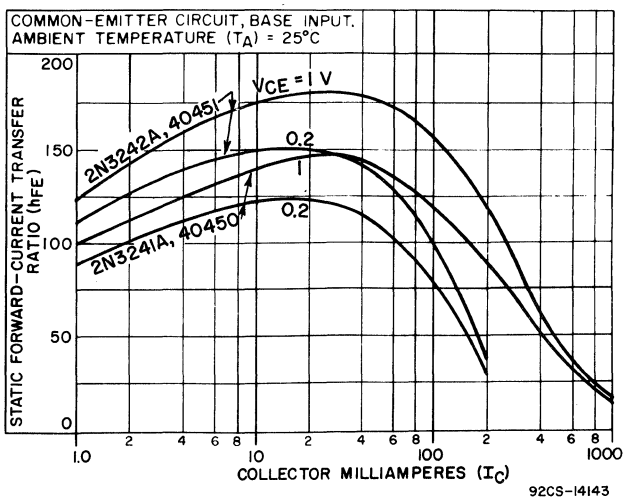


(b) I_C vs V_{BE} for 2N4074 and 40452.

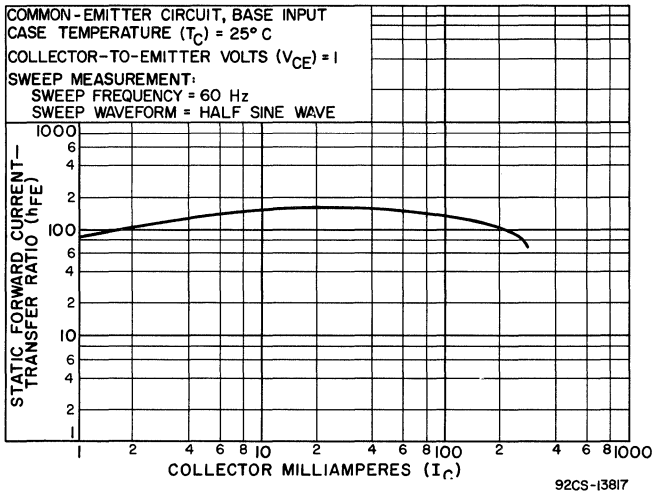


(c) I_C vs V_{BE} for 40397, 40398, 40399, 40400, 40453, 40454, 40455, and 40456.

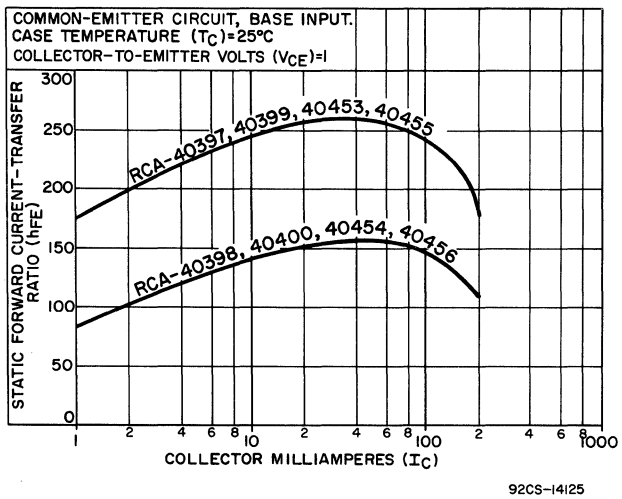
Fig.12 - Typical transfer characteristics.



(a) h_{FE} vs I_C for 2N3241A, 2N3242A, 40450, and 40451.



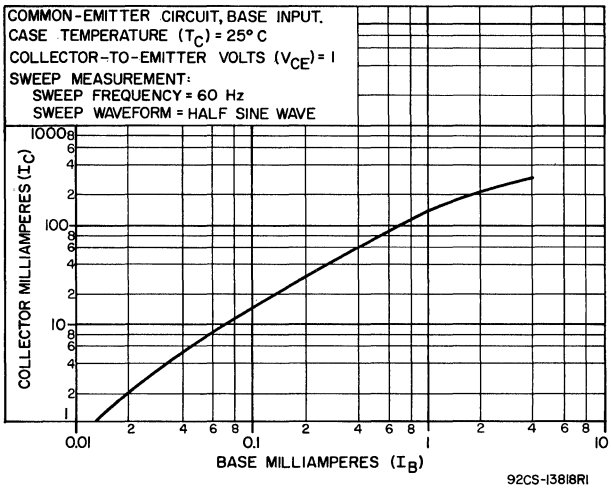
(b) h_{FE} vs I_C for 2N4074 and 40452.



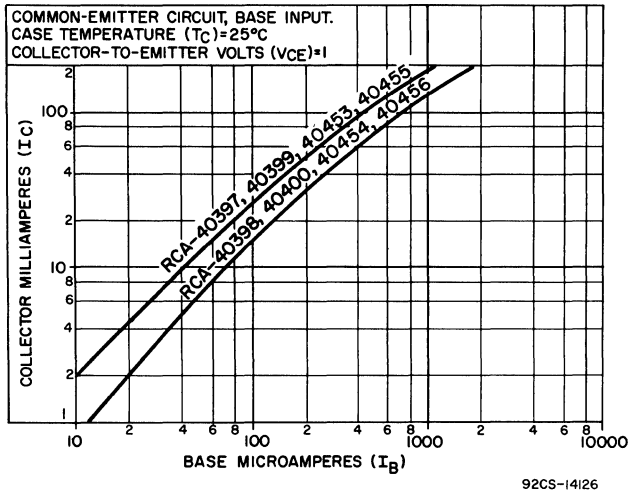
(c) h_{FE} vs I_C for 40397, 40398, 40399, 40400, 40453, 40454, 40455, and 40456.

Fig.13 - Typical static beta characteristics.

TYPICAL CHARACTERISTICS

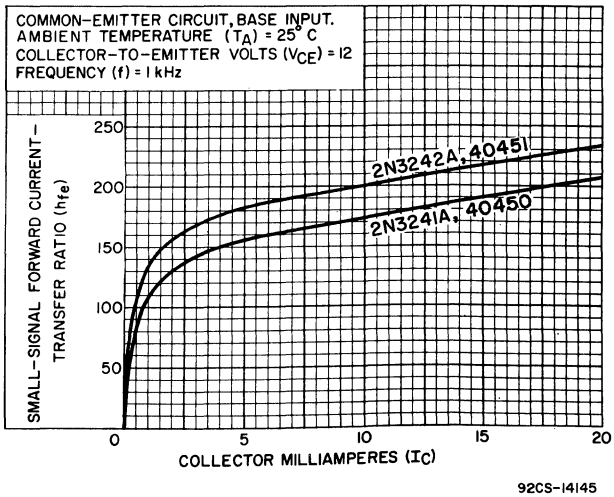


(a) I_C vs I_B for 2N4074 and 40452.

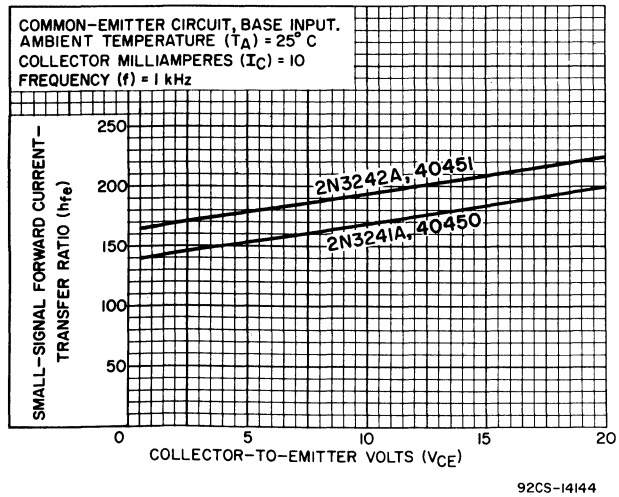


(b) I_C vs I_B for 40397, 40398, 40399, 40400, 40453, 40454, 40455, and 40456.

Fig.14 - Typical current-transfer characteristics.

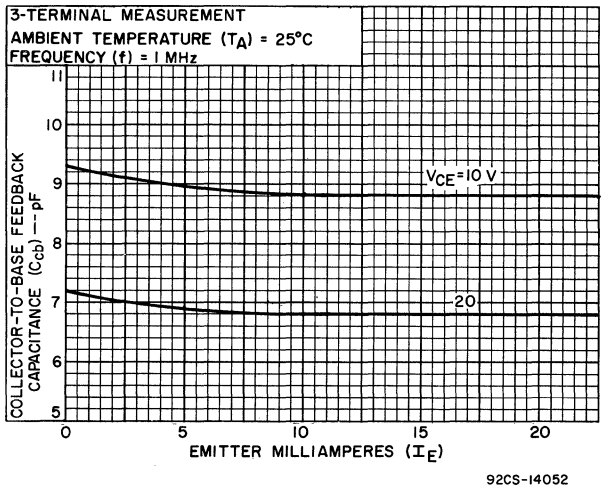


(a) h_{fe} vs I_C for 2N3241A, 2N3242A, 40450, and 40451.

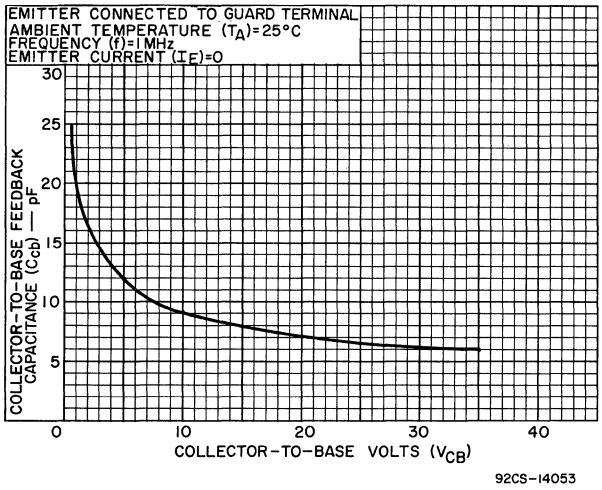


(b) h_{fe} vs V_{CE} for 2N3241A, 2N3242A, 40450, and 40451.

Fig.15 - Typical small-signal-beta characteristics.



(a) C_{cb} vs I_E for 2N3241A, 2N3242A, 40450, and 40451.



(b) C_{cb} vs V_{CB} for 2N3241A, 2N3242A, 40450, and 40451.

Fig.16 - Typical feedback-capacitance characteristics.

TYPICAL SWITCHING CHARACTERISTICS FOR TYPES 2N3241A, 2N3242A, 40450, 40451

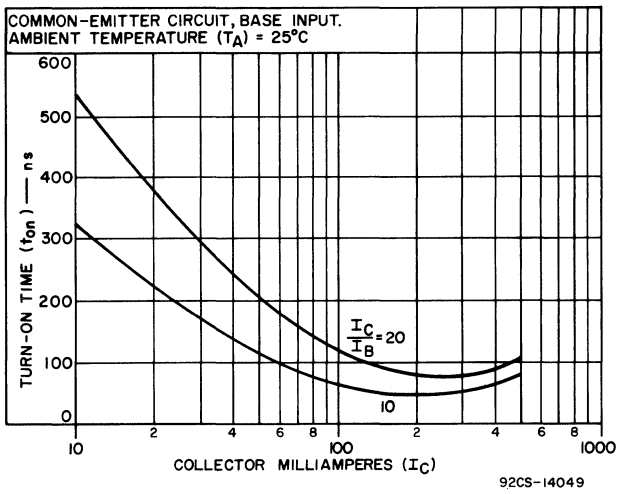


Fig.17 - "Turn-on" characteristics.

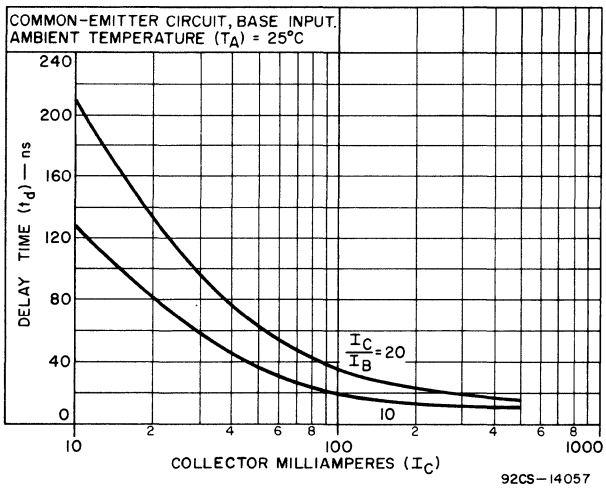


Fig.18 - Delay time vs collector current.

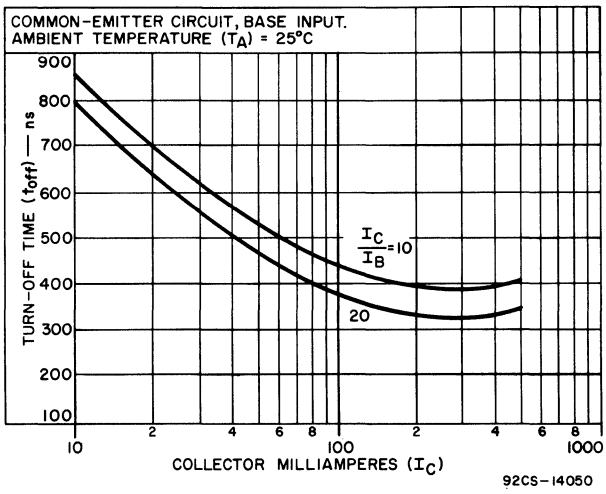


Fig.19 - "Turn-off" characteristics.

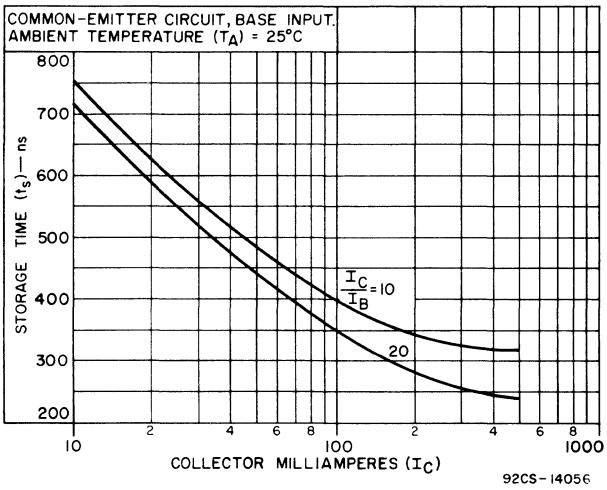
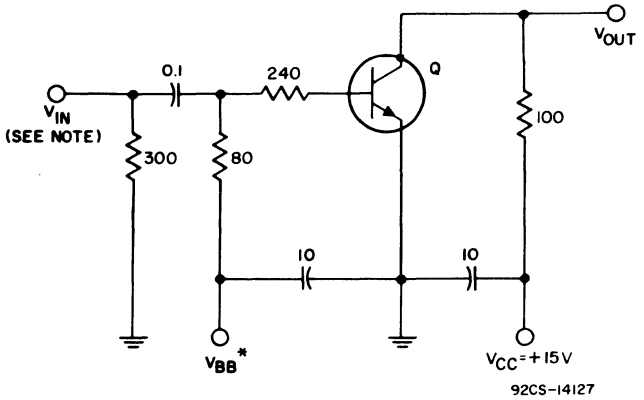
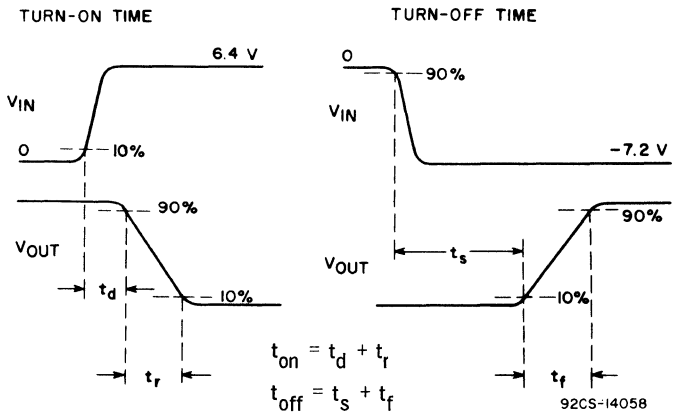


Fig.20 - Storage time vs collector current.

SWITCHING CHARACTERISTICS AT T_A = 25°C (Measured in Test Circuit shown in Fig.21)

Characteristics	Symbols	TEST CONDITIONS				MAX. VALUES
		"Off" Base-to-Emitter Voltage $V_{BE(off)}$	"Turn-On" Base Current I_{B1}	"On" Collector Current I_C	"Turn-Off" Base Current I_{B2}	Types 2N3241A, 2N3242A 40450, 40451
		V	mA	mA	mA	ns
Turn-On Time	t_{on}					
Delay Time	t_d	-2	15	150	-	25
Rise Time	t_r	-2	15	150	-	50
Turn-Off Time	t_{off}					
Storage Time	t_s	-	15	150	-15	500
Fall Time	t_f	-	15	150	-15	75



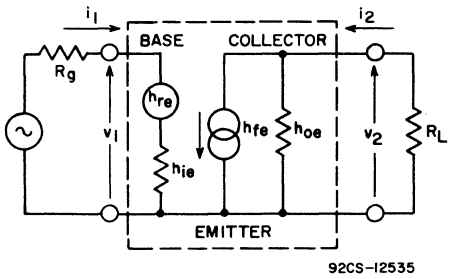


Note: V_{IN} rise time $\leq$ 1 ns, pulse width $\geq$ 100 ns, duty factor $\leq$ 0.02. Resistance values in ohms, capacitance values in μF.

* For t_{on} Test V_{BB} = -2 V
For t_{off} Test V_{BB} = +5.6 V

Q = Types 2N3241A, 2N3242A, 40450 or 40451

Fig.21 - Turn-on and turn-off-time test circuit and waveforms for types 2N3241A, 2N3242A, 40450, and 40451.



$$\text{Input Resistance} = \frac{v_1}{i_1} = \frac{h_{ie} + (\Delta^h R_L)}{1 + (h_{oe} R_L)}$$

$$\text{Output Resistance} = \frac{v_2}{i_2} = \frac{h_{ie} + R_g}{\Delta h + (h_{oe} R_g)}$$

$$\text{Forward Current-Transfer Ratio} = \frac{i_2}{i_1} = \frac{h_{fe}}{1 + (h_{oe} R_L)}$$

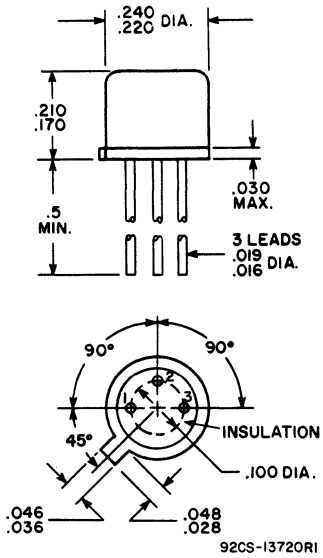
$$\text{Forward Voltage-Transfer Ratio} = \frac{V_2}{V_1} = \frac{-h_{fe} R_L}{h_{ie} + (\Delta^h R_L)}$$

V_1 = ac input signal voltage
i_1 = ac base current
V_2 = ac output signal voltage
i_2 = ac collector current
h_{ie} = small-signal short-circuit input impedance
h_{oe} = small-signal open-circuit output admittance
h_{re} = small-signal open-circuit reverse voltage-transfer ratio
h_{fe} = small-signal short-circuit forward current-transfer ratio
Δ^h = $(h_{ie}h_{oe}) - (h_{re}h_{fe})$
R_g = generator resistance
R_L = load resistance

Fig.22 - Low-frequency small-signal equivalent circuit of 2N3241A, 2N3242A, 2N4074, 40397, 40398, 40399, 40400, 40450, 40451, 40452, 40453, 40454, 40455, and 40456.

DIMENSIONAL OUTLINE

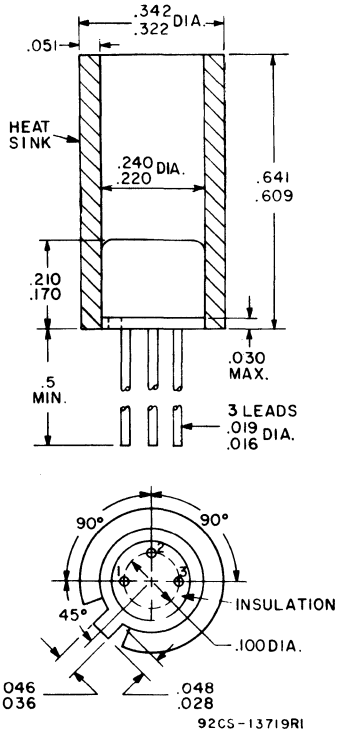
For types 2N3241A, 2N3242A, 2N4074, 40397, 40398, 40399, and 40400



Dimensions in Inches

DIMENSIONAL OUTLINE

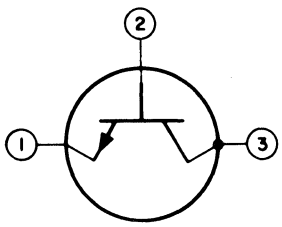
For types 40450, 40451, 40452, 40453, 40454, 40455, and 40456



Dimensions in Inches

TERMINAL DIAGRAM

For 2N3241A, 2N3242A, 2N4074, 40397, 40398, 40399, 40400, 40450, 40451, 40452, 40453, 40454, 40455, and 40456

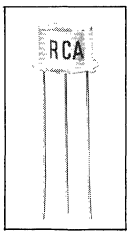


Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector, Case

SILICON N-P-N HIGH-SPEED TRANSISTOR



JEDEC TO-52

Planar Epitaxial Type For Switching Applications In Military and Commercial Data-Processing Equipment

RCA 2N3261▲ is a planar epitaxial transistor of the silicon NPN type with exceptional versatility for computer applications. It is capable of high switching speed over an unusually wide range of collector current – a capability which makes it especially useful in very fast digital-logic circuits operating at low-to-moderate power levels, in terminated-line-driver service, and as a very high-speed memory driver.

The sophisticated structure of the 2N3261 provides a high ratio of emitter periphery-to-emitter area and low input and output capacitances, as well as high current-handling capability; features contributing to the outstanding performance of the 2N3261. Its precisely controlled internal dimensions also provide very desirable static characteristics such as: low cutoff currents, low saturation voltages, and high dc betas.

The 2N3261 is hermetically sealed in the compact JEDEC TO-52 package.

SWITCHING SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR TO BASE VOLTAGE V_{CBO}	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	6 max.	volts
COLLECTOR CURRENT, I_C	500 max.	ma
TRANSISTOR DISSIPATION, P_T:		
For case temperatures[a] up to 25° C	1 max.	watt
For case temperatures[a] above 25° C	derate at 6.7	mW/°C
For free-air temperatures up to 25° C	0.3 max.	watt
For free-air temperatures above 25° C	derate at 2	mW/°C
TEMPERATURE RANGE:		
Storage	−65 to +200	°C
Operating	−65 to +175	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥1/16" from seating surface for 10 seconds max.	230 max.	°C

[a]Measured at center of seating surface.

▲Formerly developmental No. TA-2332.

Features:

- high switching speeds at high currents
  t_{on} = 9 nsec, t_{off} = 11 nsec (typ)
  @ I_C = 100 ma, $I_{B1} = -I_{B2}$ = 10 ma
- low saturation voltages:
  $V_{CE(sat)}$ = 0.35 volt max. at I_C = 100 ma
  $V_{BE(sat)}$ = 1.1 volts max. at I_C = 100 ma
- low cutoff currents:
  I_{CEV} = 25 na max.
  I_{BEV} = −25 na max.
- low input and output capacitances
  C_{ib} = 4.0 pf max.
  C_{ob} = 3.5 pf max.
- wide operating temperature range
  −65 to +175°C
- high pulsed DC beta at high collector current:
  h_{FE} = 20 min at I_C = 200 ma.
- high small-signal beta at high frequencies
  $|h_{fe}|$ = 6 min at f = 100 Mc, I_C = 10 ma

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Printed in U.S.A.
2N3261 8-66
Supersedes Issue dated 4-65

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS			Units
		Free-Air Temperature T_{FA}	Frequency f	DC Collector-to-Emitter Voltage V_{CE}	DC Collector-to-Base Voltage V_{CB}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N3261			
		°C	Mc	volts	volts	volts	ma	ma	ma	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CEV}	25 150		15 15		0 0				– –	5 6.5	25 25	na μa
Base-Cutoff Current	I_{BEV}	25		15		0				–	–5	–25	na
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.01		40	–	–	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	25						10	0	15*	–	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.01	0		6	–	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25						100	10	–	0.28*	0.35*	volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25						100	10	0.8	0.93	1.1	volts
Static Forward Current-Transfer Ratio	h_{FE}	25 25 25 –55		1 1 1 1				10 100 200 10		40 30* 20* 20	60 50* 35* 35	150 – – –	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\lvert h_{fe} \rvert$	25 25	100 100	1 10				100 10		3 6	4.4 8.3	– –	
Common-Base, Open-Circuit Output Capacitance	C_{ob}	25	1		5		0			–	2.8	3.5	pf
Common-Base, Open-Circuit Input Capacitance	C_{ib}	25	1			0.5		0		–	3	4	pf
(See Fig. 1)					V_{CC} volts	$V_{BE(off)}$ volts	I_{B1} ma	I_{CS} ma	I_{B2} ma				
Delay Time	t_d	25			6	–4	10	100	–10	–	4	6	ns
Rise Time	t_r	25			6	–4	10	100	–10	–	4.8	7	ns
(See Fig. 1) Storage Time	t_s	25			6	–	10	100	–10	–	7	10	ns
Fall Time	t_f	25			6	–	10	100	–10	–	3.5	6	ns
Storage Time (See Fig. 2)	t_s	25			10	–	10	10	–10	–	6	10	ns

* Pulse Test: Pulse duration ≤ 100 μsec, Duty Factor ≤ 0.02

TYPICAL SWITCHING CHARACTERISTICS

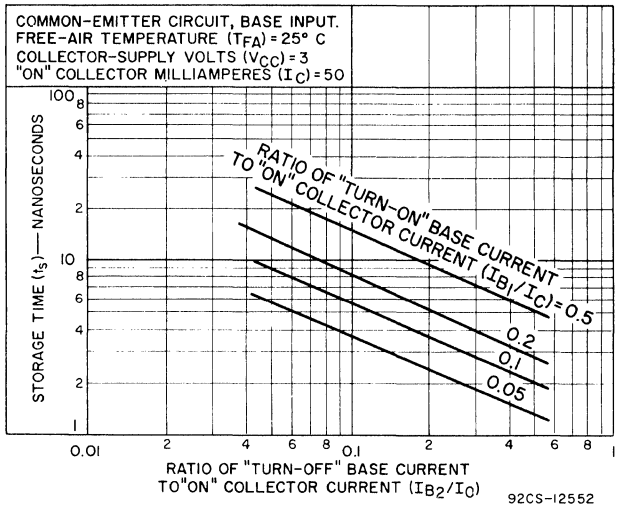


Fig.7 - Storage Time

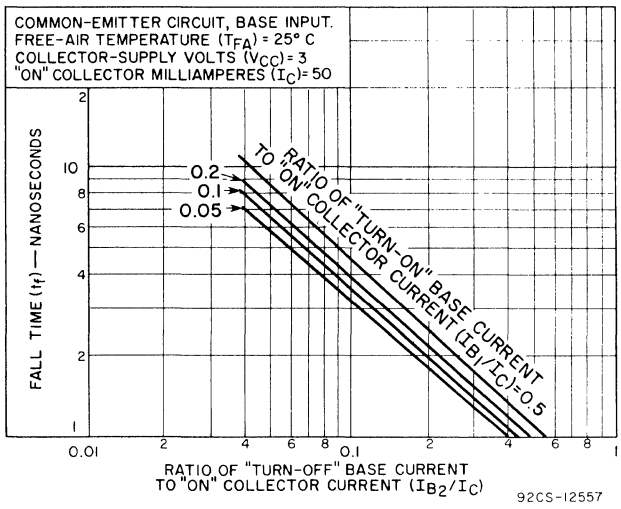


Fig.8 - Fall Time

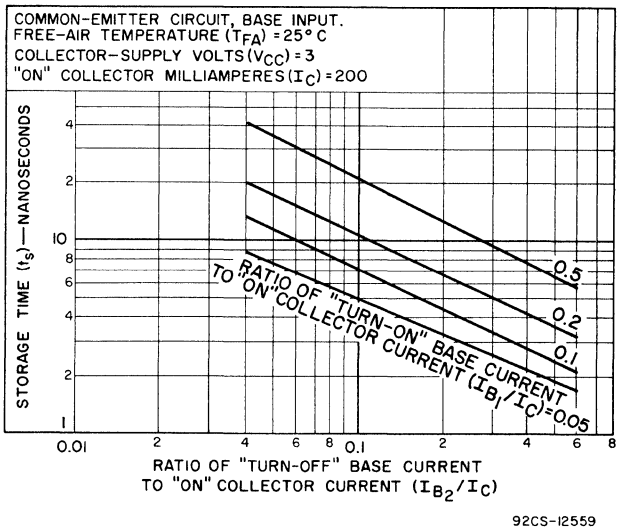


Fig.9 - Storage Time

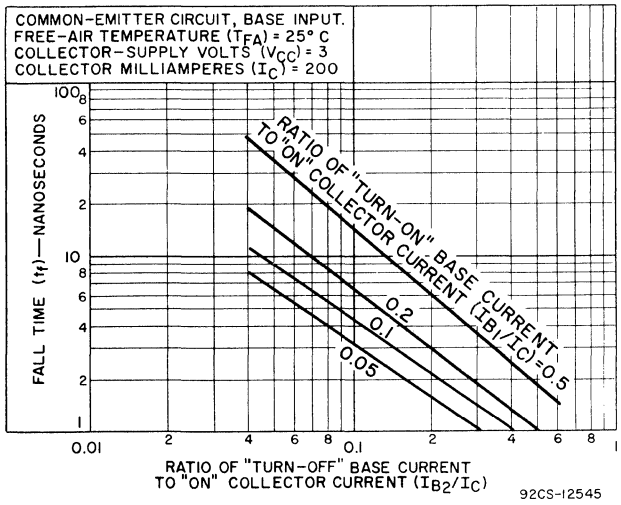


Fig.10 - Fall Time

TYPICAL CHARACTERISTICS

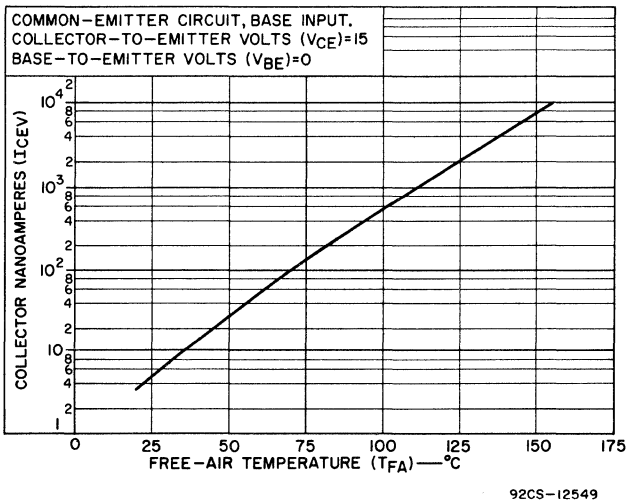


Fig.11 - I_{CEV} vs Temperature

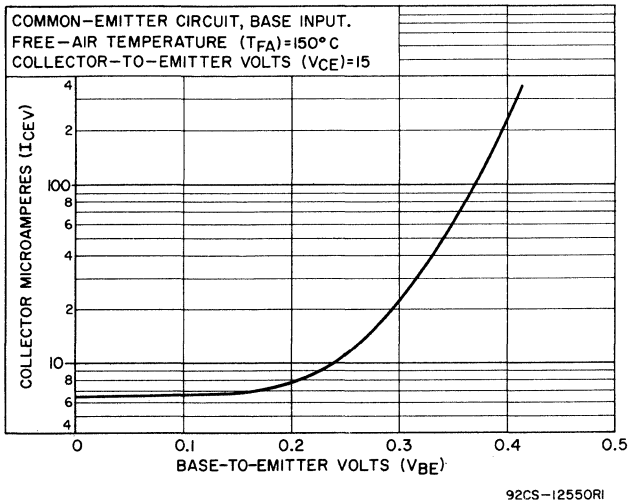


Fig.12 - I_{CEV} vs V_{BE}

TYPICAL CHARACTERISTICS

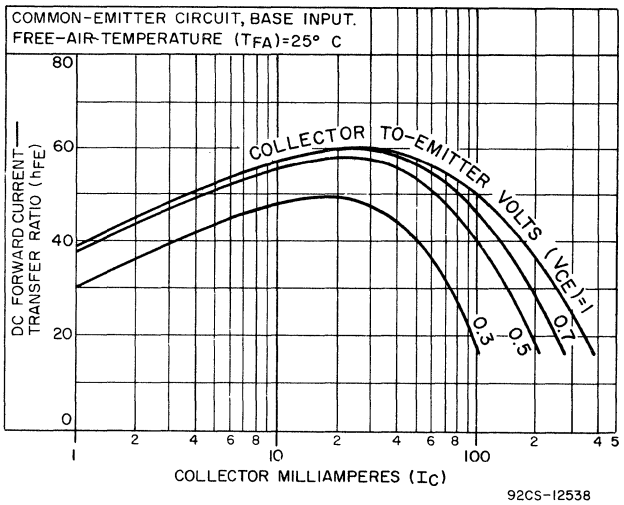


Fig.13 - h_{FE} vs I_C

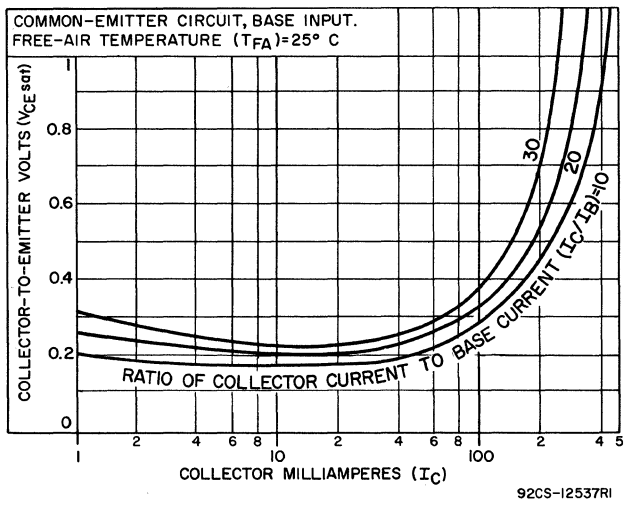


Fig.14 - $V_{CE(sat)}$ vs I_C

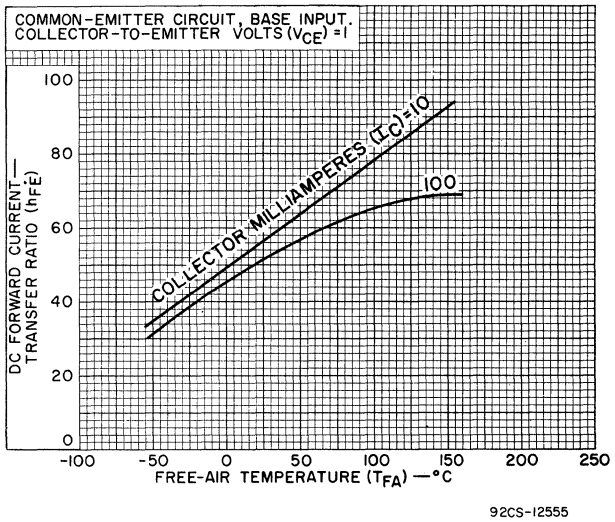


Fig.15 - h_{FE} vs Temperature

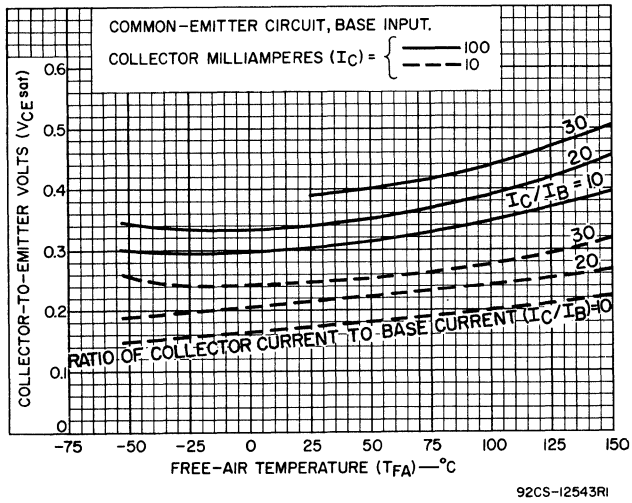


Fig.16 - $V_{CE(sat)}$ vs Temperature

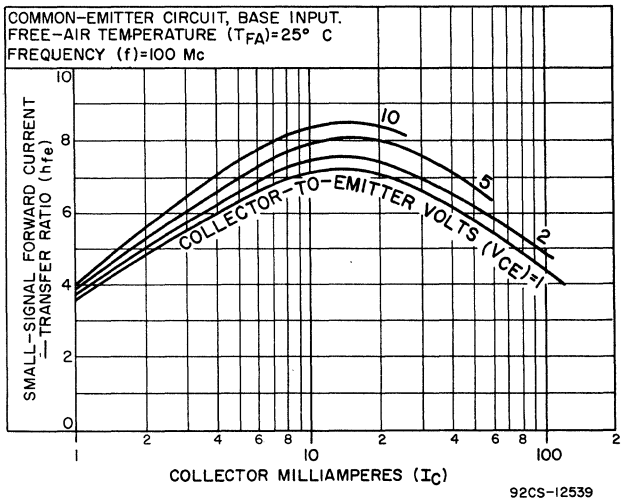


Fig.17 - 100 Mc h_{fe} vs I_C

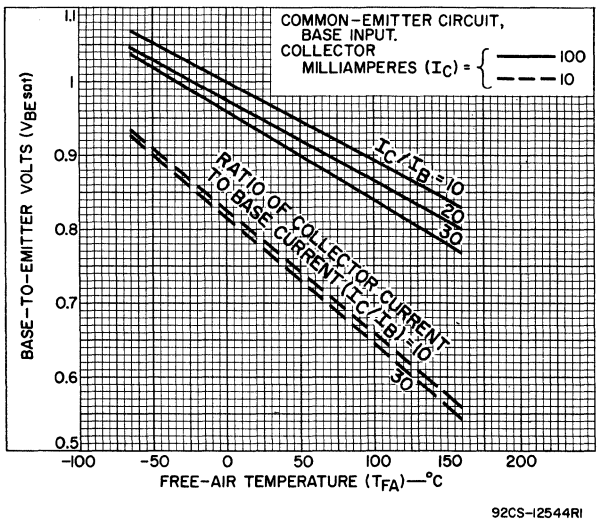
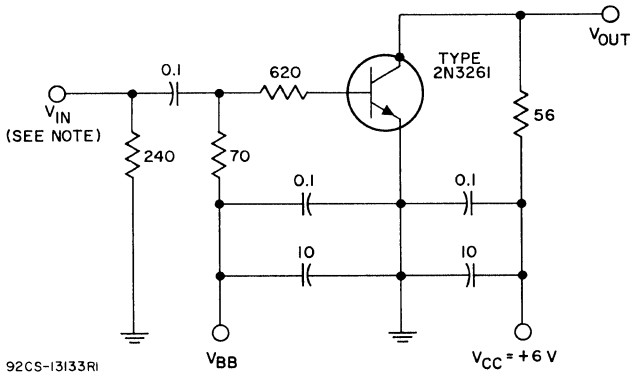
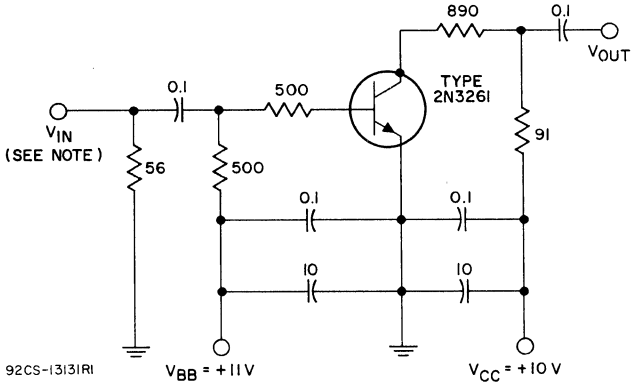


Fig.18 - $V_{BE(sat)}$ vs Temperature





Note: V_{IN} rise time $\leq$ 1 nsec, pulse width $\geq$ 100 nsec, duty cycle $\leq$ 2%, Resistance values in ohms, Capacitance values in μf.

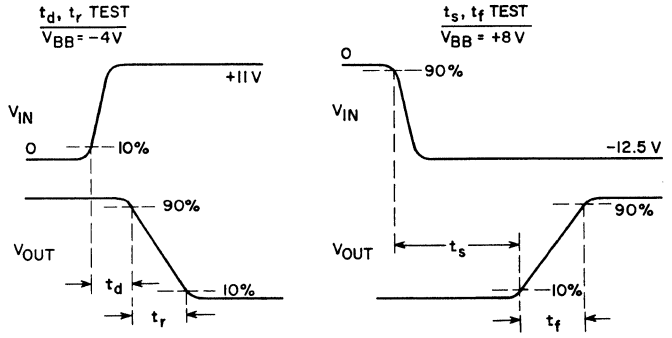


Fig.1 - Switching Time Test Circuit

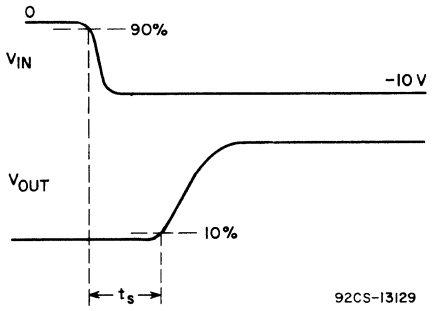


Fig.2 - Storage Time Test Circuit

TYPICAL SWITCHING CHARACTERISTICS

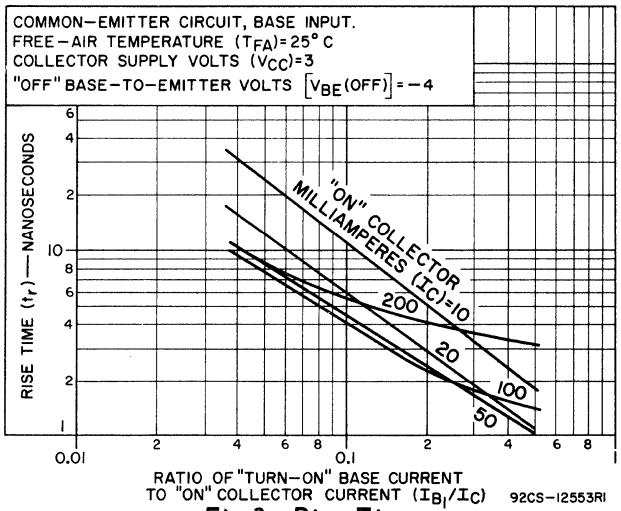


Fig.3 - Rise Time

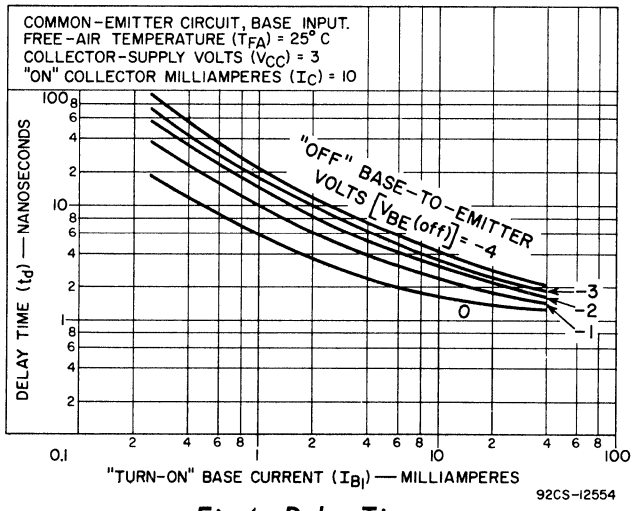


Fig.4 - Delay Time

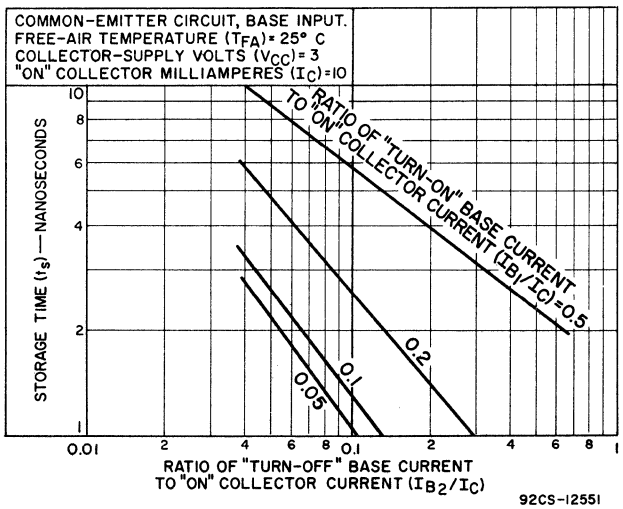


Fig.5 - Storage Time

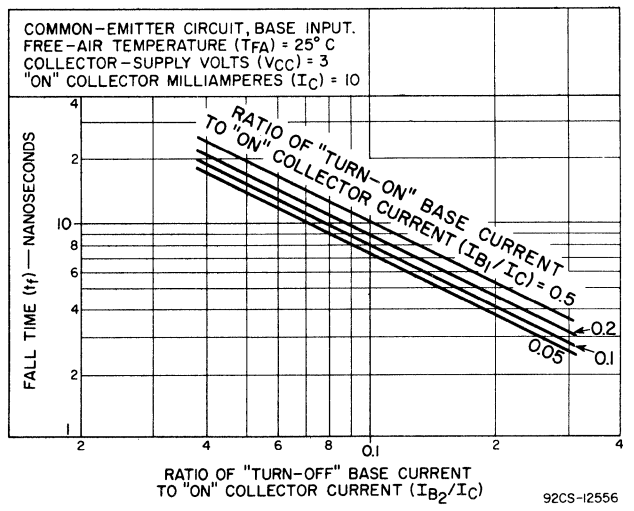


Fig.6 - Fall Time

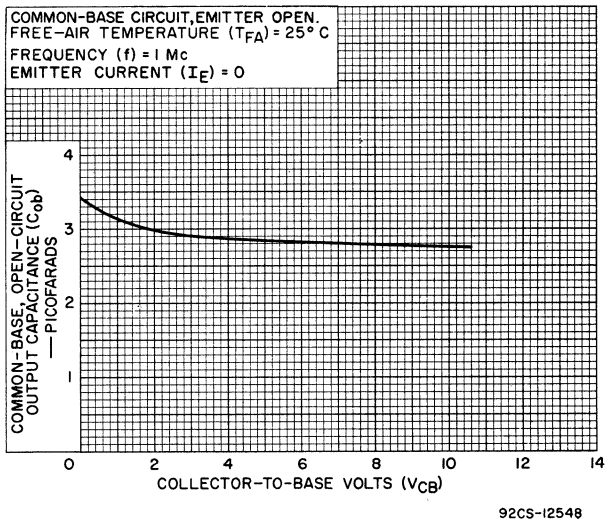


Fig.19 - Output Capacitance

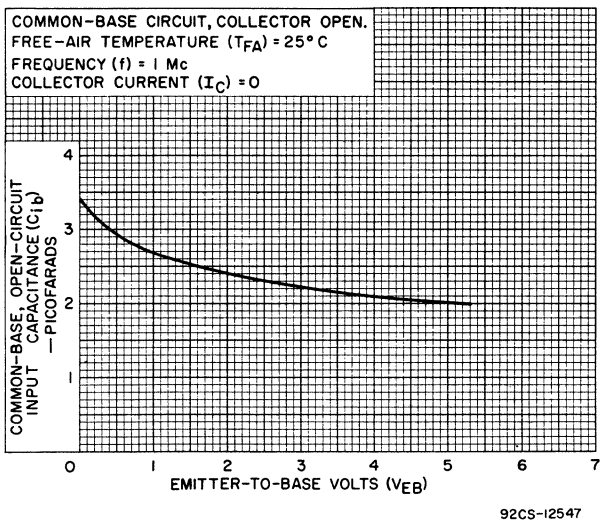


Fig.20 - Input Capacitance

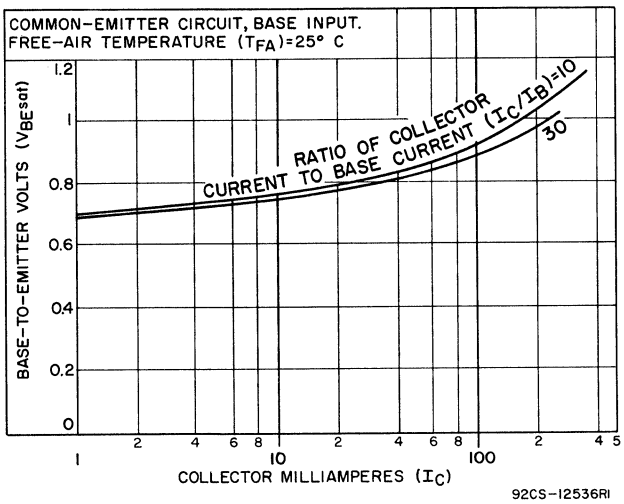
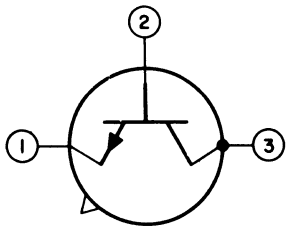


Fig.21 - $V_{BE(sat)}$ vs I_C

TERMINAL DIAGRAM

Bottom View



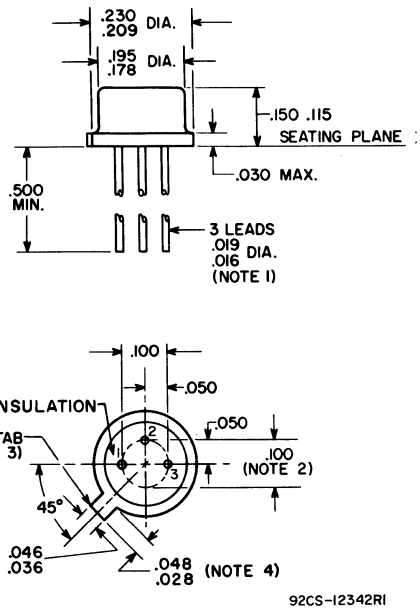
LEAD 1 – EMITTER

LEAD 2 – BASE

LEAD 3 – COLLECTOR, CASE

DIMENSIONAL OUTLINE

JEDEC No. TO-52



Dimensions in Inches

Note 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050 INCH AND 0.250 INCH FROM THE SEATING PLANE. BETWEEN 0.250 INCH AND 0.500 INCH OF THE LEAD, A MAXIMUM DIAMETER OF 0.021 INCH IS HELD. OUTSIDE THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: LEADS HAVING MAXIMUM DIAMETER (0.019 INCH) MEASURED IN GAUGING PLANE 0.054 INCH + 0.001 INCH–0.000 INCH BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007 INCH OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM–WIDTH TAB.

NOTE 3: INDEX TAB FOR VISUAL ORIENTATION ONLY.

NOTE 4: MEASURED FROM MAXIMUM DIAMETER OF ACTUAL DEVICE.

SILICON N-P-N PLANAR TRANSISTOR

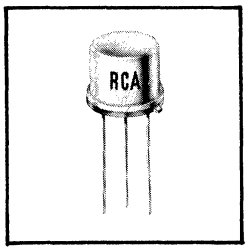
2N3262

File No. 56

RCA-2N3262 is a triple-diffused planar transistor of the silicon n-p-n type intended for high-voltage, high-frequency pulse amplifiers and high-voltage saturated switches in military and industrial equipment. The high-current switching capability of the 2N3262 makes it especially suitable for memory-core driver applications.

The 2N3262 utilizes the JEDEC TO-39 package which is identical to the JEDEC TO-5 package except its leads have a minimum length of 0.5".

For High-Voltage, High-Speed Switching and Pulse-Amplifier Applications



JEDEC TO-39

- High Voltage Ratings —
- Fast Rise Time at High Collector Currents— 20 nsec rise time (max.) at I ampere
- High Power Dissipation —
- Low Collector to Emitter Saturation Voltage at High Collector Currents— 0.6 volts (max.) at I ampere

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO}	100 max.	volts
Collector-to-Emitter Voltage		
Reverse bias, V_{CEX} For V_{EB} = 1.5 volts	100 max.	volts
With base open (sustaining voltage), $V_{CEO(sus)}$	80 max.	volts
Emitter-to-Base Voltage, V_{EBO}	4 max.	volts
Collector Current, I_C	1.5 max.	amperes
Transistor Dissipation, P_T:		
At case temperatures up to 25° C	8.75 max.	watts
At case temperatures above 25° C	Derate linearly (50 mw/°C) to 175° C	
At free-air temperatures up to 25° C	1 max.	watt
At free-air temperatures above 25° C	Derate linearly (5.71 mw/°C) to 175° C	
Temperature Range:		
Storage	-65 to +200	°C
Operating (Junction)	-65 to +200	°C
Lead Temperature:		
1/16" ± 1/32" from seating surface for 10 sec. max.	230	°C

Electrical Characteristics, *Case Temperature = 25° C Unless Otherwise Specified*

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Emitter Volts	DC Current (Milliamperes)			Min.	Max.	
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C			
Collector-Cutoff Current at T_{FA} = 25° C	I_{CBO}	30			0				0.1	μa
Emitter-Cutoff Current	I_{EBO}			3			0		100	μa
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance (R_{BE}) = 10 ohms	$V_{CER(sus)}$						500*	90		volts
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$					0	500*	80		volts
Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}			1.5			0.25	100		volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4		volts
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$					100	1000		1.4	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					100	1000		0.6	volts
DC Forward Current Transfer Ratio	h_{FE}		4				500	40		
Input Capacitance (at 1 Mc)	C_{ib}			3			0		300	pf
Feedback Capacitance (at 1 Mc)	$C_{b'c}$	28					0		20	pf
Pulse-Amplifier Rise Time (See Figs. 13 & 14)	t_r		V_{cc}=80				25		20	nsec
Sat. Switch Turn-On Time— Delay Time + Rise Time (See Figs. 8 & 10)	t_{on}		28		I_{B1}=I_{B2} =100		1000		40	nsec
Sat. Switch Turn-Off Time— Storage + Fall Time (See Figs. 8 & 10)	t_{off}		28		I_{B1}=I_{B2} = 100				750	nsec
Forward Current Transfer Ratio (at 50 Mc)	h_{fe}		28				100	3		

* Pulsed; pulse duration = 15 μsec; duty factor = 0.15%.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3262 5/66
Reprinted from 2N3262 3/64

TYPICAL TRANSFER CHARACTERISTICS

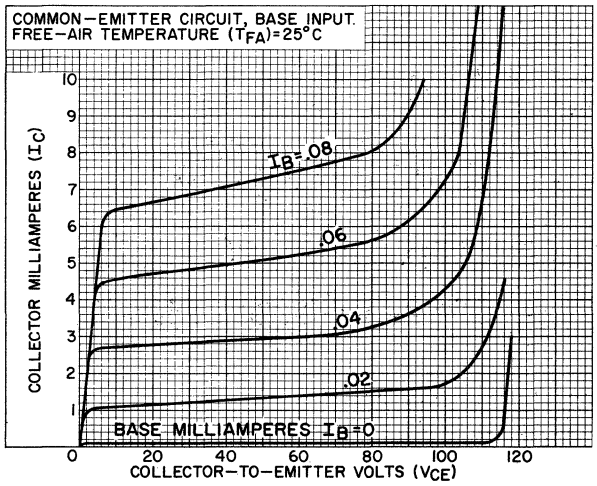


Fig. 1

TYPICAL OPERATION CHARACTERISTICS

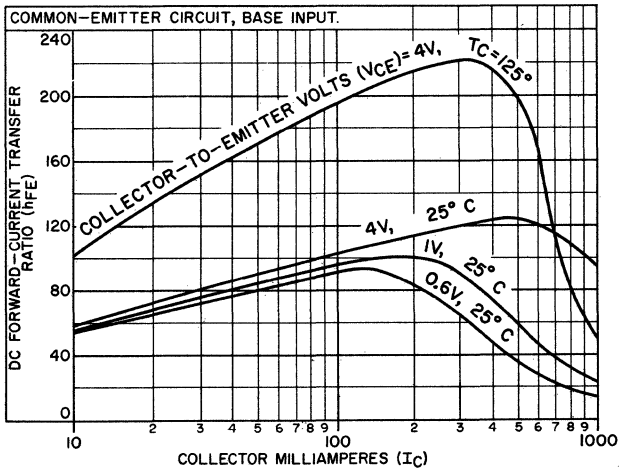


Fig. 2

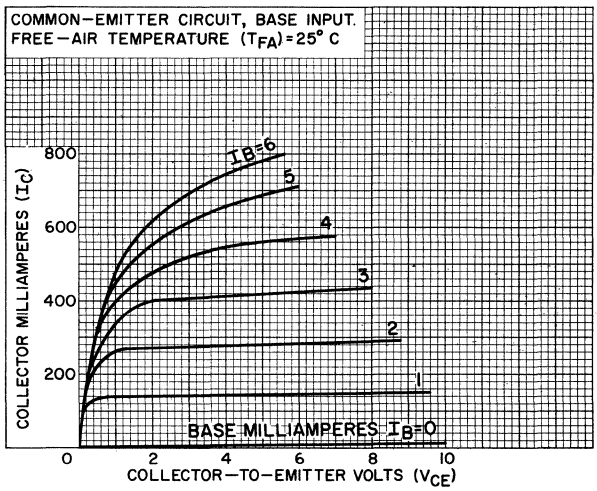


Fig. 3

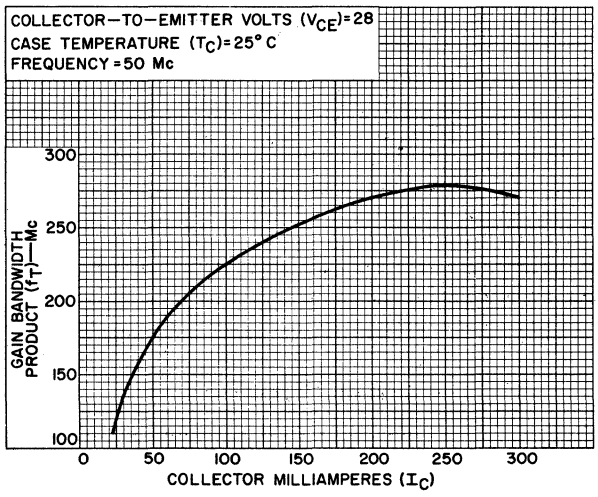


Fig. 4

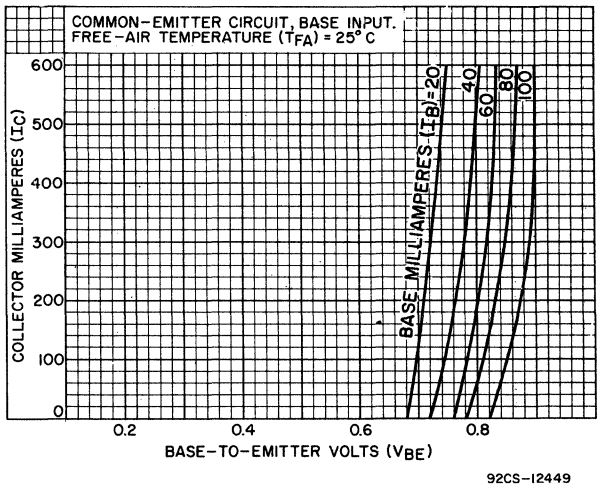


Fig. 5

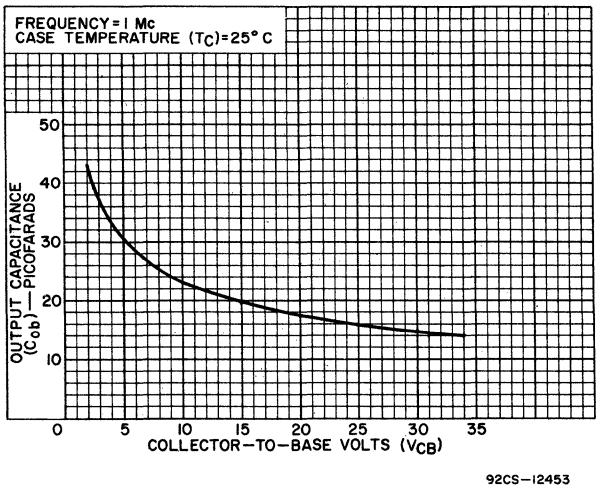


Fig. 6

TYPICAL SATURATED-SWITCHING CHARACTERISTICS AND TEST CIRCUIT

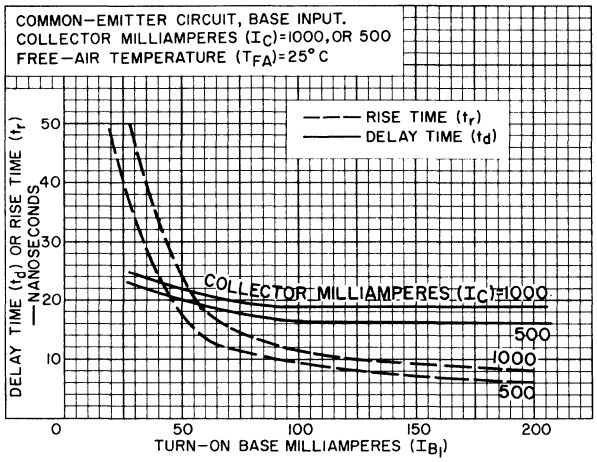
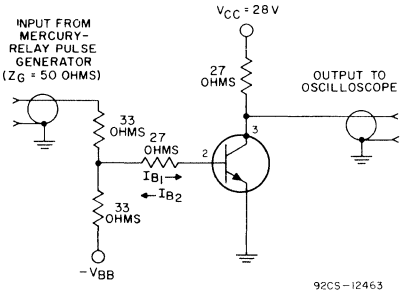


Fig.7

CIRCUIT USED TO MEASURE t_{on} AND t_{off} FOR OPERATION AS A SATURATED SWITCH



INPUT PULSE:

t_r < 3 nsec | REP. RATE = 120 CPS
t_f < 10 nsec | PULSE WIDTH = 300 μsec

Fig. 8

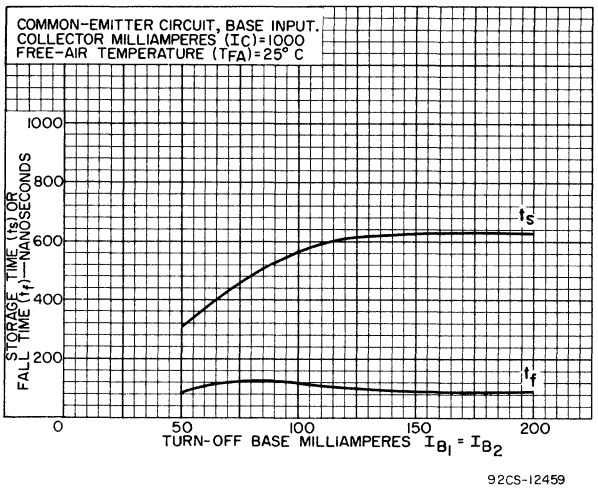
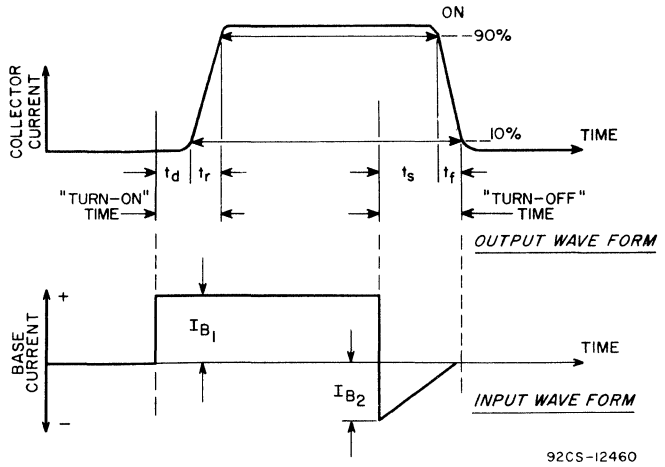


Fig.9

WAVE FORMS FOR SATURATED SWITCH CIRCUIT



I_{B_1} = 100 ma | t_{on} = 40 nsec
I_{B_2} = -100 ma | t_{off} = 750 nsec
I_C = 1 amp

Fig.10

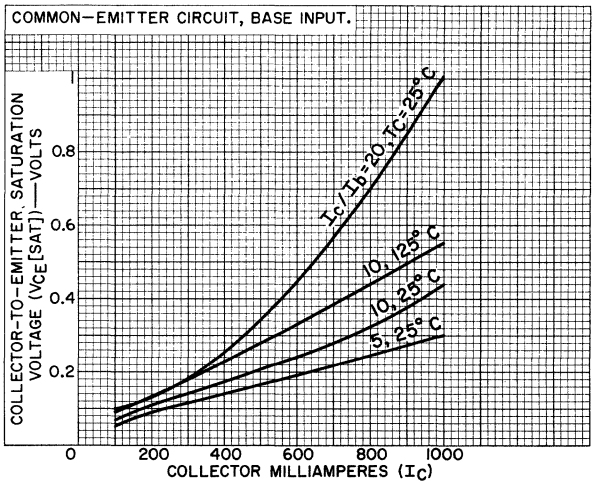


Fig.11

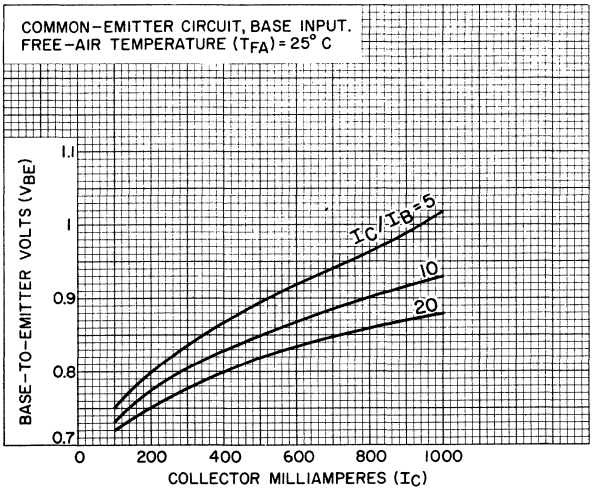
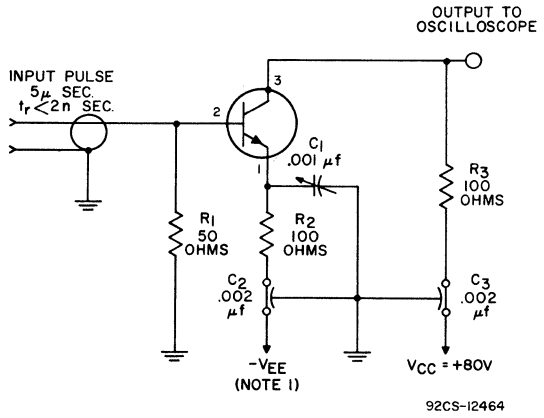


Fig.12

PULSE-AMPLIFIER TEST CIRCUIT



NOTE 1: V_{EE} ADJUSTED FOR I_E = 35 ma WITH NO INPUT.

Fig.13

WAVE FORM FOR PULSE-AMPLIFIER TEST CIRCUIT

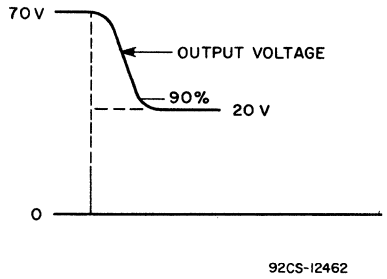
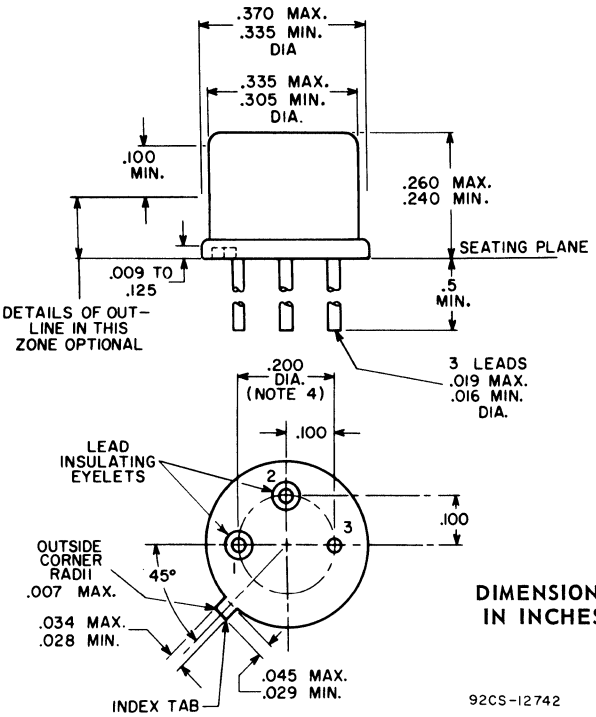


Fig.14

DIMENSIONAL OUTLINE
JEDEC TO-39



DIMENSIONS IN INCHES

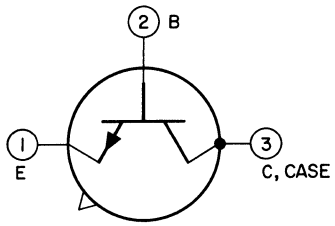
NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED 0.010".

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE SEATING PLANE. BETWEEN 0.250" AND 1.5", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER (0.019") MEASURED IN GAUGING PLANE OF 0.054" + 0.001" − 0.000" BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN 0.007" OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

TERMINAL DIAGRAM



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR, CASE

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RCA POWER TRANSISTORS

2N3263 2N3264 2N3265 2N3266

RCA-2N3263, 2N3264, 2N3265, and 2N3266* are epitaxial silicon power transistors of the n-p-n type designed for aerospace, military, and industrial equipment where high reliability is required. The high current-handling capability of these transistors in conjunction with fast switching speed make them especially suitable in applications where optimum circuit efficiency is desired.

The 2N3263 and the 2N3264 are sealed in flat 3/4-inch diameter packages having radial leads. Types 2N3265 and 2N3266 are sealed in 7/8-inch hexagonal double-ended-stud copper packages.

Typical high-speed switching applications for these transistors include switching-control amplifiers, power gates, switching regulators, DC-DC converters, and DC-AC inverters. Other recommended applications include DC-RF amplifiers and power oscillators.

* Formerly Dev. Type Nos. TA2492, TA2493, TA2494, and TA2495, respectively.

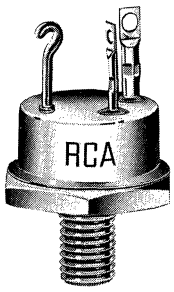
SILICON N-P-N HIGH-POWER HIGH-SPEED HIGH-CURRENT TRANSISTORS

Epitaxial Types for Aerospace, Military, and Industrial Applications



2N3263, 2N3264

H-1354



2N3265, 2N3266
(JEDEC TO-63)

H-1355

Maximum Ratings, *Absolute-Maximum Values:*

	2N3264 2N3266	2N3263 2N3265	
Collector-to-Base Voltage, V_{CBO}	120	150 max.	volts
Collector-to-Emitter Voltage:			
With base open (sustaining voltage), $V_{CEO(sus)}$	60	90 max.	volts
With 50 ohms or less between base and emitter (sustaining voltage), $V_{CER(sus)}$	80	110 max.	volts
With 1.5 volts of reverse voltage, V_{CEX}	120	150 max.	volts
Emitter-to-Base Voltage, V_{EBO}	7	7 max.	volts
Collector Current, I_C	25	25 max.	amperes
Base Current, I_B	10	10 max.	amperes
Transistor Dissipation	See *Fig.1* and *Fig.2*		
Temperature Range:			
Storage	-65 to +200		°C
Operating (Junction)	-65 to +200		°C
	2N3263 2N3264	2N3265 2N3266	
Thermal Resistance (Junction-to-case), θ_{J-C}	1.5	1.0 max.	°C/w

- High Reliability and Uniformity of Characteristics
- Operation at High-Junction Temperatures – Up to 200° C (max.)
- High Power Dissipation
- Fast Rise Time at High Collector Current – 0.2 μsec at 10 amp (typical)
- Low Saturation Voltages –

  2N3263 and 2N3265

  $V_{CE}(sat)$ = 0.75 volt (max.) at I_C = 15 amp
  $V_{BE}(sat)$ = 1.60 volts(max.) at I_C = 15 amp

  2N3264 and 2N3266

  $V_{CE}(sat)$ = 1.20 volts(max.) at I_C = 15 amp
  $V_{BE}(sat)$ = 1.80 volts(max.) at I_C = 15 amp

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3263, 2N3264, 2N3265, & 2N3266 12/66
Supersedes issue dated 2/64

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS						LIMITS				Units
		DC Collector Volts		DC Emitter Volts	DC Current (Amperes)			2N3264 2N3266		2N3263 2N3265		
		V_{CB}	V_{CE}	V_{EB}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}											
at T_C = 25° C		60				0			10			ma
		80				0					4	ma
T_C = 125° C		60				0			10			ma
		80				0					4	ma
Emitter-Cutoff Current	I_{EBO}											
at T_C = 25° C				5			0		15		5	ma
T_C = 125° C				5			0		15		5	ma
Collector Current	I_{CEX}											
(with base reverse biased)			120	1.5					20			ma
			150	1.5							20	ma
Emitter-to-Base Voltage	V_{EBO}				I_{EB}=0.02		0	7		7		volts
Collector-to-Emitter Sustaining Voltage: **Caution: See Note 1**												
With base open	V_{CEO}(sus)					0	0.2	60		90		volts
With external base-to-emitter resistance $R_{BE} \leq$ 50 ohms	V_{CER}(sus)					0	0.2	80		110		volts
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)					1.2	15▲		1.20		0.75	volts
Base-to-Emitter Saturation Voltage	V_{BE}(sat)					1.2	15▲		1.80		1.60	volts
DC Forward Current Transfer Ratio	h_{FE}		3				5▲	35		40		
			3				15▲	20	80	25	75	
			4				20▲	15		20		
Safe-Operating Region for Second Breakdown: See Note 2 —												
DC Forward Biased (See *Fig.5*)	$I_{S/b}$*		50					700				ma
			75							350		ma
Reverse Biased, R_{BE} = 20 ohms, L = 40 μh	$E_{S/b}$**			6			10	2		2		mjoules
Sat. Switch Turn-On Time (delay time + rise time) (See *Figs.3 & 4*)	$t_d + t_r$		V_{CC}=30			$I_{B1} = I_{B2}$ = 1.2	15		0.5		0.5	μsec
Sat. Switch Storage Time	t_s		V_{CC}=30			$I_{B1} = I_{B2}$ = 1.2	15		1.5		1.5	μsec
Sat. Switch Fall Time	t_f		V_{CC}=30			$I_{B1} = I_{B2}$ = 1.2	15		0.5		0.5	μsec
Gain-Bandwidth Product (at 5 Mc)	f_T		10				3	20		20		Mc
Collector-to-Base Feedback Capacitance (at 1 Mc)	C_{ob}	10			0				900		900	pf
								2N3263 2N3264		2N3265 2N3266		
Thermal Resistance Junction-to-Case T_J = 100° C	$\theta_{J\text{-}C}$		40				0.5		1.5		1.0	°C/w

▲ Pulsed; pulse duration ≤ 350 μsec; duty factor ≤ 2%.

* $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

** $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2\ Li^2$, where L is a series load or leakage inductance and i is the collector current.

Note 1: CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig.10.

Note 2: Second breakdown (S/b) occurs in all high-frequency power transistors within the linear power-derating curves. This breakdown phenomenon occurs when the output impedance changes instantaneously from a large positive value to a negative value and then to a final small positive value. In general, the severity of S/b increases with both an increase in frequency response of the transistor and with an increase in the operating collector-to-emitter voltage. Repeated operation of the transistor in the S/b region will degrade and damage the transistor.

The curves in Fig.1 and Fig.2 show maximum dc dissipation as a function of collector-to-emitter voltage for the useful case-temperature range. The temperature derating factor is also shown on these curves and is applicable for average as well as dc dissipation values. The ratings shown in Fig.1 and Fig.2 are controlled by one-hundred per-cent testing. A safe region of operation in the forward bias mode which extends the useful range for different time durations of voltage and current is shown in Fig.5. Within this safe-operating region, these transistors may be operated with high reliability over their entire voltage and current ranges in medium-and-high-frequency amplifiers and in switching applications.

The energy required to induce S/b when the emitter-to-base junction is open, shorted, or reverse biased is much lower than that required in the forward-bias mode. The curves shown in Fig.7, Fig.8, and Fig.9 show collector current as a function of inductance. Use of these curves is recommended when designing circuits having inductive loads (such as solenoids, relays, deflecting yokes, and switching regulators) where protective zener diodes are not employed across the collector junction, and in circuits where some leakage induction is present (such as in inverters, converters, and in power amplifiers). For further information on S/b consult RCA Application Note SMA-30 "Second Breakdown in Transistors Under Conditions of Cutoff."

RATING CHARTS

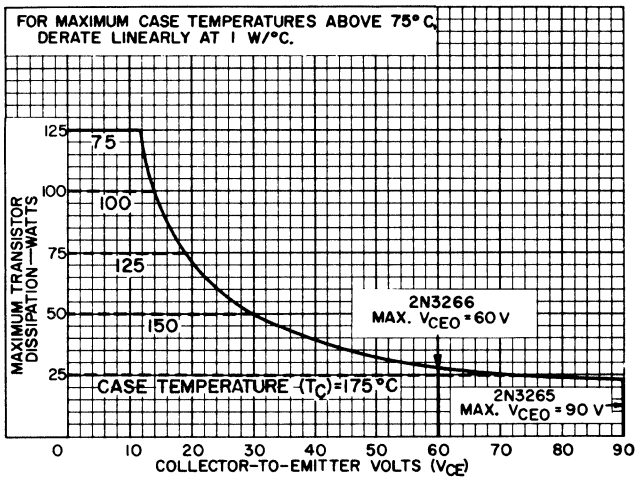


Fig. 1

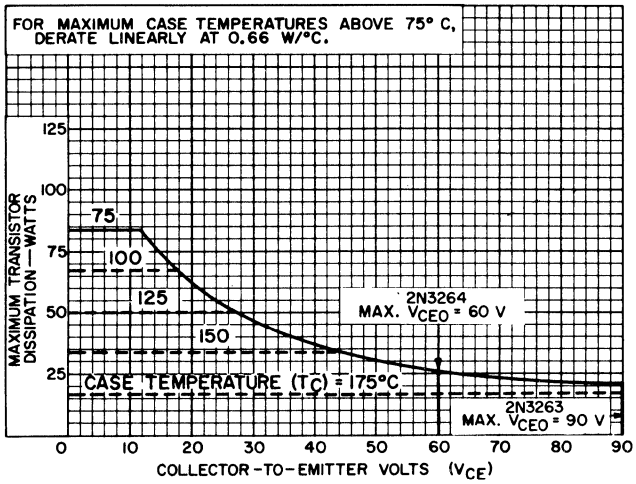
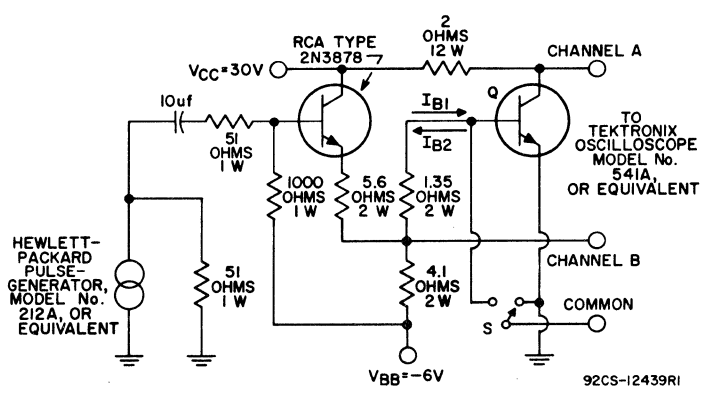


Fig. 2

CIRCUIT USED TO MEASURE t_{on} AND t_{off} FOR OPERATION AS A SATURATED SWITCH



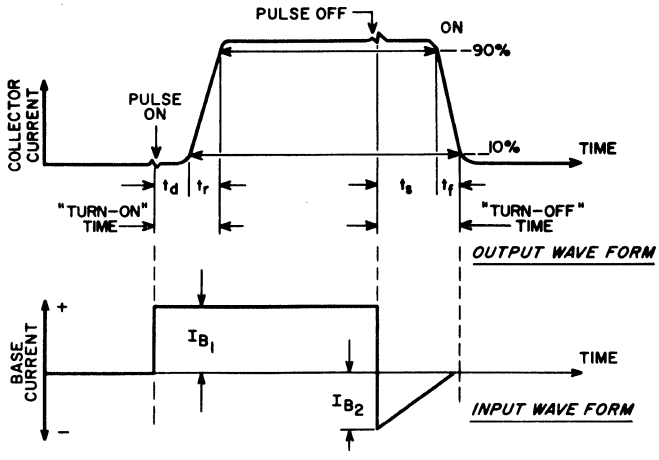
INPUT PULSE:

t_r < 20 nsec
t_f < 20 nsec
REP. RATE = 400 cps
PULSE WIDTH = 5 μsec

Q = 2N3263, 2N3264, 2N3265, 2N3266

Fig. 3

WAVE FORMS FOR SATURATED SWITCH CIRCUIT SHOWN IN FIG.3



I_{B_1} = 1.2 a
I_{B_2} = -1.2 a
I_C = 15 a

t_{on} = 0.5 μsec
t_{off} = 2.0 μsec

Fig. 4

SAFE OPERATING REGION AS A FUNCTION OF PULSE WIDTH

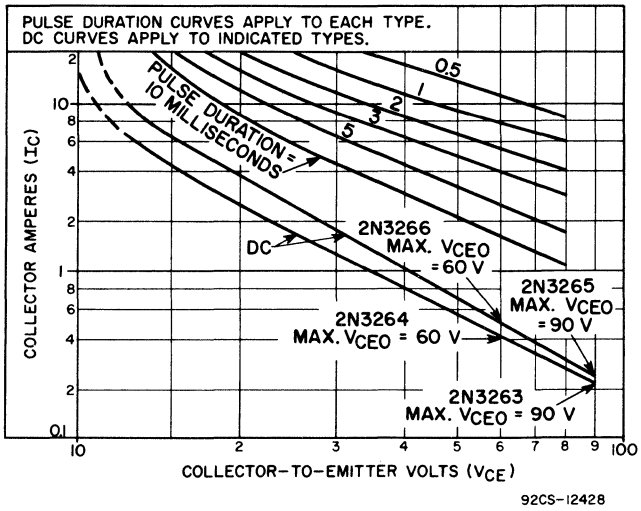


Fig. 5

TYPICAL CHANGE IN $I_{S/b}$ AS A FUNCTION OF BASE-TO-EMITTER RESISTANCE

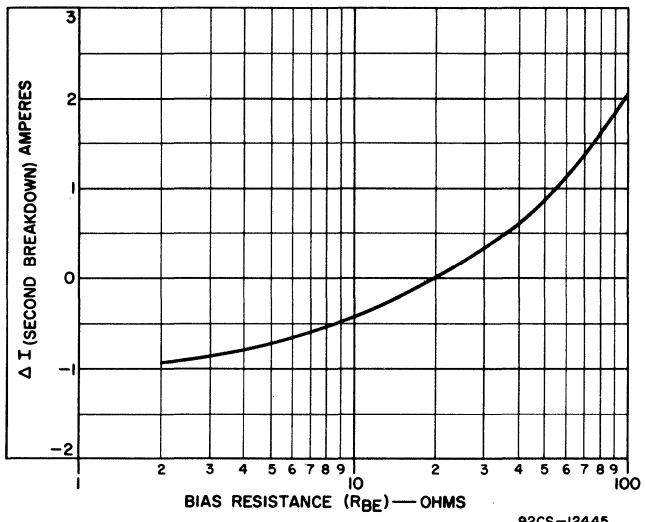


Fig. 6

COLLECTOR CURRENT AS A FUNCTION OF INDUCTANCE

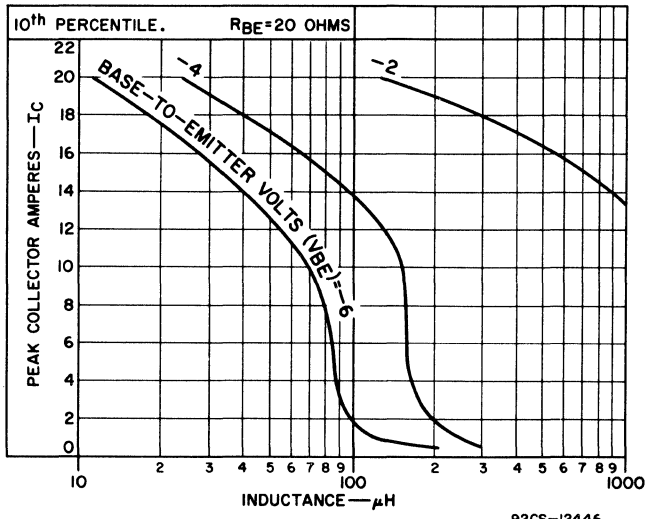


Fig. 7

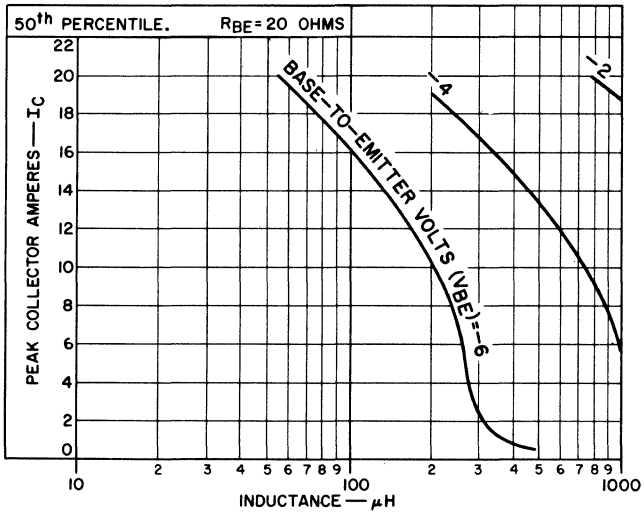


Fig. 8

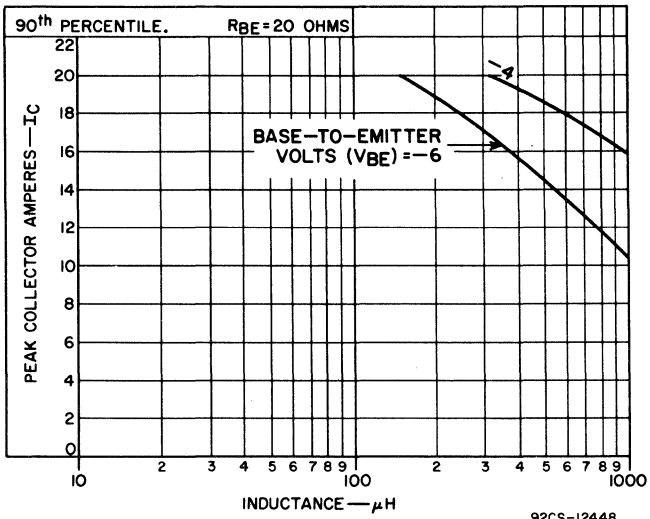


Fig. 9

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES $V_{CEO(sus)}$ AND $V_{CER(sus)}$

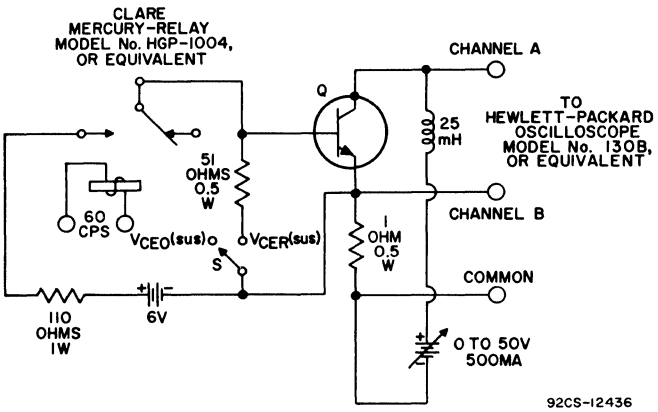
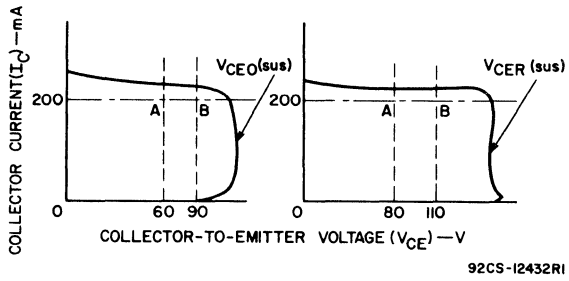


Fig. 10

COLLECTOR CHARACTERISTICS CHARTS



The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ are acceptable when the traces fall to the right and above points "A" for types 2N3264 and 2N3266. The traces must fall to the right and above points "B" for types 2N3263 and 2N3265.

Fig. 11

TYPICAL SATURATED-SWITCHING CHARACTERISTICS

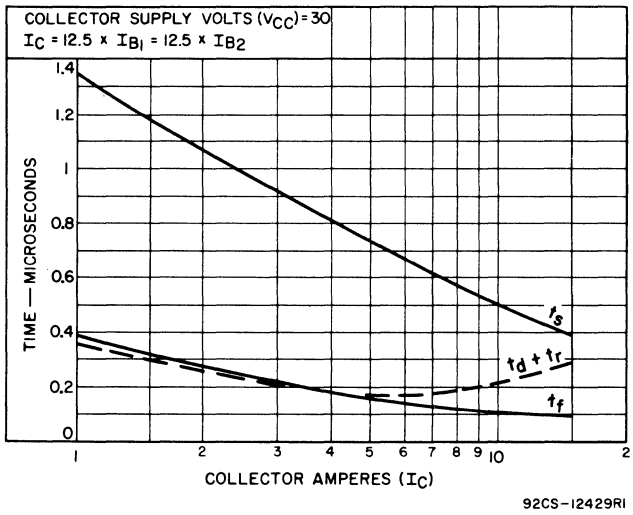


Fig. 12

TYPICAL INPUT CHARACTERISTICS

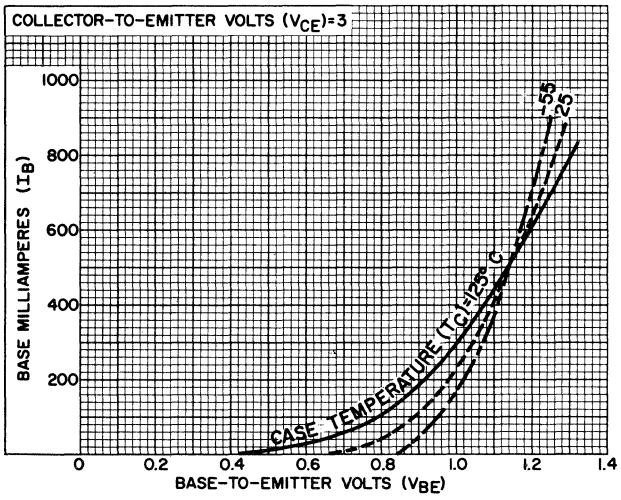


Fig. 13

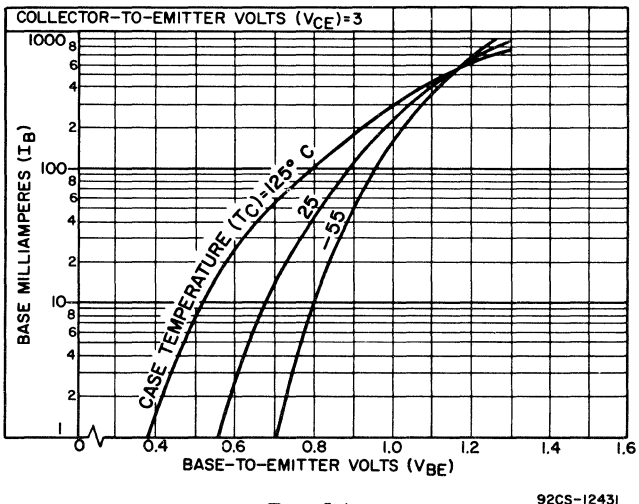


Fig. 14

DC BETA CHARACTERISTICS

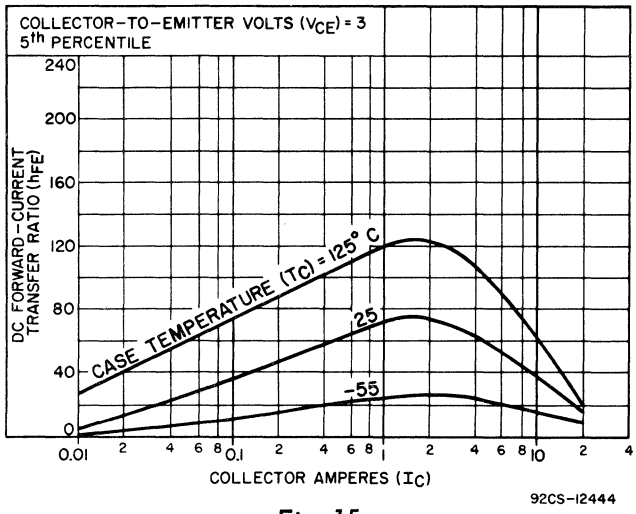


Fig. 15

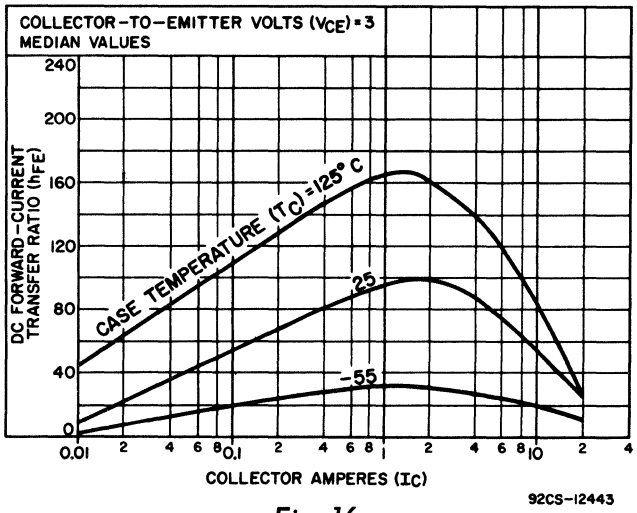


Fig. 16

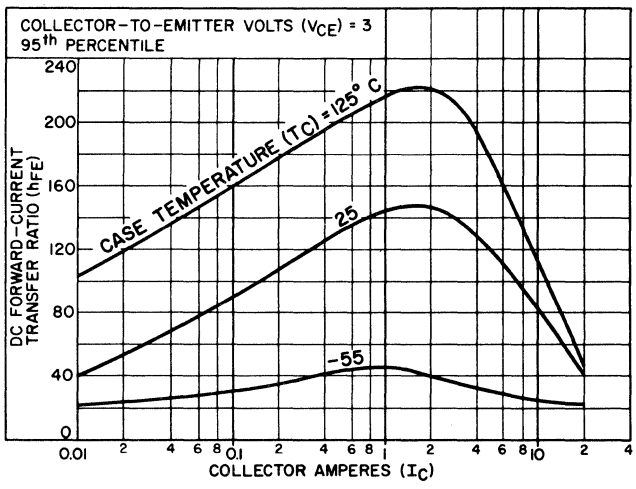


Fig. 17

TYPICAL TRANSFER CHARACTERISTICS

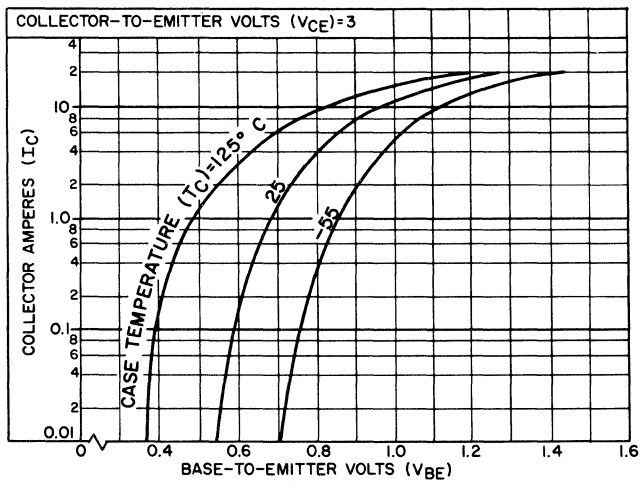


Fig. 18

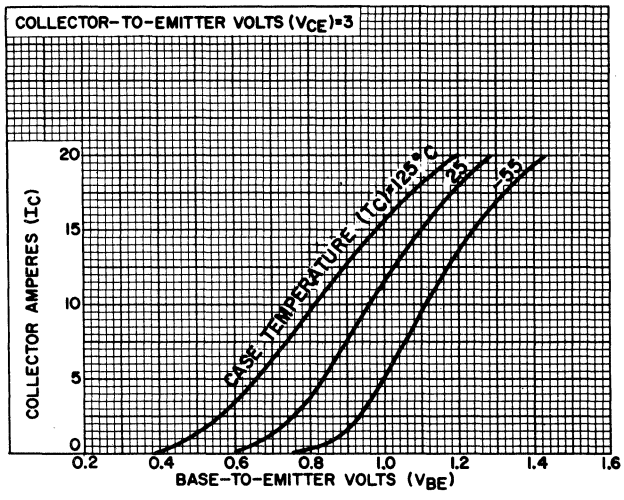


Fig. 19

TYPICAL CHARACTERISTICS

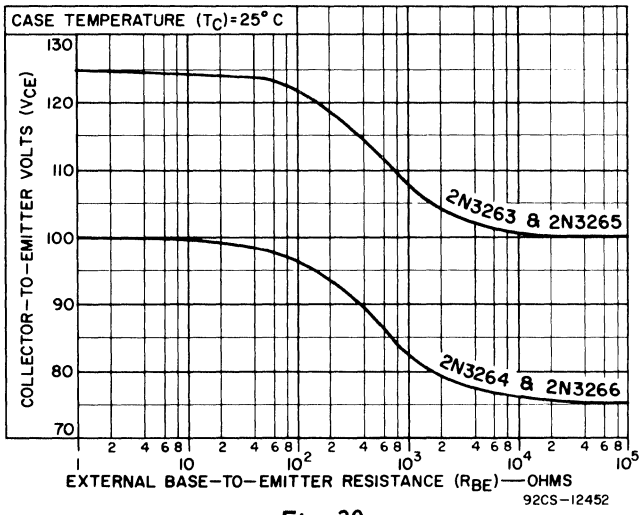
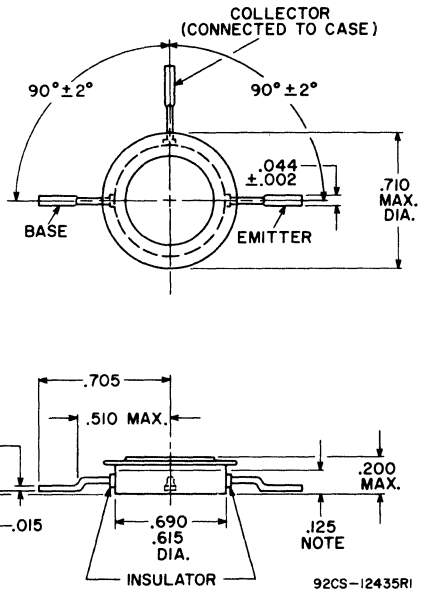


Fig. 20

DIMENSIONAL OUTLINE
for Types 2N3263 and 2N3264

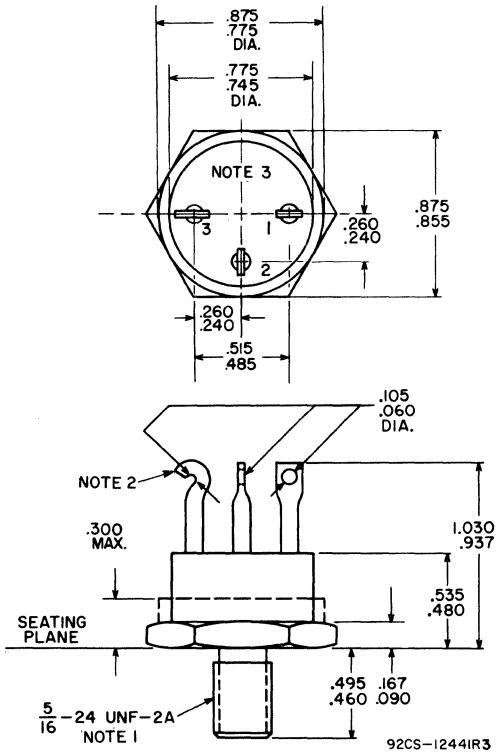


DIMENSIONS IN INCHES

NOTE: THE CONTROLLED AREA OF THE 0.690 MAX. – 0.615 MIN. DIAMETER DOES NOT INCLUDE THE BRAZED AREA AROUND THE CERAMIC AND COLLECTOR TERMINAL.

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DIMENSIONAL OUTLINE
FOR TYPES 2N3265 & 2N3266
JEDEC No. TO-63



DIMENSIONS IN INCHES

NOTE 1: COMPLETE THREADS EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.

NOTE 2: THIS TERMINAL MAY BE HOOK TYPE OR FLATTENED AND PIERCED.

NOTE 3: POSITION OF TERMINALS WITH RESPECT TO THE HEXAGON IS NOT CONTROLLED.

RCA HIGH-VOLTAGE TRANSISTORS

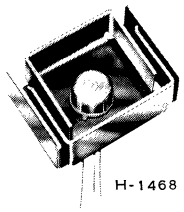
2N3439, 2N3440
2N4063, 2N4064
Including 40390

File No. 64

RCA-2N3439*, 2N3440**, 2N4063, & 2N4064 are triple-diffused silicon n-p-n transistors with high-breakdown voltages, high-frequency response, and fast-switching speeds. These transistors are intended for industrial, commercial, and military equipment. Typical applications include high-voltage differential and operational amplifiers, high-voltage inverters, and high-voltage, low-current switching and series regulators.

The 2N3439 and the 2N3440 differ primarily in their voltage ratings; the 2N4063 and 2N4064 have the same voltage ratings as the 2N3439 and 2N3440 respectively, but employ a flange package.

*Formerly Dev. Type No. TA2458.
**Formerly Dev. Type No. TA2470.

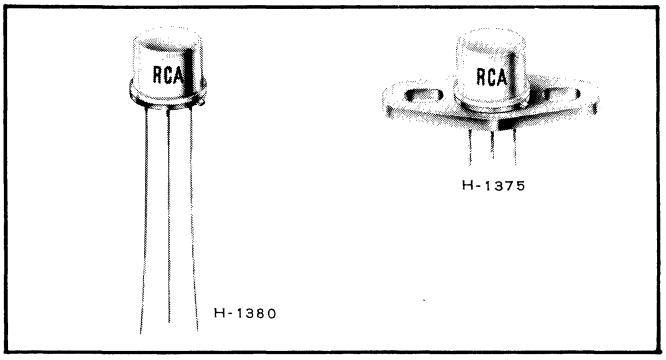


40390

ALSO AVAILABLE. . .

Type 40390 is a 2N3440 with a factory-attached heat radiator; it is intended for printed circuit-board applications.

SILICON N-P-N TYPES



2N3439, 2N3440
JEDEC TO-5

2N4063, 2N4064
JEDEC TO-5 + FLANGE

For High-Speed Switching and Linear-Amplifier Applications in Industrial Commercial, and Military Equipment

- **High-voltage ratings:**
  V_{CBO} = 450 V max. (2N3439, 2N4063)
  = 300 V max. (2N3440, 2N4064)
  V_{CEO}(sus) = 350 V max. (2N3439, 2N4063)
  = 250 V max. (2N3440, 2N4064)
- **Low saturation voltage:**
  V_{CE}(sat) = 0.5 V max.
- **Maximum area-of-operation curves for DC and pulse operation**
- **Designed to assure freedom from second breakdown in class −A, −B, and −C operation at maximum ratings**

MAXIMUM RATINGS		2N3439 2N4063	2N3440 2N4064 40390	
Absolute-Maximum Values:				
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	450	300	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE	V_{CEO}(sus)	350	250	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
COLLECTOR CURRENT	I_C	1	1	A
BASE CURRENT	I_B	0.5	0.5	A
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25°C		10	10(2N3440)	W
		—	10(2N4064)	W
At free-air temperatures up to 25°C		—	3.5(40390)	W
At free-air temperatures up to 50°C		1(2N3439)	1(2N3440)	W
At free-air temperatures above 25°C or 50°C		See Fig. 7.		
For pulse operation		See Fig. 6.		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		← −65 to 200 →		°C
LEAD TEMPERATURE (During soldering):				
At distance ≥ 1/32 in. from seating plane for 10 s max.		← 255 →		°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.

2N3439, 2N3440, 2N4063
2N4064, & 40390 9/66
Supersedes issue dated 6/64

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25°C

Characteristic	Symbol	TEST CONDITIONS							LIMITS				Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (milliamperes)			Types 2N3439 2N4063		Types 2N3440 2N4064 40390		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		300 200					0 0	- -	20 -	- -	- 50	μA μA
	I_{CEV}		450 300		-1.5 -1.5				- -	500 -	- -	- 500	μA μA
Emitter-Cutoff Current	I_{EBO}			6		0			-	20	-	20	μA
DC Forward-Current Transfer Ratio	h_{FE}		10 10			20 2			40 30	160 -	40 -	160 -	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 1 & 2.)* With base open	$V_{CEO}(sus)$					50		0	350[a]	-	250[a]	-	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$					50		4	-	1.3	-	1.3	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					50		4	-	0.5	-	0.5	V
Small-Signal, Forward-Current Transfer Ratio (at 5 MHz)	h_{fe}		10			10			3	-	3	-	
Output Capacitance (at 1 MHz)	C_{ob}	10					0		-	10	-	10	pF
Second-Breakdown[b] Collector Current: With base forward biased[c]	$I_{S/b}$[d]		200						50	-	50	-	mA
Thermal Resistance: Junction-to-Case	θ_{J-C}								-	17.5	-	17.5	°C/W

[a] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ **MUST NOT** be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 1.

[b] Safe-operating region for second breakdown is explained under "SECOND BREAKDOWN" on page 6.

[c] Specified value of $I_{S/b}$ for given value of V_{CE} as base voltage is increased from zero in a positive direction.

[d] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

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CIRCUIT USED TO MEASURE SUSTAINING VOLTAGE, $V_{CEO}(sus)$ FOR TYPES 2N3439, 2N3440, 2N4063, & 2N4064

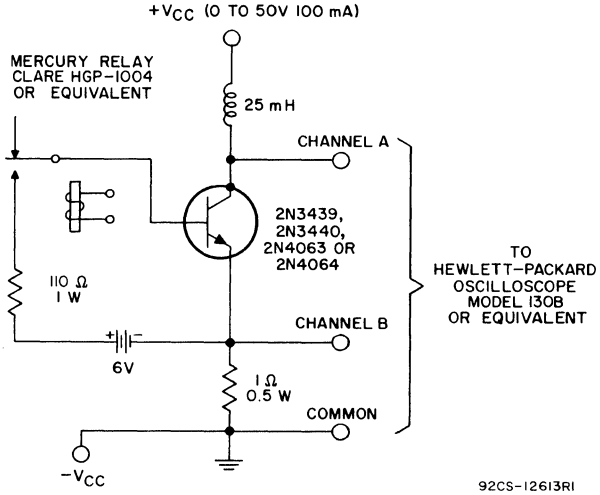
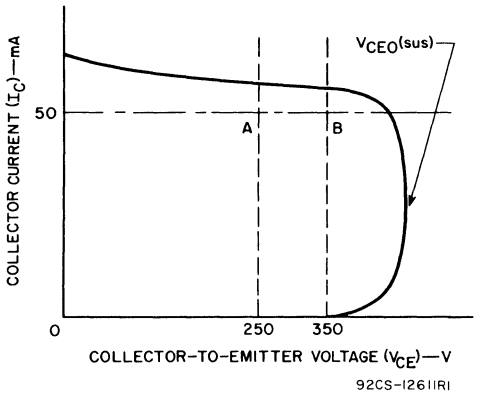


Fig. 1

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN IN FIG. 1)



The sustaining voltage $V_{CEO}(sus)$ is acceptable when the trace falls to the right and above point "A" for types 2N3440 and 2N4064. The trace must fall to the right and above point "B" for types 2N3439 and 2N4063.

Fig. 2

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPES 2N3439 & 2N4063

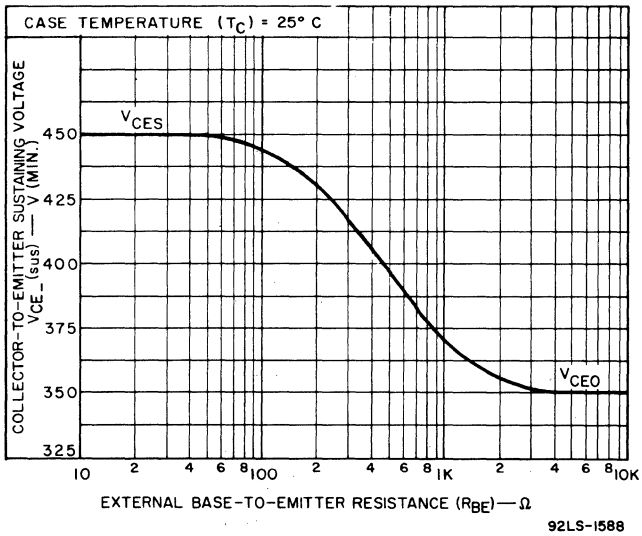


Fig. 3

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPES 2N3440, & 2N4064

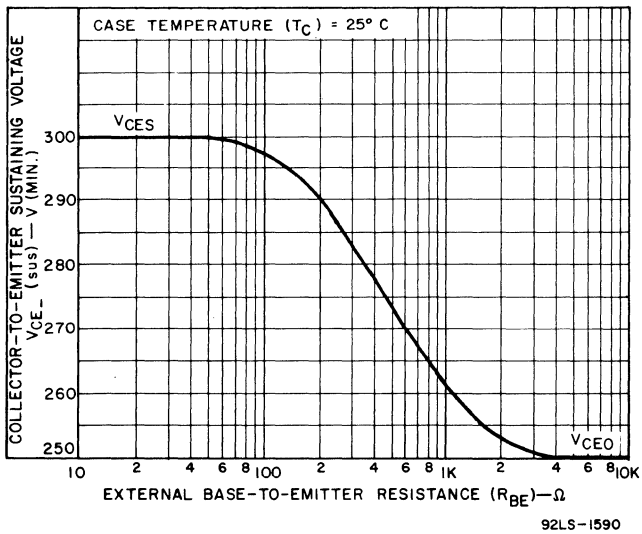


Fig. 4

MAXIMUM AREA-OF-OPERATION

For pulse operation at a temperature greater than 25° C, Fig. 5 is used together with Fig. 6 to obtain the maximum allowable power. This is done as follows:

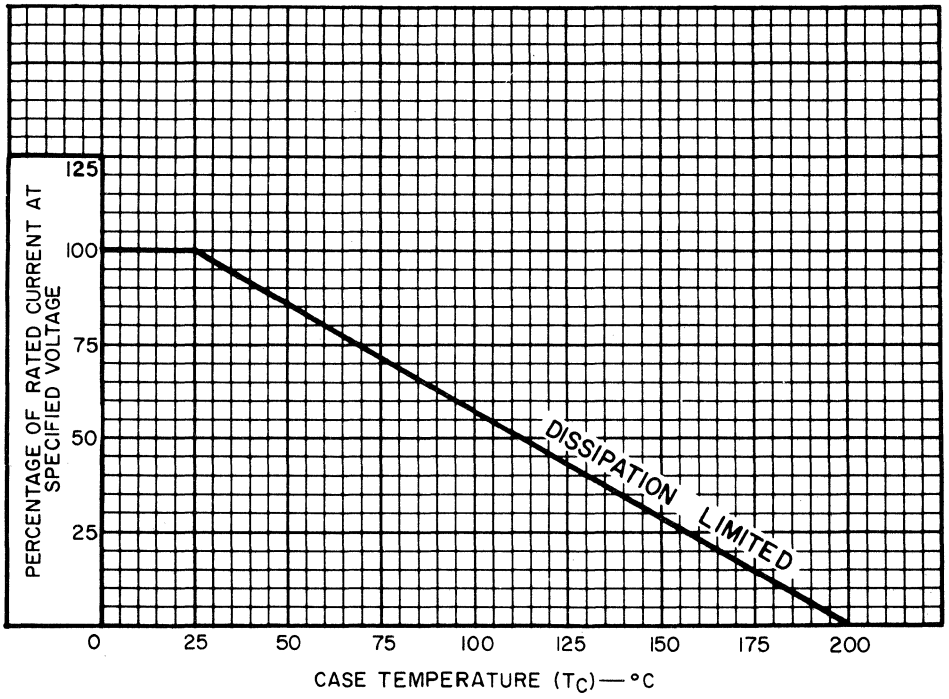
(1) For a specified pulse width and collector-to-emitter voltage, V_{CE}, determine (from Fig. 6) the maximum collector current at 25° C, using the curve marked "THERMALLY LIMITED".

(2) Refer to Fig. 5 and determine the percentage current derating at the specified temperature. Apply this derating to the Value of I_C from step (1), to obtain the maximum current for thermally-limited operation.

(3) The maximum allowable current is the value obtained in step (2).

For repetitive-pulse operation, the actual case temperature to be use in Fig. 5 is the sum of the maximum ambient temperature and the rise in case temperature resulting from the average transistor power dissipation. The temperature rise is the product of average power dissipation and the thermal resistance from case to ambient, which depends on the heat-sink properties.

DISSIPATION DERATING CURVE FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064



92LS-1469

Fig. 5

TYPICAL DC-BETA CHARACTERISTICS FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

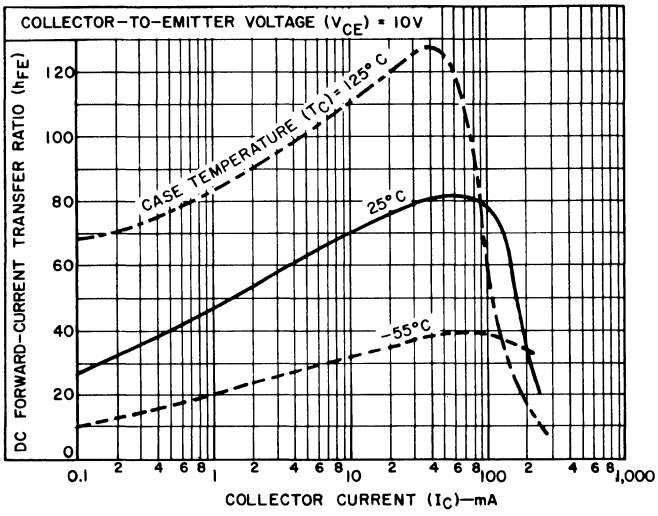


Fig. 8 92LS-1599

TYPICAL OUTPUT CHARACTERISTICS FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

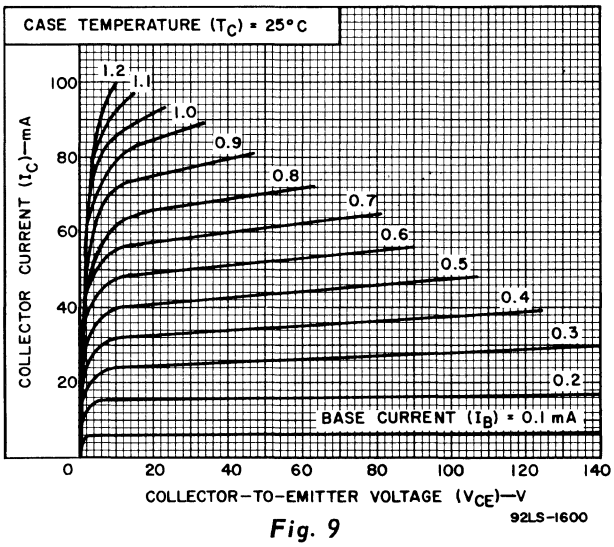


Fig. 9 92LS-1600

TYPICAL INPUT CHARACTERISTICS FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

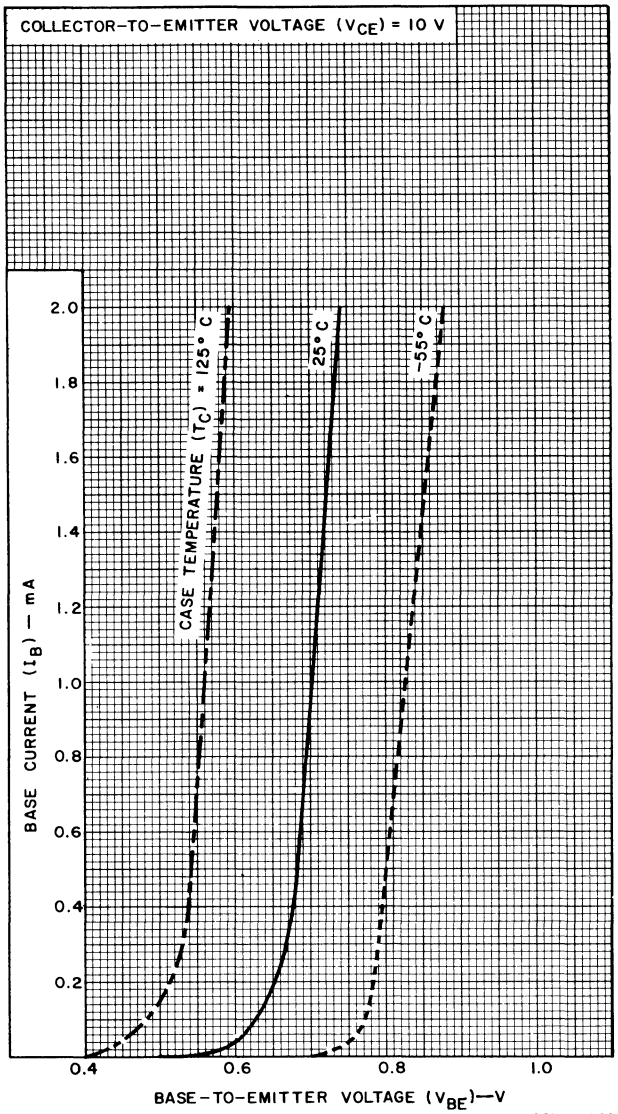


Fig. 10 92LM-1602

TYPICAL TRANSFER CHARACTERISTICS FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

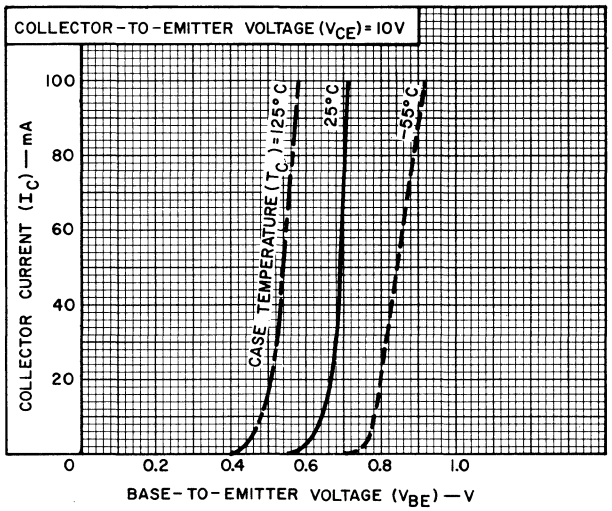


Fig. 11 92LS-1597

TYPICAL GAIN-BANDWIDTH PRODUCT FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

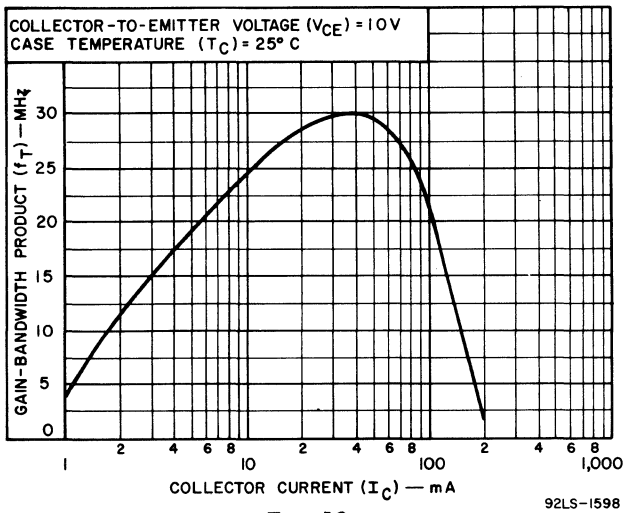
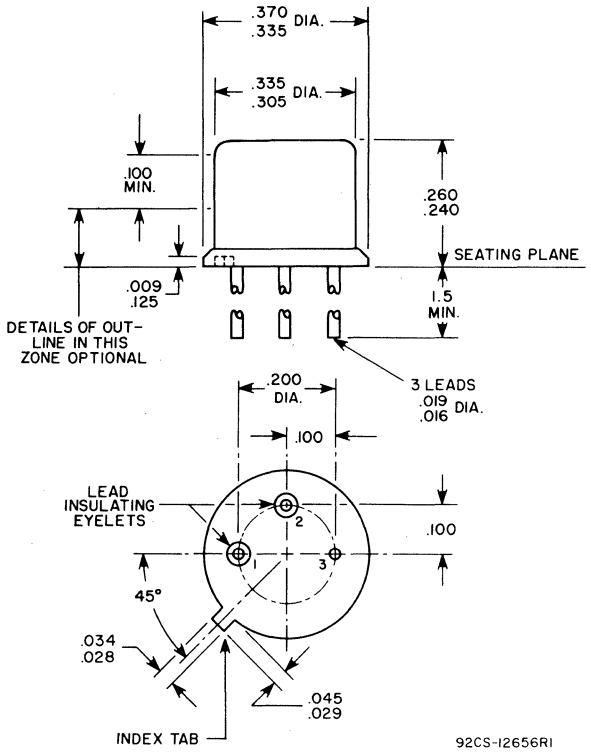


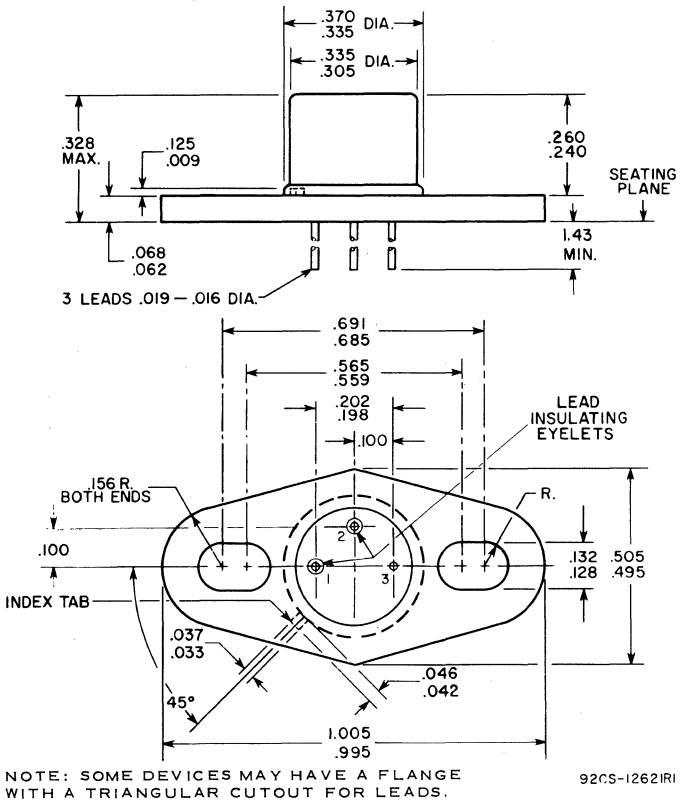
Fig. 12 92LS-1598

DIMENSIONAL OUTLINE FOR TYPES 2N3439 & 2N3440 JEDEC No. TO-5



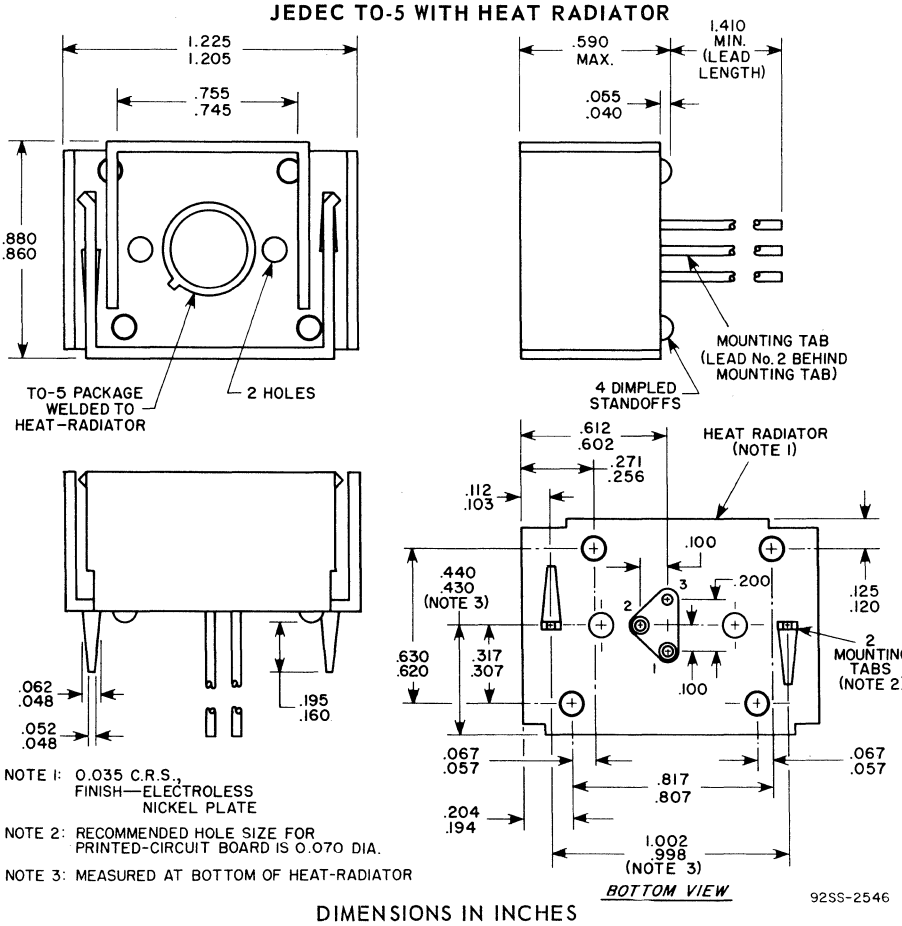
DIMENSIONS IN INCHES

DIMENSIONAL OUTLINE FOR TYPES 2N4063 & 2N4064 JEDEC TO-5 WITH FLANGE



DIMENSIONS IN INCHES

DIMENSIONAL OUTLINE FOR TYPE 40390 JEDEC TO-5 WITH HEAT RADIATOR



NOTE 1: 0.035 C.R.S., FINISH—ELECTROLESS NICKEL PLATE

NOTE 2: RECOMMENDED HOLE SIZE FOR PRINTED-CIRCUIT BOARD IS 0.070 DIA.

NOTE 3: MEASURED AT BOTTOM OF HEAT-RADIATOR

DIMENSIONS IN INCHES

TERMINAL CONNECTIONS FOR TYPES 2N3439 & 2N3440

Lead 1 - Emitter
Lead 2 - Base
Case, Lead 3 - Collector

TERMINAL CONNECTIONS FOR TYPES 2N4063 & 2N4064

Lead 1 - Emitter
Lead 2 - Base
Flange, Lead 3 - Collector

TERMINAL CONNECTIONS FOR TYPE 40390

Lead 1 - Emitter
Lead 2 - Base
Heat Radiator, Lead 3 - Collector

MAXIMUM OPERATING AREAS FOR TYPES
2N3439, 2N3440, 2N4063, & 2N4064

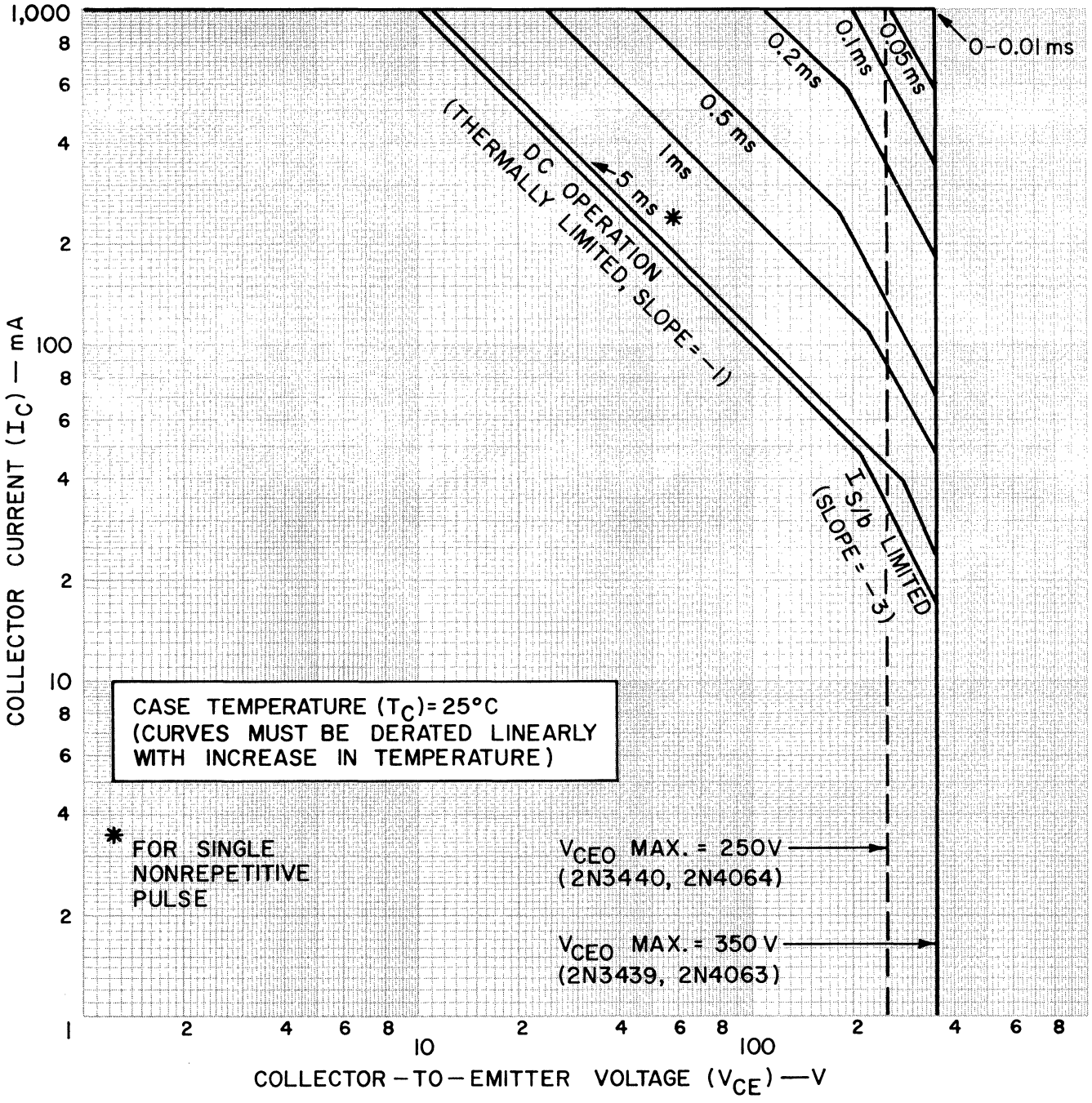


Fig. 6

DISSIPATION DERATING CURVES FOR TYPES
2N3439, 2N3440, & 40390

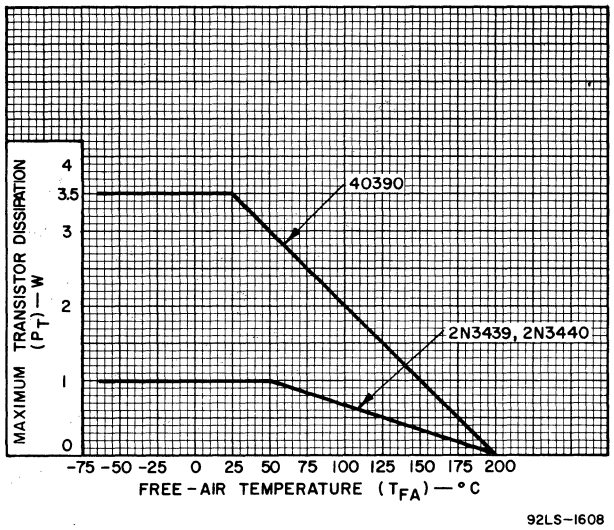


Fig. 7

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

Figure 6 shows the DC and pulse current derating curves applicable to the 2N3439, 2N3440, 2N4063 & 2N4064, respectively. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant at 10 watts). That portion where the slope is approximately -3 shows the region where the device is second breakdown limited, and applies for one-second pulse duration (essentially equal to DC operation). For shorter pulses, the transistor's second breakdown capability improves.

The 40390 is not limited by second breakdown. Fig. 7 shows the derating curve applicable for this type.

RCA POWER TRANSISTORS

2N3441
40373

"HOMETAXIAL"-BASE* SILICON N-P-N HIGH-VOLTAGE TYPES

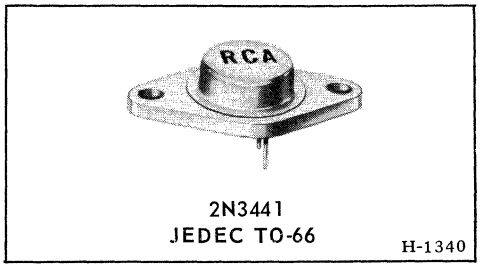
General-Purpose Transistors for Industrial, Commercial, and Military Equipment

RCA-2N3441** is a Hometaxial-base,* silicon n-p-n transistor intended for a wide variety of intermediate-power, high-voltage applications.

The 2N3441 is particularly useful in power-switching circuits, in series- and shunt-regulator driver and output stages, and in dc-to-dc converters.

*"Hometaxial" was coined by RCA from "homogeneous" and and "axial" to describe a single-diffused transistor with a base region of homogeneous resistivity silicon in the axial direction (emitter-to-collector).

**Formerly Dev. Type TA2469A

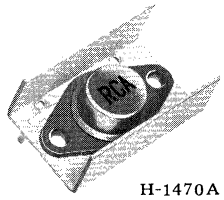


2N3441
JEDEC TO-66

H-1340

- Designed and tested to assure freedom from second breakdown in class -A, -B, and -C operation.
- V_{CEV} = 160 volts min.
- R(sat) = 2.0 ohms max.

ALSO AVAILABLE . . . . .



H-1470A

40373

Type 40373 is a 2N3441 with a factory-attached heat radiator; it is intended for printed circuit-board applications.

MAXIMUM RATINGS

Absolute-Maximum Values:

		2N3441, 40373	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	160	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With -1.5 V (V_{BE}) of reverse bias	V_{CEV}	160	V
With base open	V_{CEO}	140	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	3	A
PEAK COLLECTOR CURRENT		4	A
CONTINUOUS BASE CURRENT	I_B	2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25° C		25 W (2N3441)	
At case temperatures above 25° C		See Figs. 5&6.	
At free-air temperatures up to 25° C		5.8 W (40373)	
At free-air temperatures above 25°C		See Fig. 1.	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200°	C
PIN TEMPERATURE (During soldering):			
At distance ≥1/32" from seating plane for 10 s max.		255°	C

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N3441 10/66
Supersedes 2N3441 data included in 2N3440 bulletin dated 6/64

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS		Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Type 2N3441 40373		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	
Collector-Cutoff Current	I_{CEV}		140	1.5					–	1	mA
At T_C = 150°C	I_{CEV}		140	1.5					–	5	mA
Emitter-Cutoff Current	I_{EBO}			7		0			–	1	mA
DC Forward-Current Transfer Ratio	h_{FE}		4			0.5			20	80	
Collector-to-Emitter Sustaining Voltage: *(See Fig.3 & 4.)*											
With base-emitter junction reverse biased	$V_{CEV}(sus)$				-1.5	0.1 to 1.0			160[a]		V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$					0.1 to 1.0			150[a]		V
With base open	$V_{CEO}(sus)$					0.1 to 2.0		0	140[a]		V
Base-to-Emitter Voltage	V_{BE}		4			0.5			–	1.7	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					0.5		50 mA	–	1	V
Power Rating Test	PRT		32.5			0.9			1[b]		s
			120			0.24			1[b]		s
Thermal Resistance: Junction-to-Case	θ_{J-C}								7 (max.) 2N3441		°C/W
Thermal Resistance: Junction-to-Free Air	θ_{J-FA}								30 (max.) 40373		°C/W

[a] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$ and $V_{CEV}(sus)$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in *Fig.3*.

[b] At 29 W.

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DISSIPATION DERATING CURVE
FOR TYPE 40373

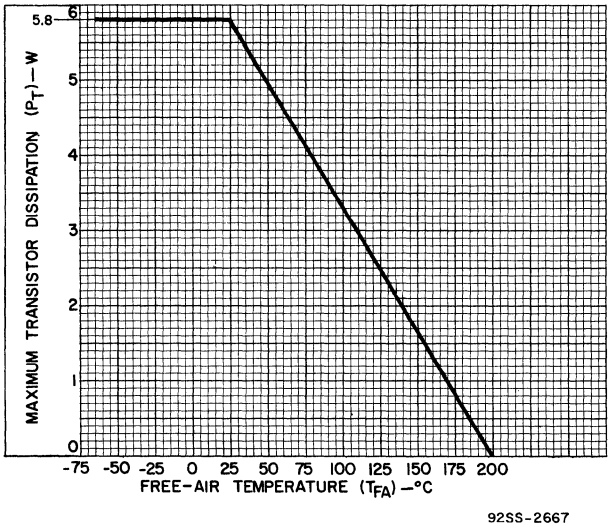


Fig.1

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPE 2N3441

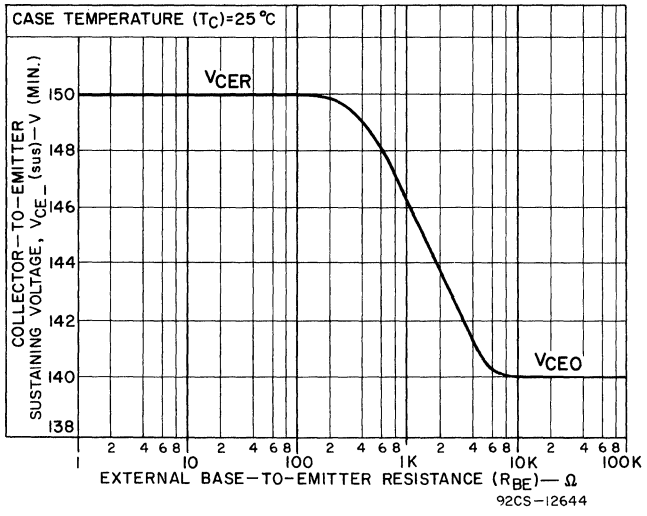


Fig.2

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES
V_{CEO}(sus), V_{CER}(sus), AND V_{CEV} (sus)
FOR TYPE 2N3441

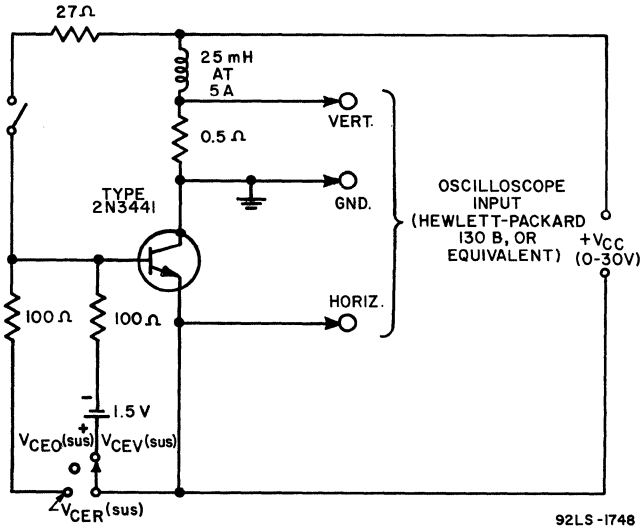
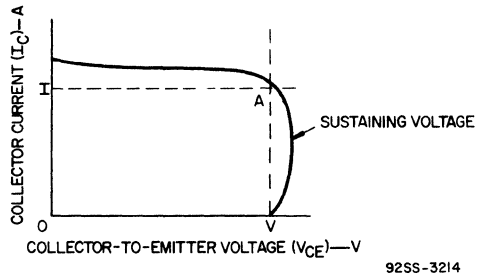


Fig.3

OSCILLOSCOPE DISPLAY FOR MEASUREMENT
OF SUSTAINING VOLTAGES
(TEST CIRCUIT SHOWN IN FIG. 3.)



Note:

The sustaining voltage, V_{CEO}(sus), V_{CER}(sus), or V_{CEV}(sus) is acceptable when the trace falls to the right and above point "A" for type 2N3441. (For values of current and voltage, see *Electrical Characteristics*)

Fig.4

MAXIMUM AREA-OF-OPERATION

Figure 6 shows the maximum operating area curve for type 2N3441 (DC, pulse, and second-breakdown limitations)at a case temperature of 25° C. The curves, shown on a log-log plot, have slopes equal to −1 when thermal (dissipation) limitation exists and approximately −2 when second-breakdown limitation exists. The dashed line, extending the dissipation limitation line, assists in determining the normalized power multiplier value.

Non-Repetitive Pulse. *Figure 6* allows direct calculation of type 2N3441 maximum dissipation limits when only a single pulse condition occurs.

Repetitive Pulse. The collector-current limitation values, shown in *Figure 6,* must be reduced when repetitive pulses are applied to type 2N3441. The amount of current derating is determined by the slope of the dissipation derating curve (*Figure 5*) where T_{EFF} is the effective case temperature produced by the pulses. The effective case temperature may be calculated by using the following equation:

$$T_{EFF} = T_C + (P_{AVG})\,(\theta_{J\text{-}C})$$

Where:

T_C = Case temperature, °C
P_{AVG} = Average power of the applied repetitive pulses, W
$\theta_{J\text{-}C}$ = Junction-to-case thermal resistance, °C/W

For type 2N3441, only dissipation-limited boundary lines and their dashed line extensions need derating when the effective case temperature increases. The second-breakdown portions of the curves, shown in *Figure 6,* do not require derating.

DISSIPATION DERATING CURVE
FOR TYPE 2N3441

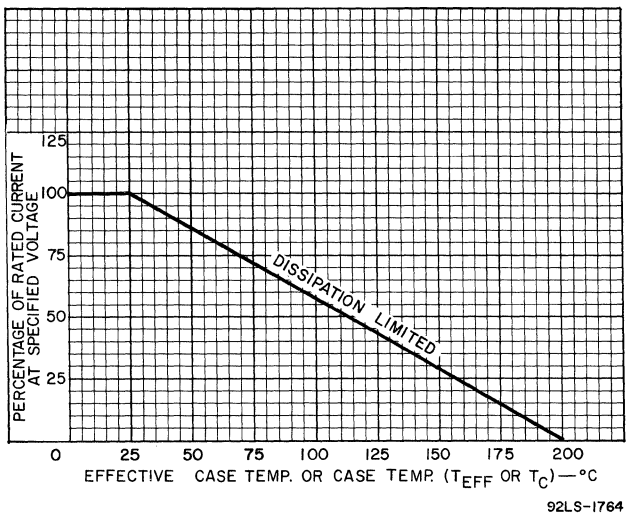


Fig.5

MAXIMUM OPERATING AREAS FOR TYPE 2N3441

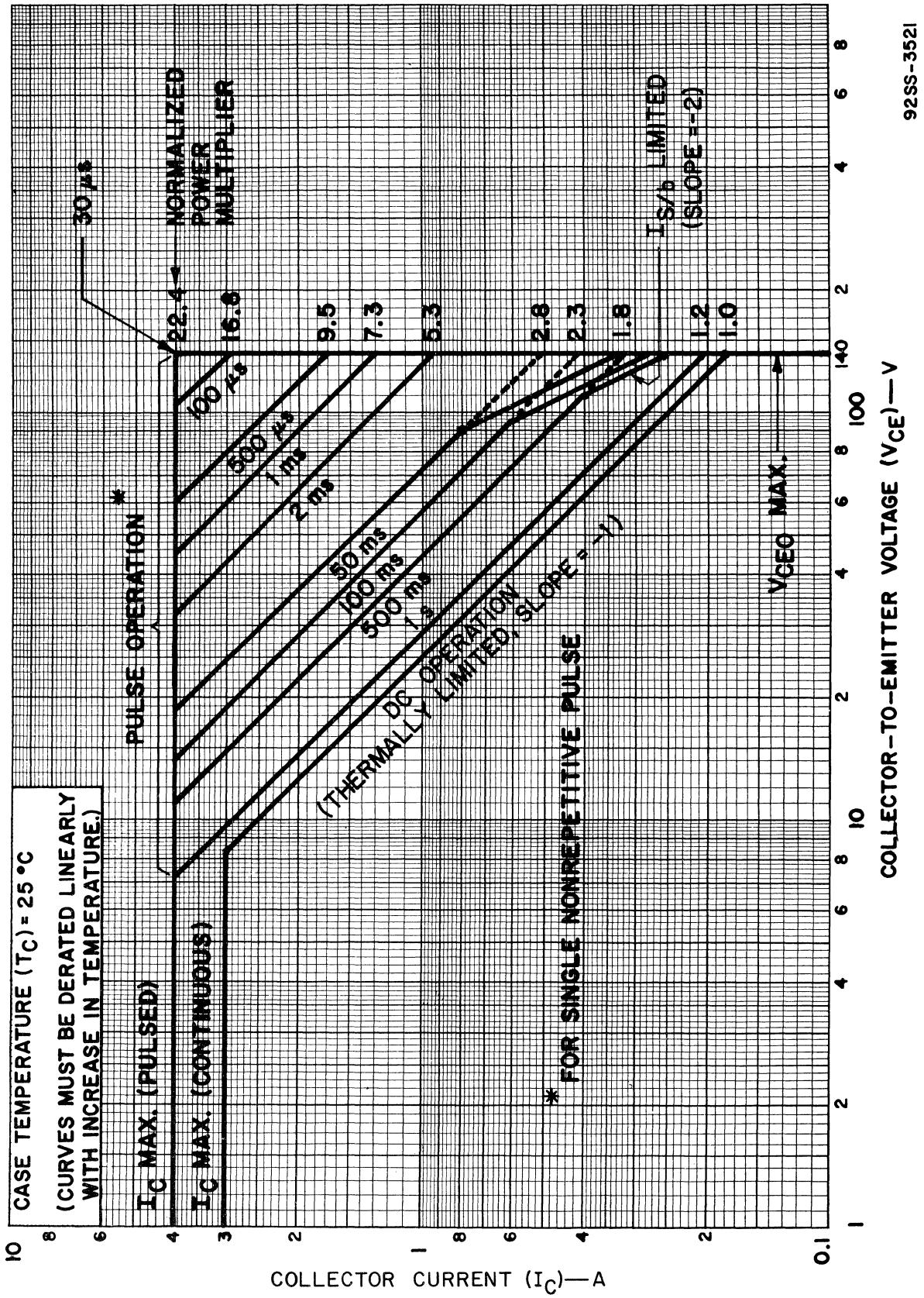


Fig. 6

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

Figure 6 shows the DC and pulse current derating curves applicable to type 2N3441. The portion of the curves with slope equal to −1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant with voltage). That portion where the slope is approximately −2 shows the region where the device is second breakdown limited, i.e., the allowable power dissipation depends on the voltage but is not constant.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the "on" condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in *Figure 7* should prove useful in the design of circuits having inductance loads (such as solenoid- or relay-control circuits, magnetic-circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. Also, these curves can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers.)

In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore, the allowable energy shown in the above mentioned curves (calculated from $E_{S/b} = \frac{1}{2}LI^2$, where L is a series load or leakage inductance and I is the peak collector current from the curves) will be conservative for smaller inductance loads. For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPE 2N3441

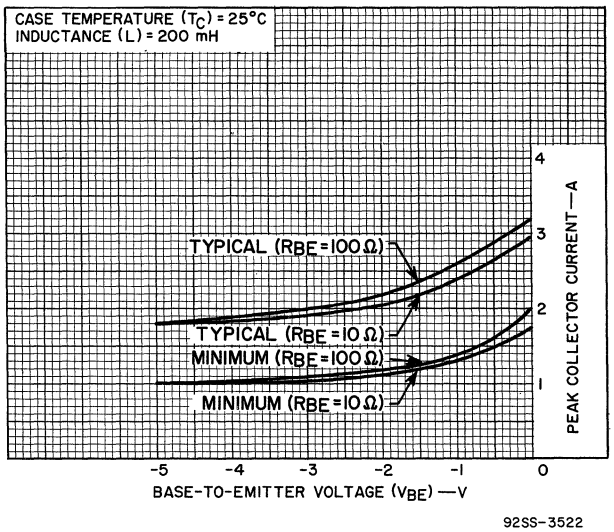


Fig.7

TYPICAL DC-BETA CHARACTERISTICS FOR TYPE 2N3441

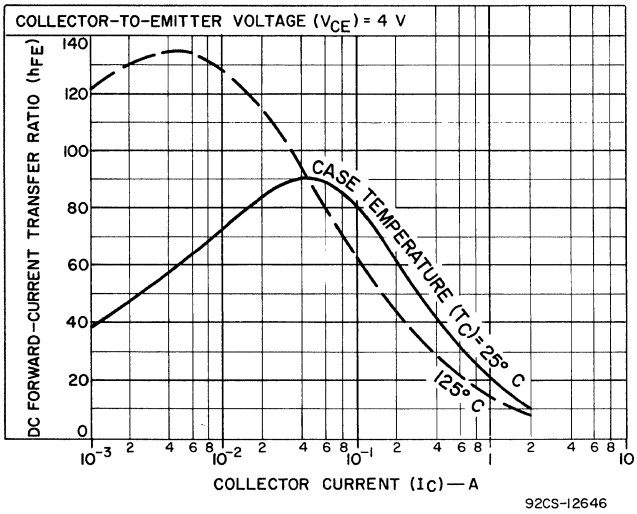


Fig.8

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3441

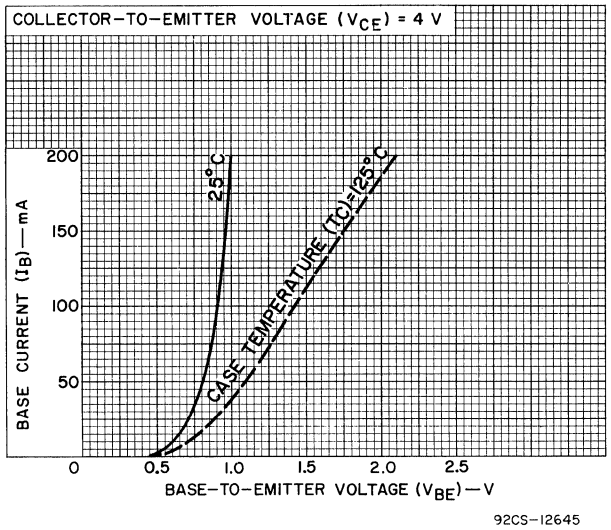


Fig.9

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3441

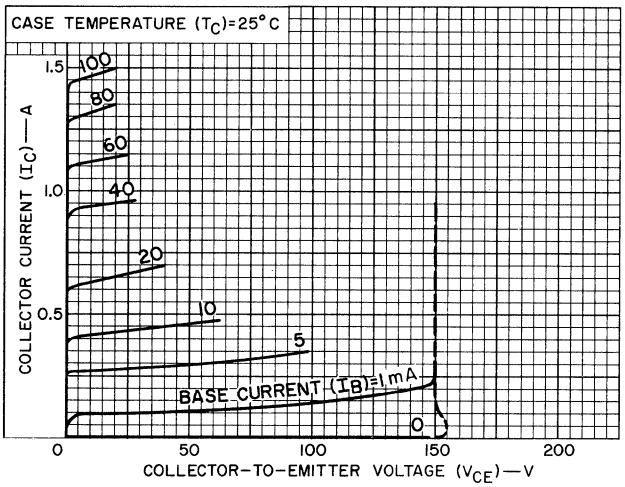


Fig.10

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N3441

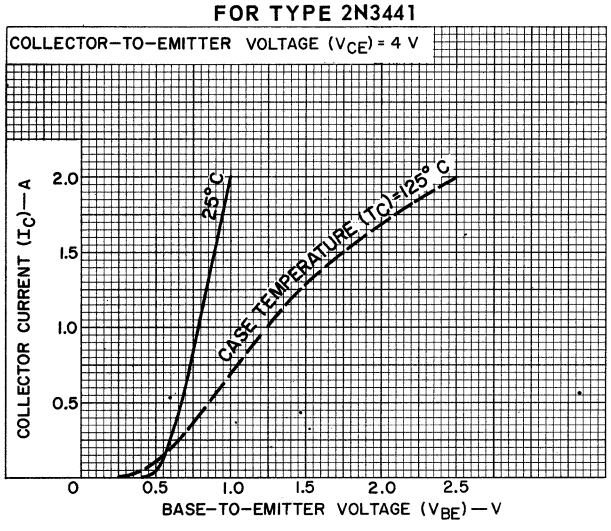


Fig.11

TYPICAL GAIN-BANDWIDTH PRODUCT FOR TYPE 2N3441

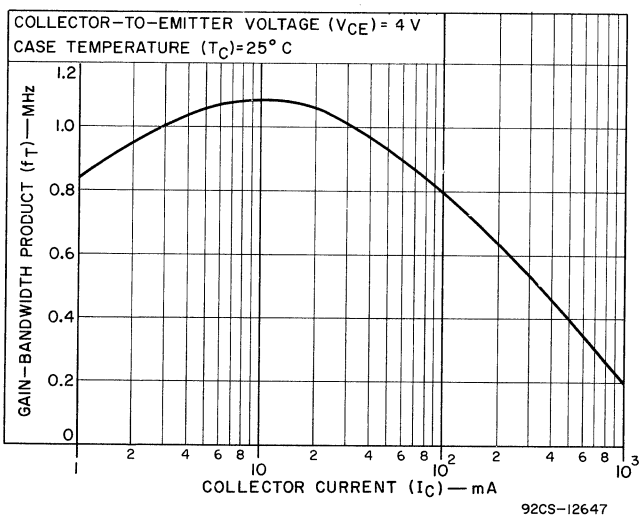
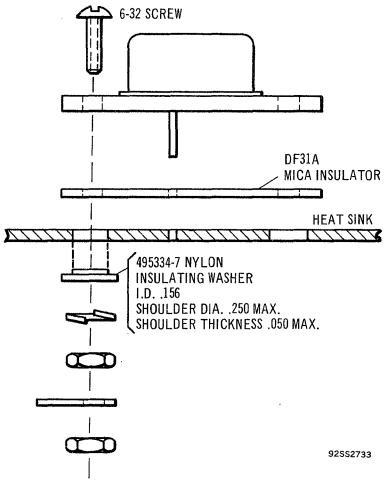


Fig.12

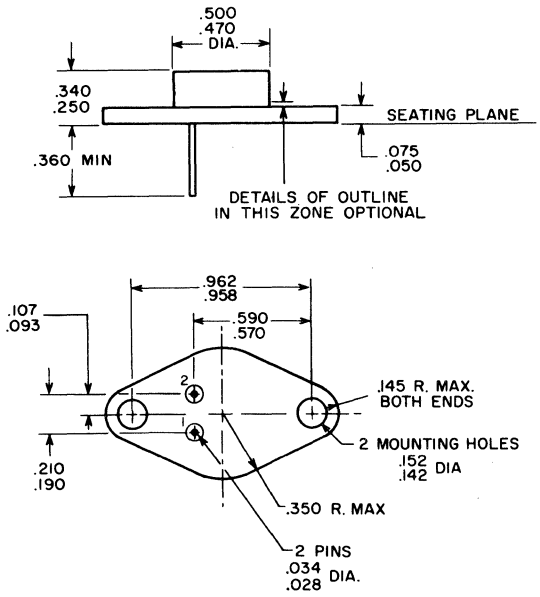
SUGGESTED HARDWARE FOR TYPE 2N3441



Note: Hardware with part numbers is supplied.

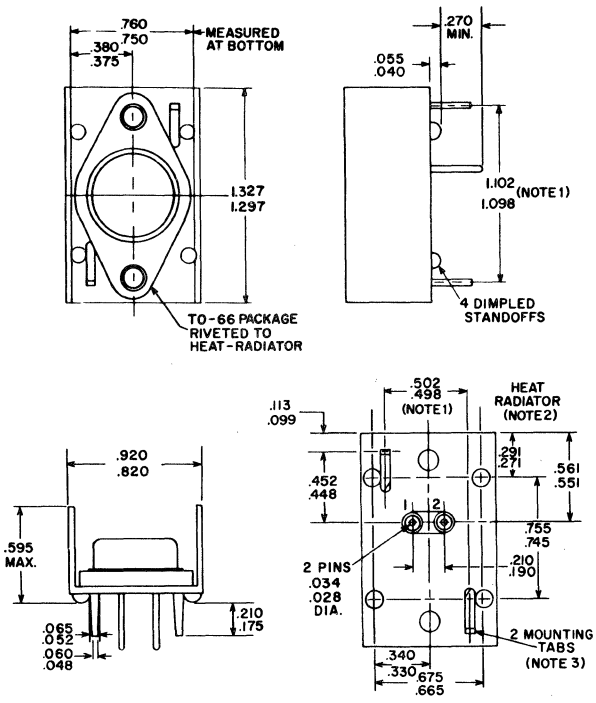
DIMENSIONAL OUTLINES

FOR TYPE 2N3441
JEDEC NO. TO-66



DIMENSIONS IN INCHES

FOR TYPE 40373
JEDEC TO-66 WITH HEAT-RADIATOR



DIMENSIONS IN INCHES

Note 1: Measured at bottom of heat-radiator.

Note 2: 0.035" C.R.S., tin plated.

Note 3: Recommended hole size for printed-circuit board is 0.070" dia.

TERMINAL CONNECTIONS

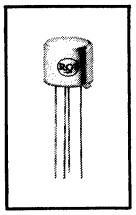
FOR TYPE 2N3441

Pin 1 - Base
Pin 2 - Emitter
Case, Flange - Collector

FOR TYPE 40373

Pin 1 - Base
Pin 2 - Emitter
Case, Heat Radiator - Collector

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



For VHF/UHF Applications in Industrial and Commercial Equipment

RCA-2N3478 is an epitaxial planar transistor of the silicon n-p-n type with characteristics which make it extremely useful as a general purpose RF amplifier at frequencies up to 470MHz. These characteristics include an exceptionally low noise figure at high frequencies, low leakage current, and a high gain-bandwidth product.

The 2N3478 utilizes a hermetically sealed four-lead package in which active elements of the transistor are insulated from the case. The case may be grounded by means of a fourth lead in applications requiring minimum feedback capacitance, shielding of the device, or both.

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO}	30 max.	V
Collector-to-Emitter Voltage, V_{CEO}	15 max.	V
Emitter-to-Base Voltage, V_{EBO}	2 max.	V
Collector Current, I_C	limited by dissipation	
Transistor Dissipation, PT:		
at ambient temperatures: up to 25° C	200 max.	mW
at ambient temperatures: above 25° C	See *Fig. 1*	
Temperature Range:		
Storage and Operating (Junction)	−65 to 200	°C
Lead Temperature (During Soldering):		
At distances not closer than 1/32" to seating surface for 10 seconds max	265 max.	°C

FEATURES

- high gain-bandwidth product – f_T = 900MHz typ.
- low noise figure
  NF = 5dB typ. at 470MHz
  4.5dB max. at 200MHz
  2.5dB typ. at 60MHz
- high unneutralized power gain
  G_{pe} = 11.5dB min. at 200MHz
- hermetically sealed four-lead package
- all active elements insulated from case
- low collector-to-base feedback capacitance, C_{cb} 0.7pF max.

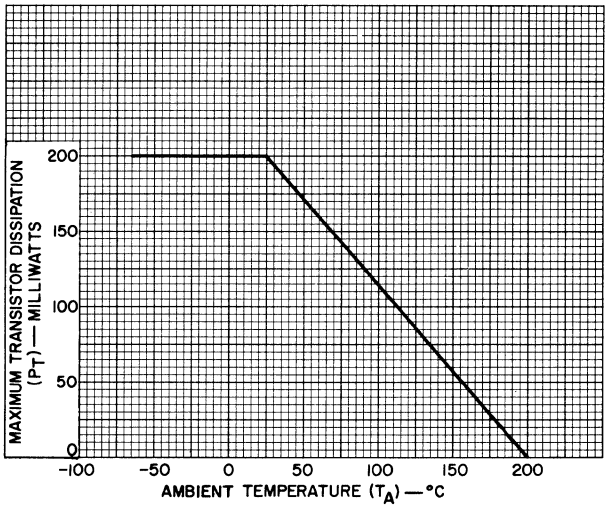


Fig. 1 - Rating chart for type 2N3478

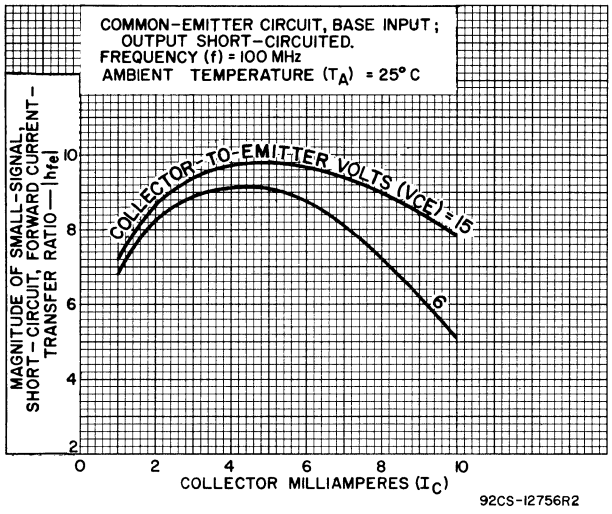


Fig. 2 - Typical small-signal beta characteristics for type 2N3478

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Marca(s) Registrada(s)

Printed in U.S.A.
2N3478 9-66
Supersedes issue dated 9-64

ELECTRICAL CHARACTERISTICS, *At an Ambient Temperature, (T_A) of 25° C*

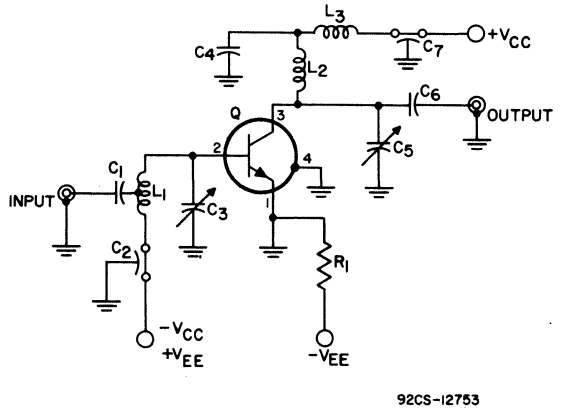
Characteristics	Symbols	TEST CONDITIONS					LIMITS			Units
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N3478			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		1		0		–	–	0.02	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.001	30	–	–	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0.001	15	–	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.001	0	2	–	–	V
Static Forward-Current Transfer Ratio	h_{FE}			8		2	25	–	150	
Magnitude of Small-Signal Forward-Current Transfer Ratio	h_{fe}[a]	100		8		2	7.5	9	16	
Collector-to-Base Feedback Capacitance	C_{cb}[b]	0.1 to 1	8		0		–	–	0.7	pF
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See *Fig. 3*)	G_{pe}[a]	200		8		2	11.5	–	17	dB
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe}[a, c]	470		6		1.5	–	12	–	dB
UHF Noise Figure	NF[a, c]	470		6		1.5	–	5	–	dB
VHF Noise Figure (See *Fig. 3*)	NF[a] NF[a, d]	200 60		8 8		2 1	– –	 2.5	4.5 –	dB dB

[a] Fourth lead (case) grounded.

[b] C_{cb} is a three terminal measurement of the collector-to-base capacitance with the emitter and case connected to the guard terminal.

[c] Source Resistance, R_s = 50 ohms.

[d] Source Resistance, R_s = 400 ohms.



C_1, C_4 = 510 pF
C_2, C_7 = 2300 pF
C_3, C_5 = 2-25 pF
C_6 = 10 pF
R_1 = 2000 ohms
Q = 2N3478
L_1 = ½ Turn #14 Formvar● center tapped
Length$_1$, ℓ_1 = 2 inches
L_2 = ½ Turn #14 Formvar●
Length$_2$, ℓ_2 = 1½ inches
L_3 = 1 μH RF choke
Source (Generator) Resistance R_g = 50 ohms
Load Resistance R_L = 50 ohms

● Trademark, Shawindian Products Corporation.

Fig. 3 - 200 MHz power gain and noise figure test circuit for type 2N3478

Typical Two-Port Admittance (y) Parameters as Functions of Collector Current for Type 2N3478

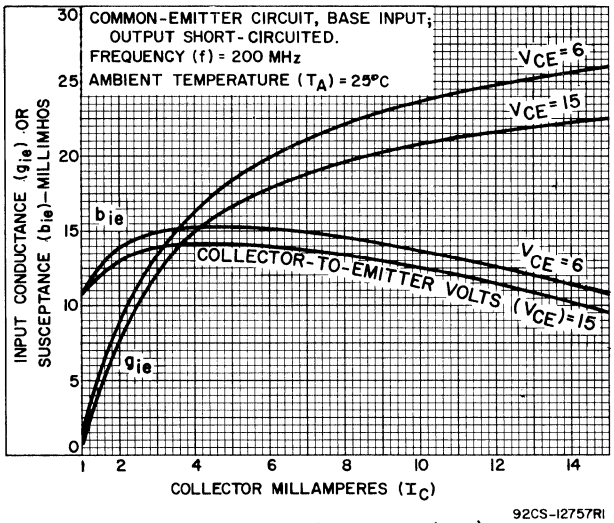


Fig. 4 - Input admittance (y_{ie})

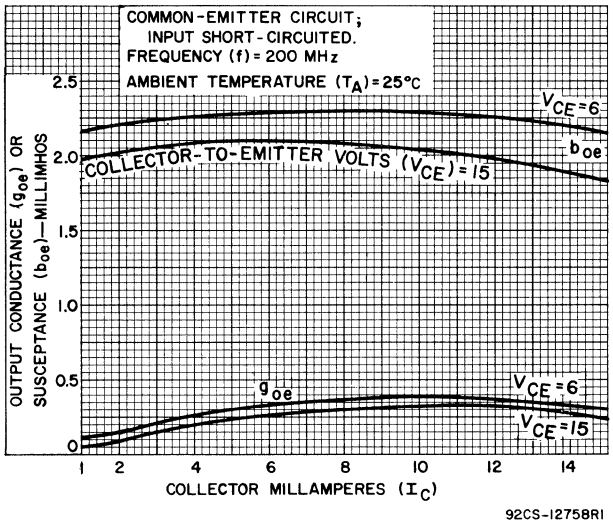


Fig. 5 - Output admittance (y_{oe})

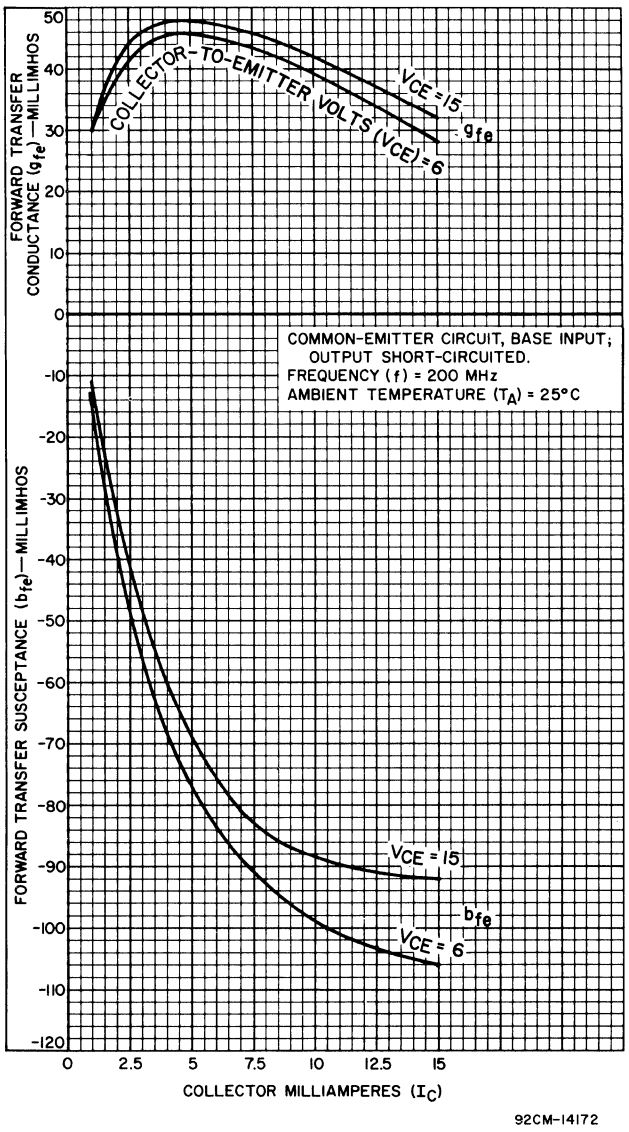


Fig. 6 - Forward transadmittance (y_{fe})

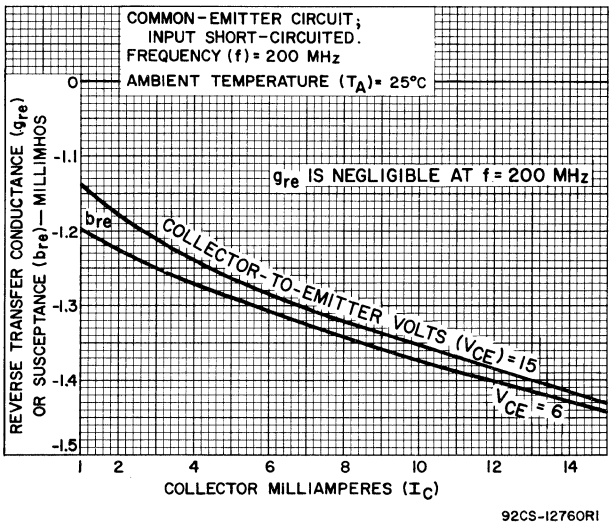
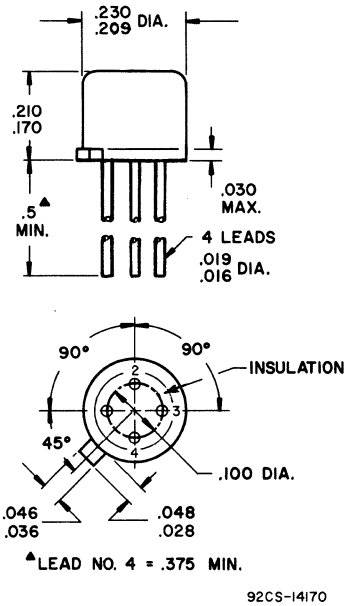


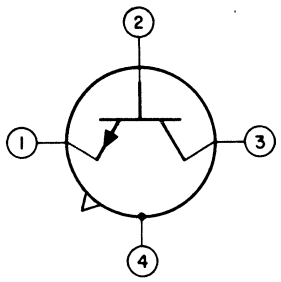
Fig. 7 - Reverse transadmittance (y_{re})

DIMENSIONAL OUTLINE



Dimensions in Inches

TERMINAL DIAGRAM
Bottom View



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector
Lead 4 - Connected to Case

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SILICON HIGH-VOLTAGE TRANSISTOR

2N3583–2N3585
40374, 2N4240

File No. 138

RCA-2N3583,* 2N3584,* 2N3585,* 2N4240,* and 40374 are triple-diffused, silicon n-p-n transistors with high breakdown voltages and fast switching speeds.

Type 40374 is a 2N3583 with a factory-attached heat radiator to permit increasing the free-air dissipation rating. This device is intended for those applications which require a power transistor for mounting on a printed-circuit board. Tabs are provided on the underside of the radiator for mounting purposes and making electrical connection to the collector.

Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection- and hi-fi amplifiers.

These transistors are also intended for a wide variety of applications in AC/DC commercial equipment.

Heat-radiator versions of types 2N3584, 2N3585, and 2N4240 can also be supplied on special order.

* Formerly Dev. Type Nos. TA2510, TA2511, TA2512, and TA2871, respectively.

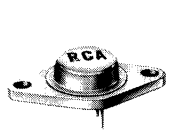
NEW!

Maximum area-of-operation curves for DC & pulse operation.

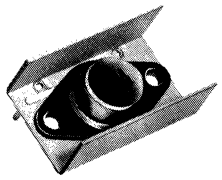
Derating curves for $I_{S/b}$-limited and dissipation-limited operation.

Now possible to determine maximum operating conditions for operation free from second breakdown.

N-P-N Types for High-Speed Switching and Linear-Amplifier Applications



2N3583, 2N3584
2N3585, 2N4240
(JEDEC TO-66)



40374
(JEDEC TO-66 WITH HEAT RADIATOR)

- **High Voltage Ratings:**

	2N3583 / 40374	2N3584	2N3585 / 2N4240	
V_{CBO}	250	375	500	V
$V_{CEO(sus)}$	175	250	300	V

- **Low collector-to-emitter saturation voltage — — $V_{CE(sat)}$ = 0.75 V max. at I_C = 1 A (2N3584 & 2N3585)**
- **100 percent tested to assure freedom from second breakdown in both forward- and reverse-bias conditions when operated within specified limits**
- **JEDEC No. TO-66 package for 2N3583, 2N3584, 2N3585, and 2N4240**
  JEDEC No. TO-66 package with heat radiator for 40374
- **Economy types for AC/DC circuits**
- **Fast turn-on time at high collector current — — 3 μs max. at 1 A (2N3584 & 2N3585)**

MAXIMUM RATINGS

Absolute-Maximum Values:	2N3583	2N3584	2N3585 2N4240	40374	
COLLECTOR-TO-BASE VOLTAGE . . . . . V_{CBO}	250	375	500	250	V
COLLECTOR-TO-EMITTER VOLTAGE. . . . . $V_{CEO(sus)}$	175	250	300	175	V
EMITTER-TO-BASE VOLTAGE . . . . . V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT . . . . . I_C	2	2	2	2	A
PEAK COLLECTOR CURRENT.	5	5	5	5	A
CONTINUOUS BASE CURRENT. . . . . I_B	1	1	1	1	A
TRANSISTOR DISSIPATION . . . . . P_T	See Figs. 4,5,6,7,8,& 9.				
TEMPERATURE RANGE:					
Storage & Operating (Junction)	← -65 to 200 →				°C
PIN TEMPERATURE:					
1/16" ± 1/32" from seating plane for 10 s max. .	255	255	255	255	°C

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Trademark(s) ® Registered
Marca(s) Registrada(s)

Printed in U.S.A.
2N3583–2N3585, 40374, 2N4240 6/66
Reprinted from 2N3583–2N3585, 40374, 2N4240 4/66

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) of 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS								Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Milliamperes)			Types 2N3583 & 40374		Type 2N3584		Type 2N3585		Type 2N4240		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		150					0	–	10	–	5	–	5	–	5	mA
Collector-Cutoff Current	I_{CEV}		225 300 400		- 1.5 - 1.5 - 1.5				– – –	1.0 – –	– – –	– 1.0 –	– – –	– – 1.0	– – –	– – 2.0	mA
Collector-Cutoff Current (At T_C = 150°C)	I_{CEV}		225 300		- 1.5 - 1.5				– –	3 –	– –	– 3	– –	– 3	– –	– 5.0	mA
Emitter-Cutoff Current	I_{EBO}			6		0			–	5.0	–	0.5	–	0.5	–	0.5	mA
DC Forward-Current Transfer Ratio	h_{FE}		10 10 10			100 750 1 amp			40 – 10	– – –	40 – 25	– – 100	40 – 25	– – 100	40 30 –	– 150 –	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 10,11,12,& 13)* With base open	$V_{CEO(sus)}$					200		0	175●	–	250●	–	300●	–	300●	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER(sus)}$					200			250●	–	300●	–	400●	–	400●	–	V
Base-to-Emitter Voltage	V_{BE}		10			1 amp			–	1.4	–	1.4	–	1.4	–	1.4	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					750 1 amp		75 125	– –	– –	– –	– 0.75	– –	– 0.75	– –	1.0 –	V
Small-Signal, Forward-Current Transfer Ratio (At 5 Mc/s)	h_{fe}		10			200			3	–	3	–	3	–	3	–	
Output Capacitance (At 1 Mc/s)	C_{ob}	10					0		–	120	–	120	–	120	–	120	pF
Second-Breakdown▲ Collector Current With base forward biased** *(See Figs. 5 & 6)*	$I_{S/b}$*		100						350	–	350	–	350	–	350	–	mA
Second-Breakdown▲ Energy With base reverse biased R_{BE} = 20 Ω, L = 100 μH	$E_{S/b}$†				-4				50	–	200	–	200	–	50	–	μJ
Sat. Switch Turn-On Time (Delay time + rise time *(See Figs. 19,20,21,23,& 26)*	t_{on}		30 V_{CC}			1 amp		100	–	–	–	3	–	2	–	–	μs
Storage Time *(See Figs. 19,20,22,24,& 26)*	t_s		30 V_{CC}			1 amp		100	–	–	–	4	–	4	–	–	μs
Fall Time *(See Figs. 19,20,21,25,& 26)*	t_f		30 V_{CC}			1 amp		100	–	–	–	3	–	3	–	–	μs
Thermal Resistance: Junction-to-Case	$\theta_{J\text{-}C}$					500			5 (Max.) 2N3583		–	5	–	5	–	5	°C/W
Junction-to-Free Air	$\theta_{J\text{-}FA}$					500			70 (Max.) 2N3583		–	70	–	70	–	70	°C/W
						500			30 (Max.) 40374		–	–	–	–	–	–	°C/W

● **CAUTION:** The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig.12.

▲ Safe-operating region for second breakdown is explained under "SECOND BREAKDOWN" on page 3.

* $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

** Specified value of $I_{S/b}$ for given value of V_{CE} as base voltage is increased from zero in a positive direction.

† $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2\ LI^2$, where L is a series load or leakage inductance and I is the peak collector current from Figs. 1,2, and 3.

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SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

Figure 5 shows the DC current derating curves applicable to the 2N3583, 2N3584, 2N3585, and 2N4240, respectively, at different temperatures. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant at 35 watts). That portion where the slope is approximately -2.5 shows the region where the device is second breakdown limited, and applies for one-second pulse duration (essentially equal to DC operation). For shorter pulses, the transistor's second breakdown capability improves (See Figures 4 and 6).

The 40374 is not limited by second breakdown. Figure 7 shows the collector current derating curves applicable for this type.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the on condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in Figures 1, 2, and 3 are recommended when designing circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals; also, Figures 1, 2, and 3 can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers). For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPES 2N3584 & 2N3585

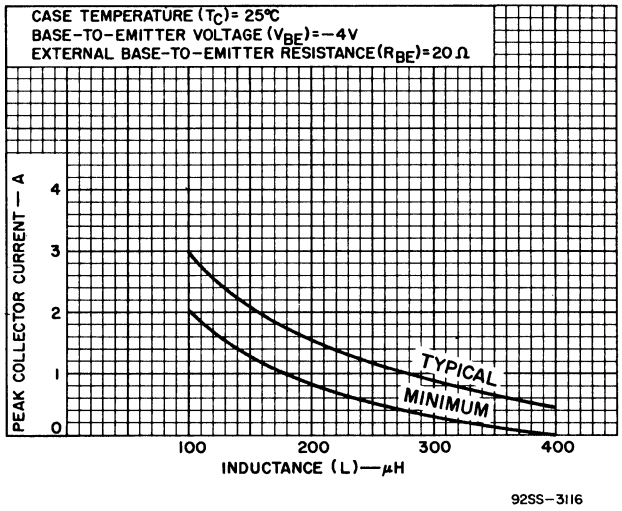


Fig. 1

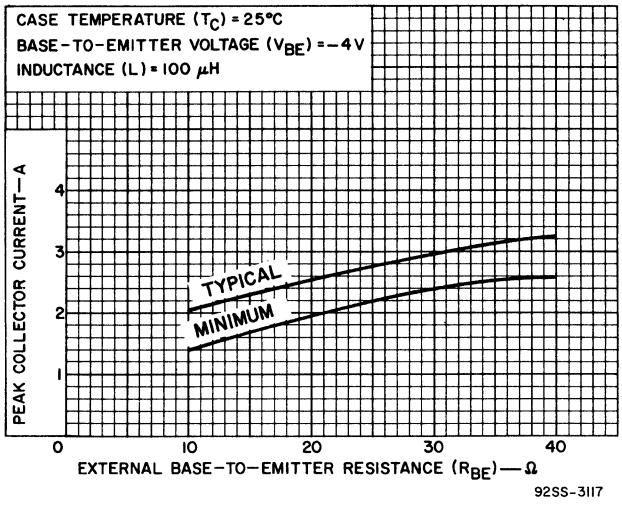


Fig. 2

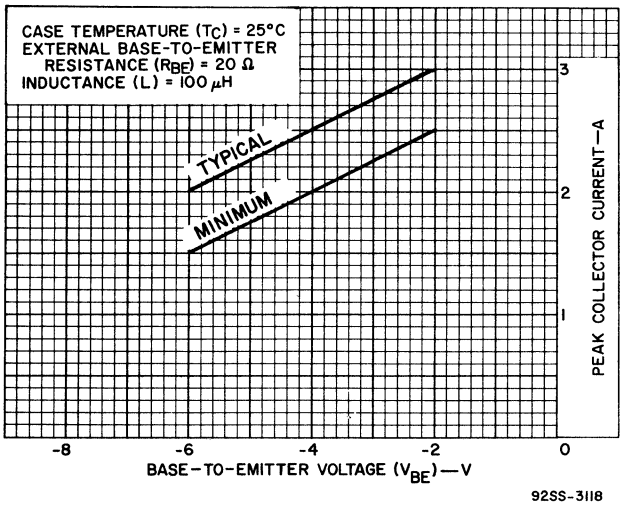


Fig. 3

MAXIMUM AREA-OF-OPERATION

Second breakdown is much less sensitive to temperature variations than normal power-dissipation limitations. Therefore, separate temperature derating curves are required for these two limiting factors as shown in Fig. 4. Figs. 4 & 5 may be used directly for DC operation. For pulse operation at a temperature greater than 25°C, Fig. 6 is used together with Fig. 4 to obtain the maximum allowable power. This is done as follows:

(1) For a specified pulse width and collector-to-emitter voltage, V_{CE}, determine (from Fig. 6) the maximum collector current at 25°C, using the curve marked "DISSIPATION LIMITED" (or its dashed-line extension);

(2) Refer to Fig. 4 and from the dissipation-limited curve determine the percentage current derating at the specified temperature. Apply this derating to the Value of I_C from step 1, to obtain the maximum current for dissipation-limited operation.

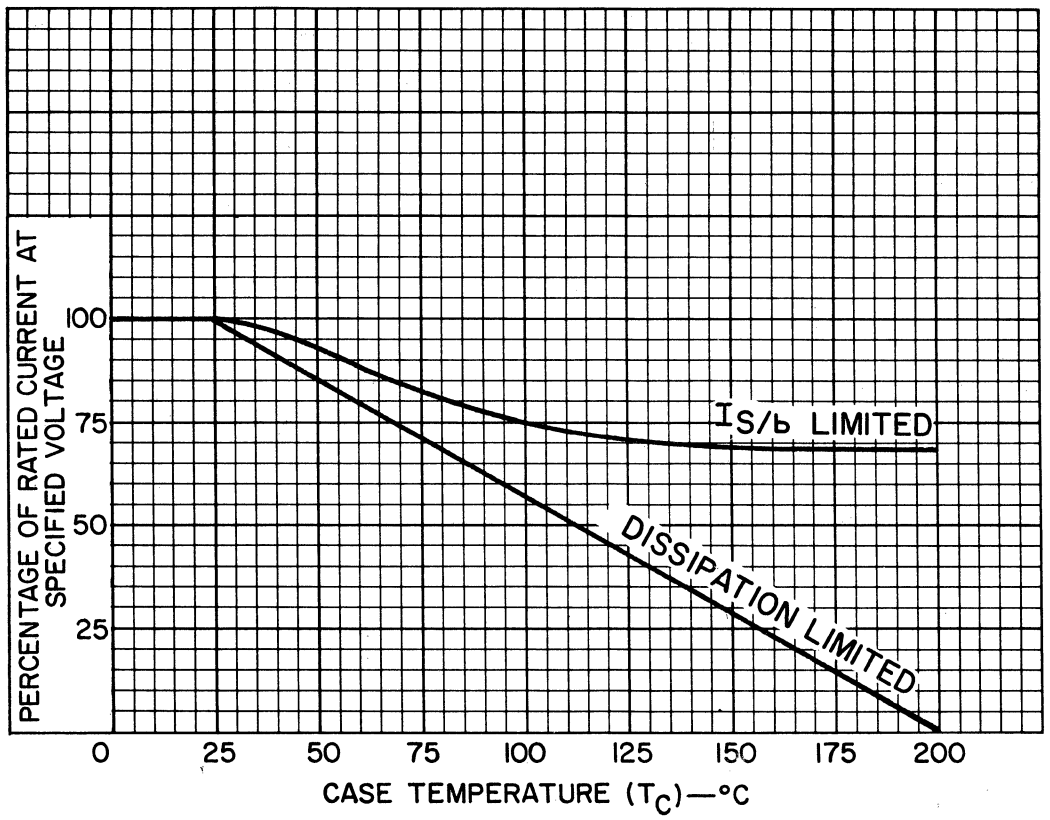
(3) If the specified value of V_{CE} required the use of a dashed-line extension of a dissipation-limited curve in step (1), then repeat step (1), using the curve marked "$I_{S/b}$ LIMITED";

(4) Repeat step 2 using the $I_{S/b}$-LIMITED curve in Fig. 4;

(5) The maximum allowable current is the smaller of the two values obtained in steps (2) and (4).

For repetitive-pulse operation, the actual case temperature to be used in Fig. 4 is the sum of the maximum ambient temperature and the rise in case temperature resulting from the average transistor power dissipation. The temperature rise is the product of average power dissipation and the thermal resistance from case to ambient, which depends on the heat-sink properties.

DISSIPATION DERATING CURVES FOR
FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240



92SS-2796

Fig. 4

MAXIMUM OPERATING AREAS FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240
DC CONDITIONS

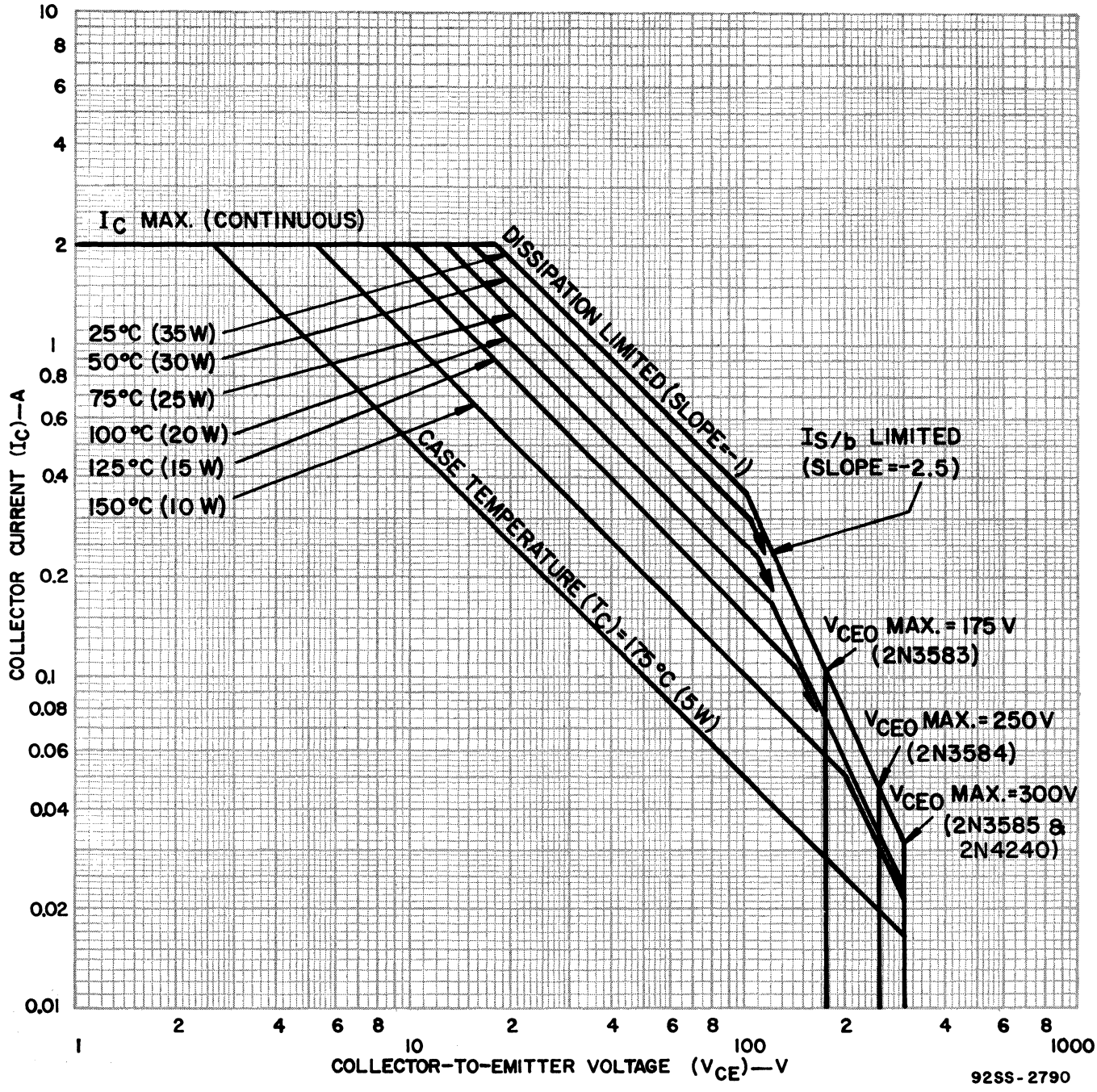


Fig. 5

MAXIMUM OPERATING AREAS FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240
PULSE CONDITIONS

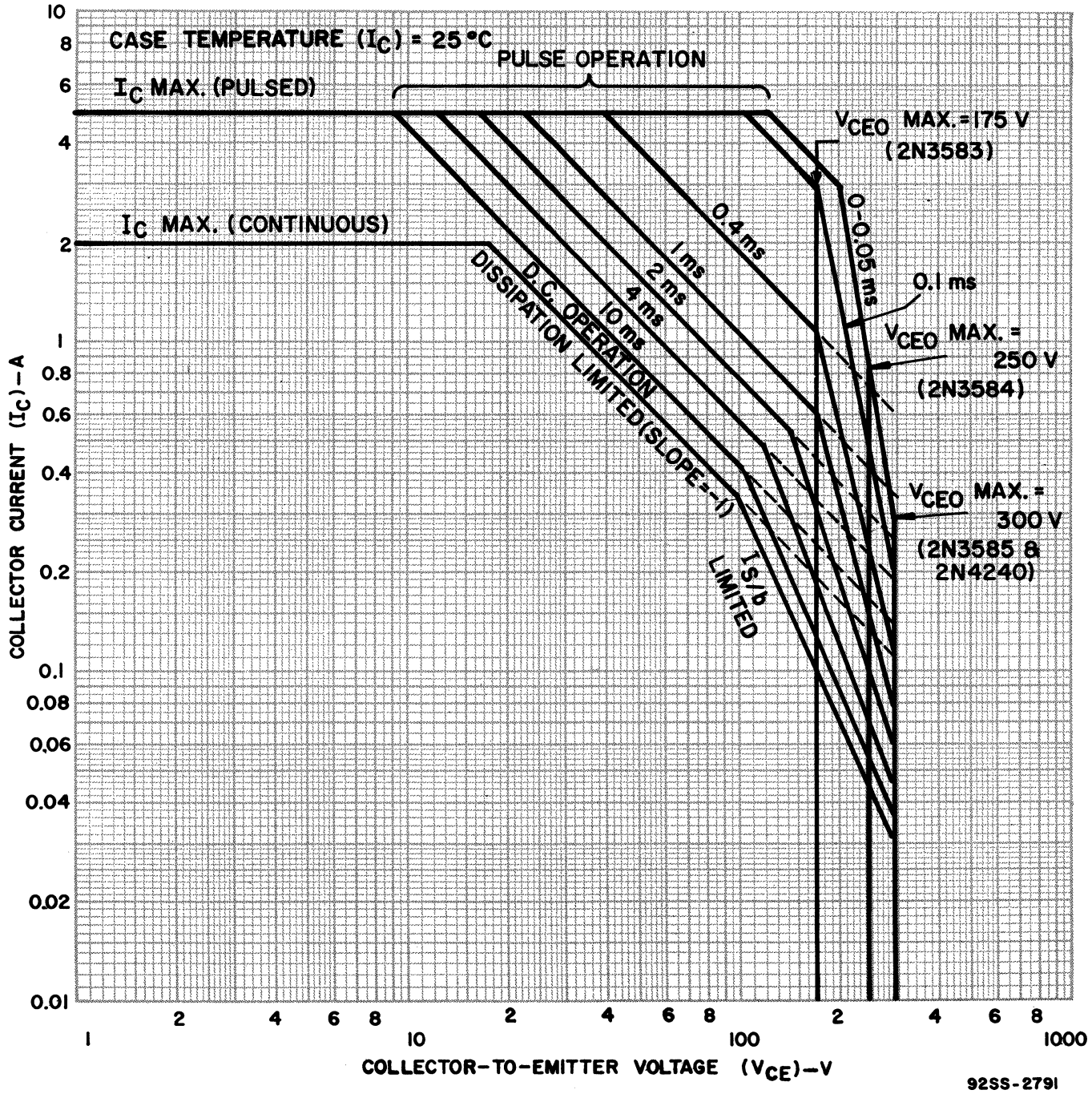


Fig. 6

MAXIMUM OPERATING AREAS FOR TYPE 40374

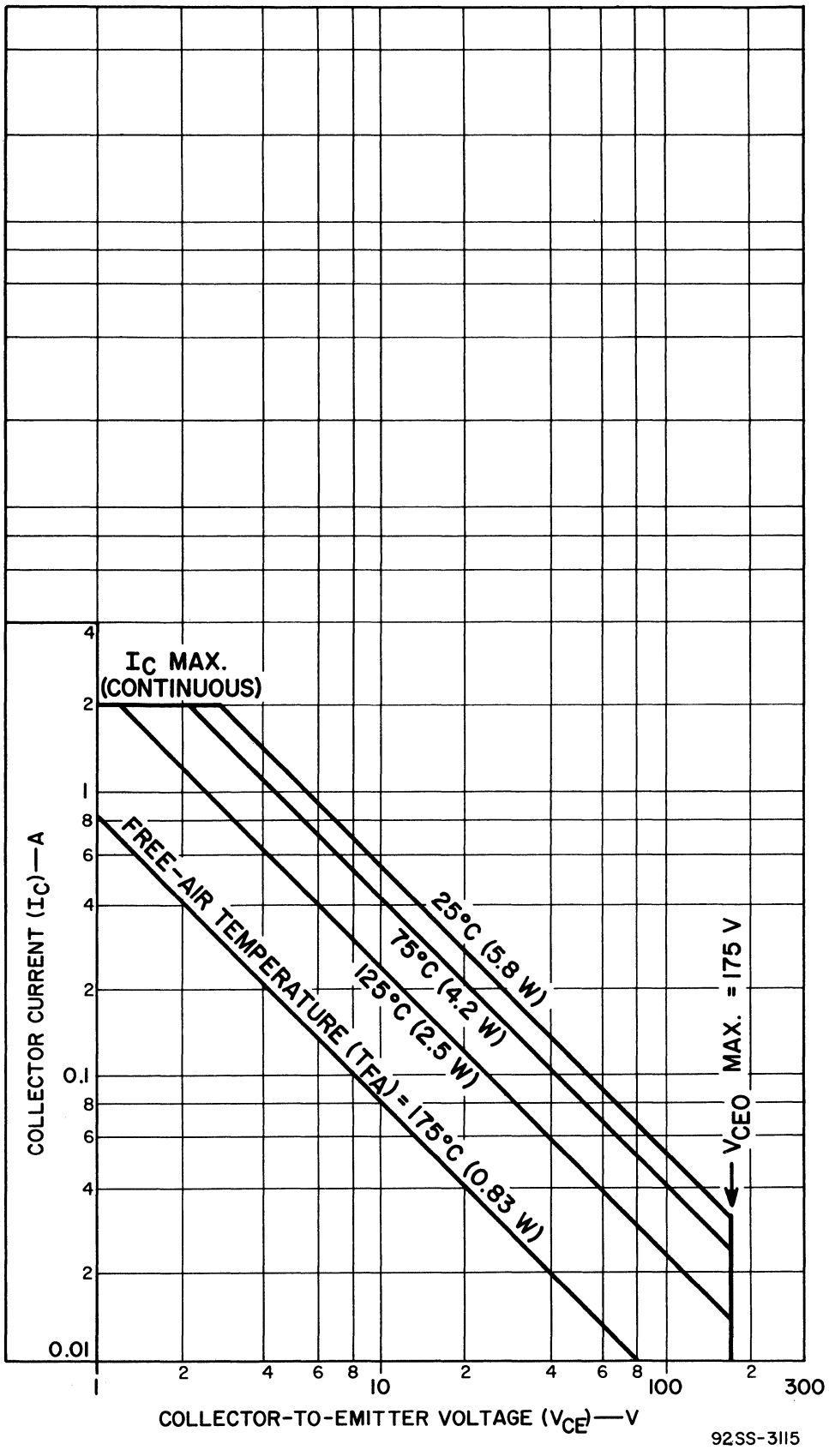


Fig. 7

DISSIPATION DERATING CURVE
FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240

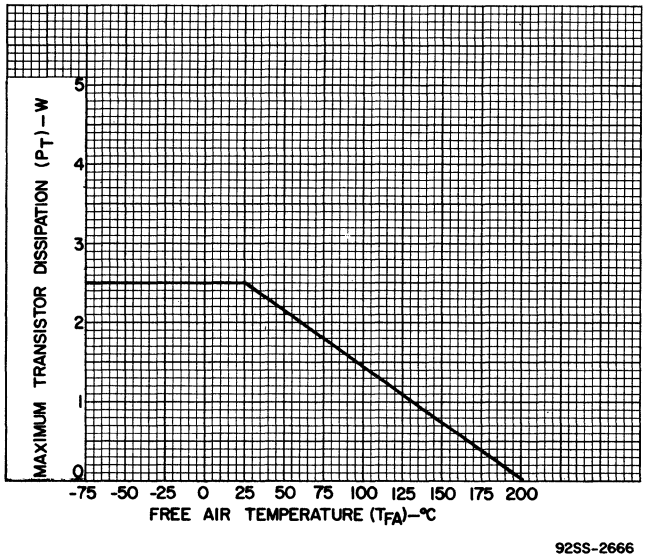


Fig. 8

DISSIPATION DERATING CURVE
FOR TYPE 40374

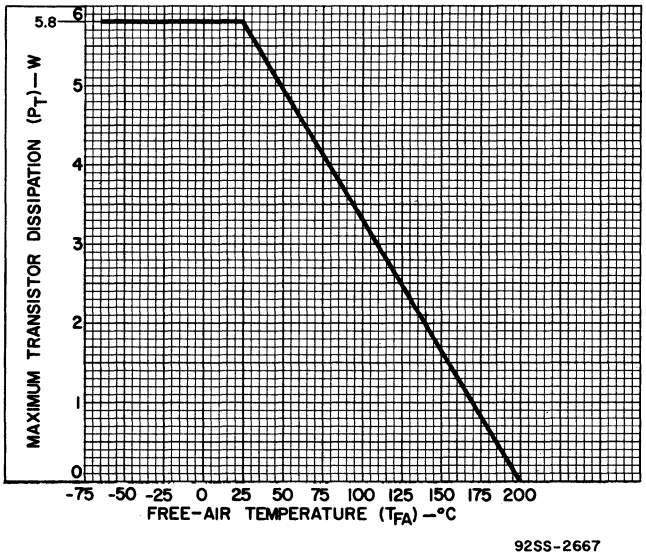


Fig. 9

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPE 2N3584

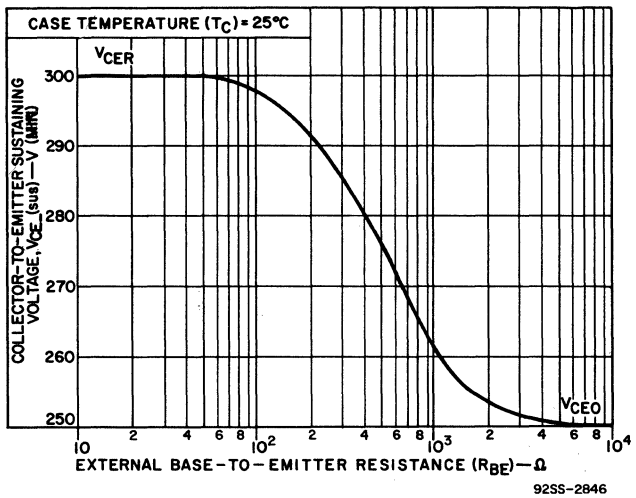


Fig. 10

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPE 2N3585 & 2N4240

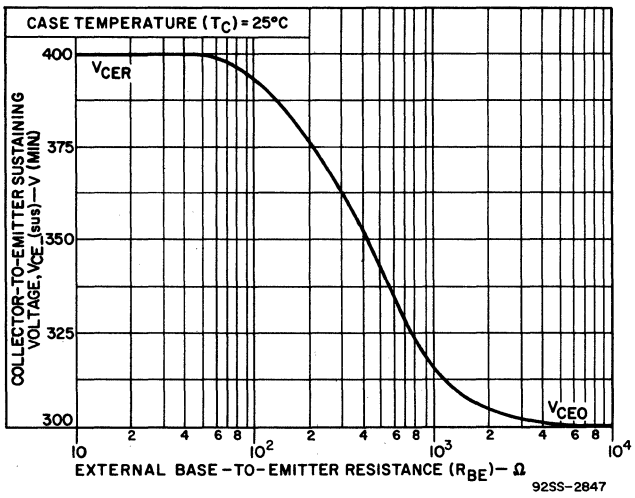
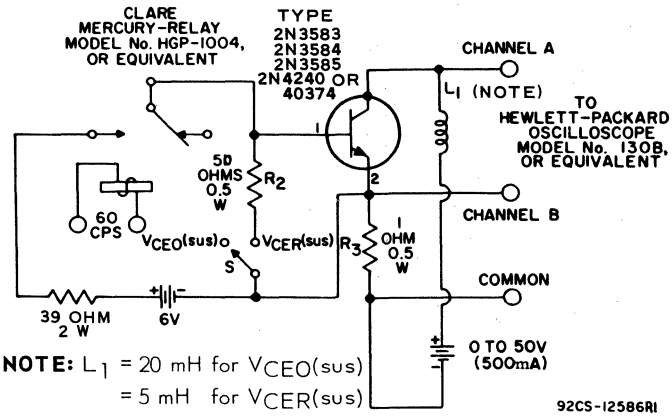


Fig. 11

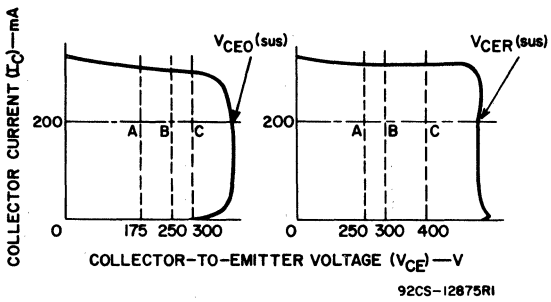
CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES
V_{CEO}(sus) & V_{CER}(sus)
FOR TYPES 2N3583, 2N3584, 2N3585, 2N4240, & 40374



NOTE: L_1 = 20 mH for V_{CEO}(sus)
= 5 mH for V_{CER}(sus)

Fig. 12

OSCILLOSCOPE DISPLAY FOR MEASUREMENT
OF SUSTAINING VOLTAGES
(TEST CIRCUIT SHOWN IN FIG. 12)



NOTE: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) are acceptable when the trace falls to the right and above point "A" for types 2N3583 and 40374, point "B" for type 2N3584, and point "C" for types 2N3585 and 2N4240.

Fig. 13

TYPICAL DC BETA vs. COLLECTOR CURRENT FOR TYPES 2N3583, **2N4240**, & **40374**

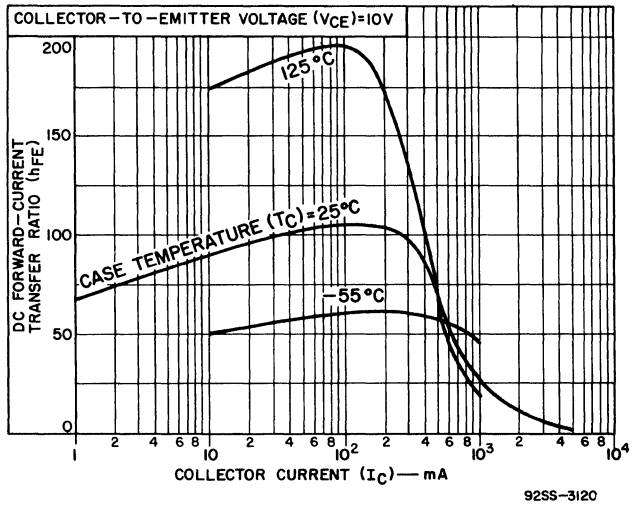


Fig. 14

TYPICAL DC BETA vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

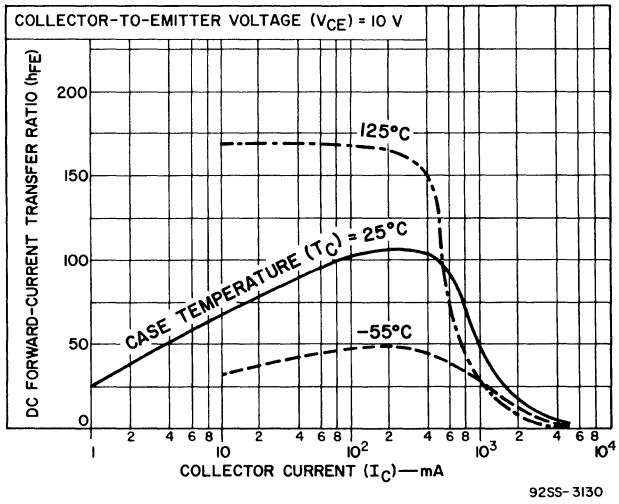


Fig. 15

TYPICAL OUTPUT CHARACTERISTICS FOR TYPES 2N3583 & 40374

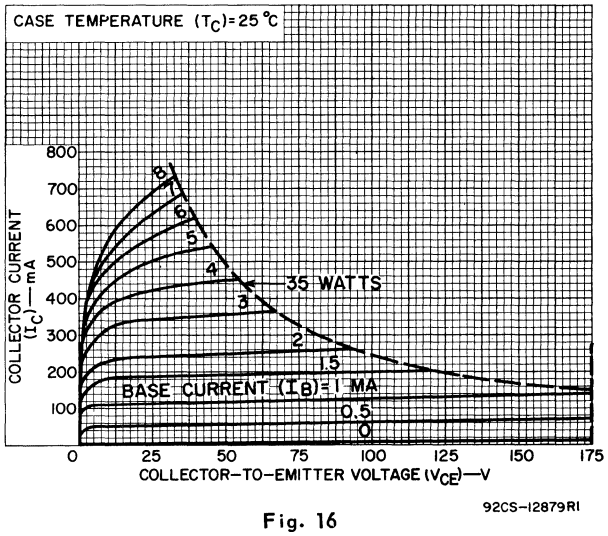


Fig. 16

TYPICAL INPUT CHARACTERISTICS FOR TYPES 2N3583, 2N3584, 2N3585, **2N4240**, & **40374**

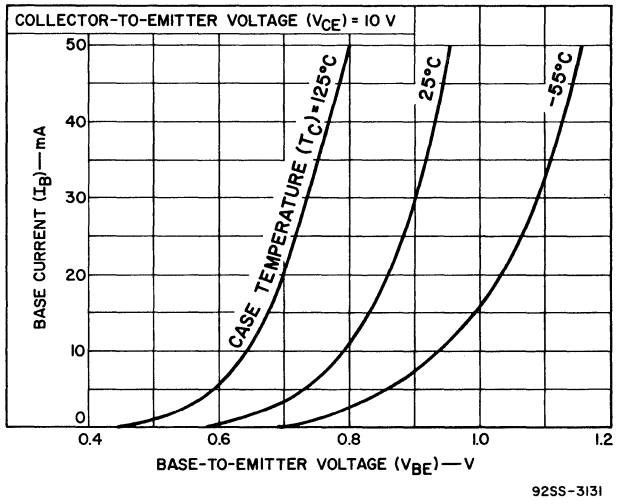


Fig. 17

TYPICAL COLLECTOR-TO-EMITTER SATURATION VOLTAGE vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

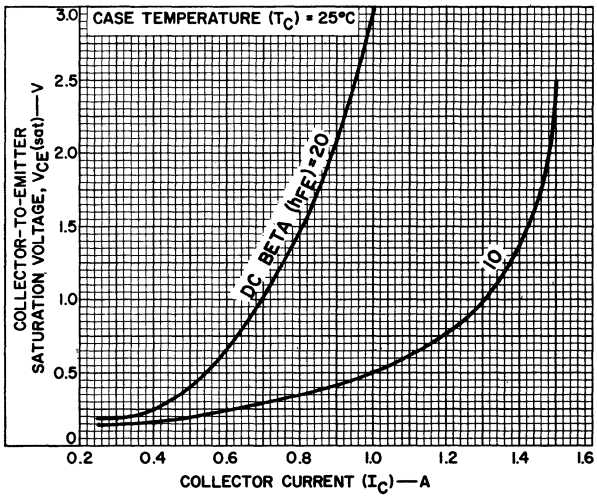
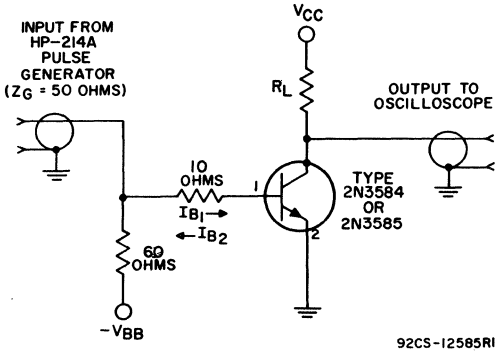


Fig. 18

CIRCUIT USED TO MEASURE SWITCHING TIMES FOR TYPES 2N3584 & 2N3585



INPUT PULSE:

Pulse Width = 20 μs

Fig. 19

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES (TEST CIRCUIT SHOWN IN FIG.19)

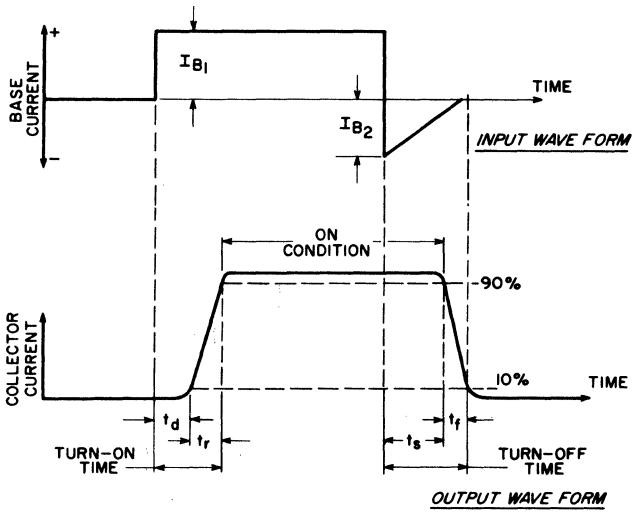


Fig. 20

TYPICAL TURN-ON TIME & FALL TIME vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

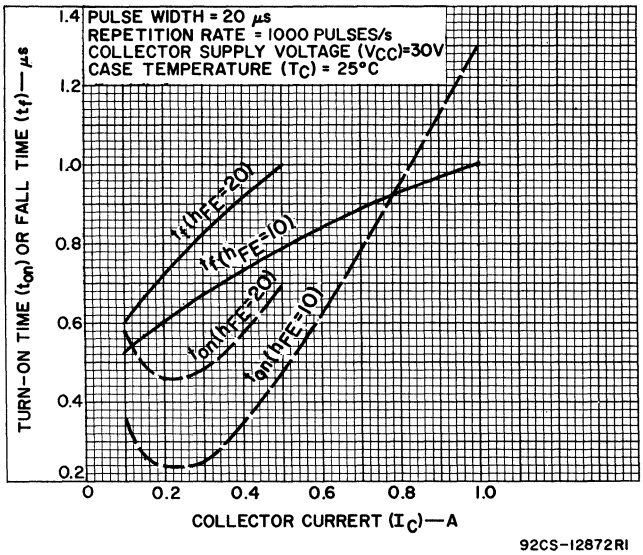


Fig. 21

TYPICAL STORAGE TIME vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

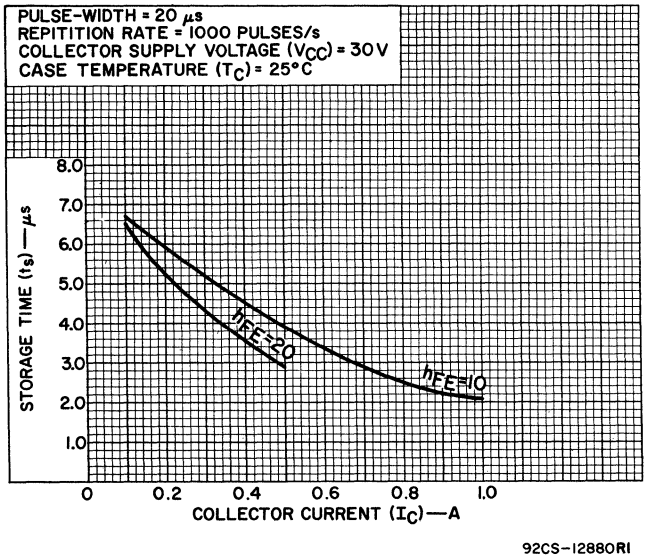


Fig. 22

TYPICAL TURN-ON TIME vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

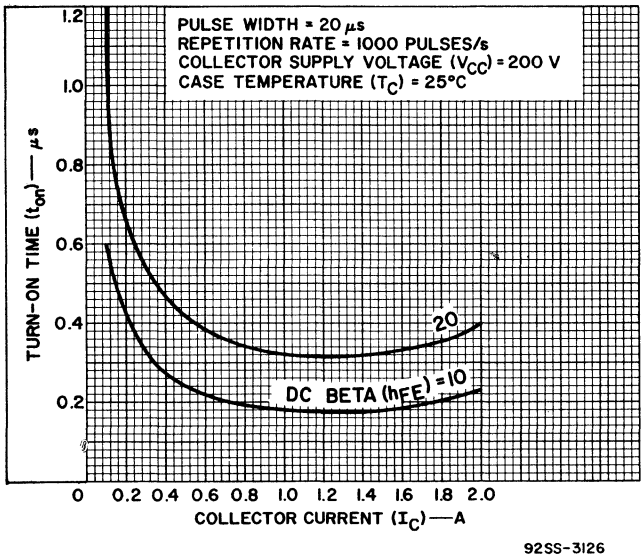


Fig. 23

TYPICAL STORAGE TIME vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

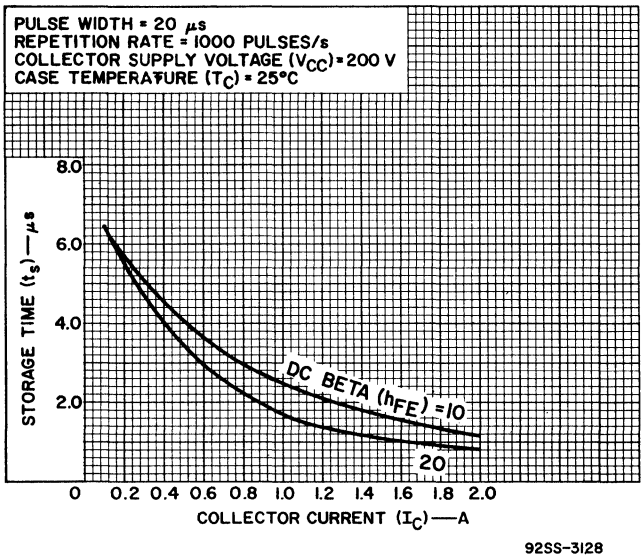


Fig. 24

TYPICAL FALL TIME vs. COLLECTOR CURRENT FOR TYPES 2N3584 & 2N3585

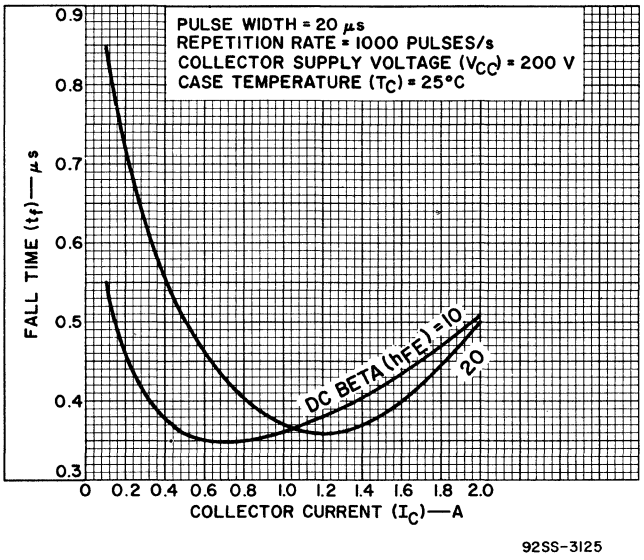


Fig. 25

TYPICAL TURN-ON TIME, FALL TIME, & STORAGE TIME vs. COLLECTOR SUPPLY VOLTAGE FOR TYPES 2N3584 & 2N3585

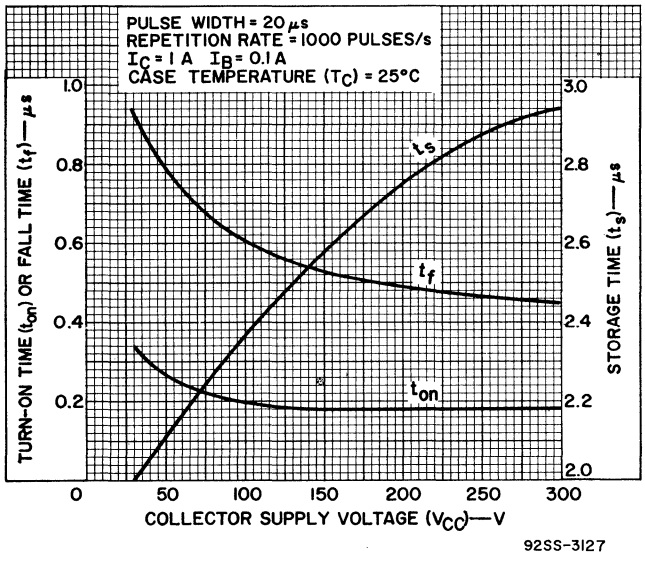
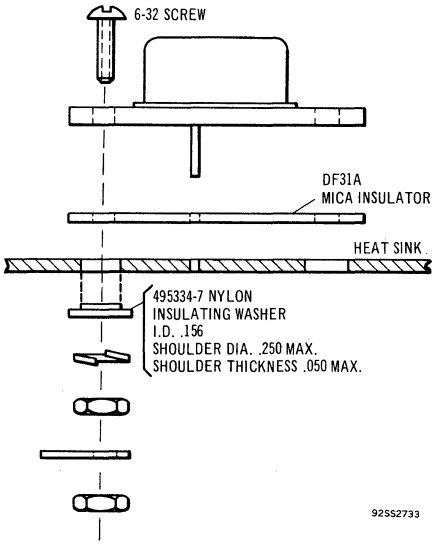


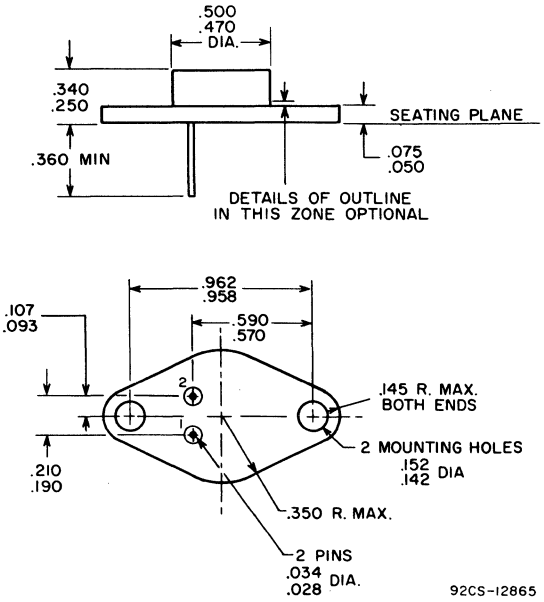
Fig. 26

SUGGESTED HARDWARE FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240



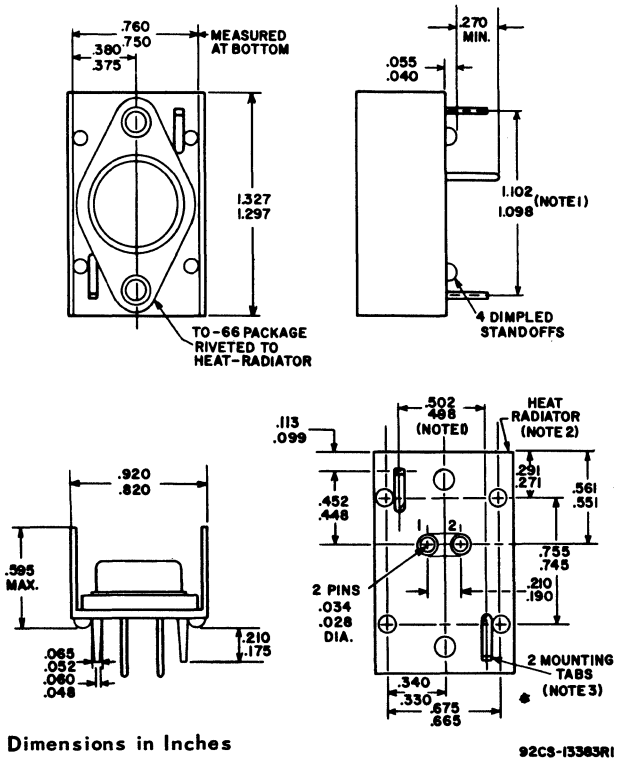
NOTE: Hardware with part numbers are supplied

DIMENSIONAL OUTLINE FOR TYPES 2N3583, 2N3584, 2N3585, & 2N4240 JEDEC NO. TO-66



Dimensions in Inches

DIMENSIONAL OUTLINE FOR TYPE 40374 JEDEC TO-66 WITH HEAT-RADIATOR



Dimensions in Inches

NOTE 1: Measured at bottom of heat-radiator.

NOTE 2: 0.035" C.R.S., tin plated.

NOTE 3: Recommended hole size for printed-circuit board is 0.070" dia.

TERMINAL CONNECTIONS FOR TYPES 2N3583, 2N3584, 2N3585, 2N4240, & 40374

Pin 1 - Base

Pin 2 - Emitter

Flange, Case-Collector (For 2N3583, 2N3584, 2N3585, & 2N4240)

Heat Radiator-Collector (For 40374)

SILICON N-P-N "overlay" TRANSISTORS

2N3632 2N3553
2N3375

File No. 92

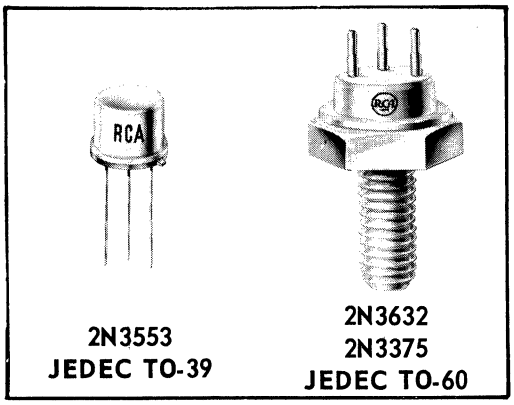
RCA-2N3632, 2N3553, and 2N3375 are epitaxial silicon n-p-n planar transistors of the "overlay" emitter electrode construction. They are intended for class–A*, –B, or –C amplifier, frequency multiplier, or oscillator operation. The 2N3375 and the 2N3553 are especially intended for VHF-UHF applications; the 2N3632 for use in VHF circuits.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a single base and collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter or collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, and frequency capability.

High-Power

VHF-UHF

Amplifier



2N3553
JEDEC TO-39

2N3632
2N3375
JEDEC TO-60

- **High Power Output, Class-C Amplifier**

RCA TYPE	FREQUENCY			
	400 MHz	260 MHz	175 MHz	100 MHz
2N3632		10W Typ.	13.5W Min.	
2N3553		2.5W Typ.	2.5W Min.	
2N3375	3W Min.			7.5W Min.

- **High Power Output, Oscillator**
  2.5W (Typ.) at 500 MHz, 2N3375
  1.5W (Typ.) at 500 MHz, 2N3553
- **High Voltage Ratings**
- **Second Breakdown Protected**

POWER OUTPUT vs. FREQUENCY FOR TYPE 2N3632

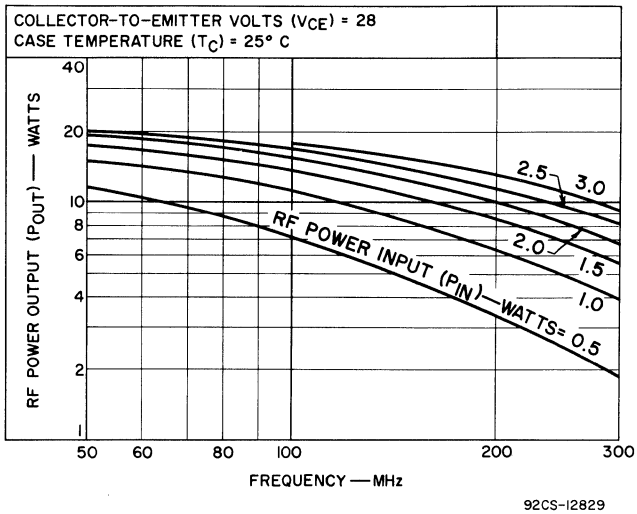


Fig. 1

RATINGS FOR RF SERVICE*

Maximum Ratings, *Absolute-Maximum Values:*

		2N3553	2N3375	2N3632	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	65	65	V
COLLECTOR-TO-EMITTER VOLTAGE:					
With base open	V_{CEO}	40	40	40	V
With $V_{BE} = -1.5V$	V_{CEV}	65	65	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	4	4	V
COLLECTOR CURRENT:					
Peak		1.0	1.5	3.0	A
Continuous	I_C	0.33	0.5	1.0	A
TRANSISTOR DISSIPATION*	P_T				
At case temperatures up to 25° C		7.0	11.6	23	W
At case temperatures above 25° C		Derate linearly to 0 watts at 200° C			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		-65 to 200			°C
LEAD TEMPERATURE (During soldering):					
At distances ≥ 1/32 in. from insulating wafer (TO-60 package) or from seating plane (TO-39 package) for 10 s max		230			°C

*Secondary breakdown considerations limit maximum DC operating conditions. . . contact your RCA representative for specific data.

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Printed in U.S.A.
2N3632,2N3553 & 2N3375 5/66
Supersedes 2N3632, 2N3553 & 2N3375 10/65

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						LIMITS						Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)			2N3632		2N3553		2N3375		
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		-	0.25	-	0.1	-	0.1	mA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0 0 0		0.1 0.3 0.5	- - 65	- - -	- 65 -	- - -	65 - -	- - -	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	0 to 200[a]	40[b]	-	40[b]	-	40[b]	-	V
	BV_{CEV}			−1.5			0 to 200[a]	65[b]	-	65[b]	-	65[b]	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1 0.25		0 0	- 4	- -	4 -	- -	4 -	- -	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					100 50	500 250	- -	1 -	- -	- 1	- -	1 -	V
Collector-to-Base Capacitance Measured at 1 MHz	C_{ob}	30			0			-	20	-	10	-	10	pF
RF Power Output Amplifier, Unneutralized At 100 MHz (See *Fig.7*) 175 MHz (See *Figs.5 & 10*) 260 MHz (See *Figs.4, 6, & 11*) 400 MHz (See *Fig.8*) Oscillator At 500 MHz (See *Fig.9*)	P_{OUT}		28 28 28 28 28					- 13.5[g] 10[h] (typ.) - -	- - - -	- 2.5[i] - 1.5[f] (typ.)	- - - -	7.5[c] - 3[d] 2.5[e] (typ.)	- - - -	W
Gain-Bandwidth Product	f_T		28 28				100 150	- 400 (typ.)	-	500 (typ.) -	-	- 500 (typ.)	-	MHz
Base-Spreading Resistance Measured at 100 MHz 200 MHz 400 MHz	$r_{bb'}$		28 28 28				100 250 250	- 6.5 (typ.) -	- -	12.0 (typ.) - -	- -	- - 10.0 (typ.)	- -	ohms
Collector-to-Case Capacitance	C_s							-	6	-	-	-	6	pF

[a] Pulsed through an inductor (25 mH); duty factor = 50%.

[b] Measured at a current where the breakdown voltage is a minimum.

[c] For P_{IN} = 1.0 W; minimum efficiency = 65%.

[d] For P_{IN} = 1.0 W; minimum efficiency = 40%.

[e] Typical efficiency = 40%.

[f] Typical efficiency = 30%.

[g] For P_{IN} = 3.5 W; minimum efficiency = 70%.

[h] For P_{IN} = 3.0 W; typical efficiency = 60%.

[i] For P_{IN} = 1/4 W; minimum efficiency = 50%.

POWER OUTPUT vs. FREQUENCY FOR TYPE 2N3375

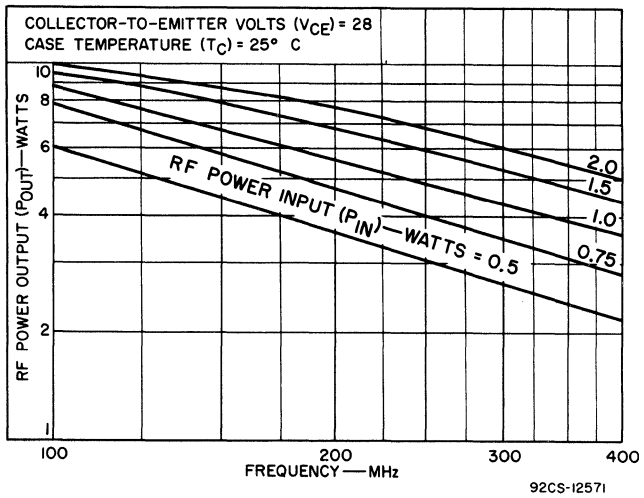


Fig.2

POWER OUTPUT vs. FREQUENCY FOR TYPE 2N3553

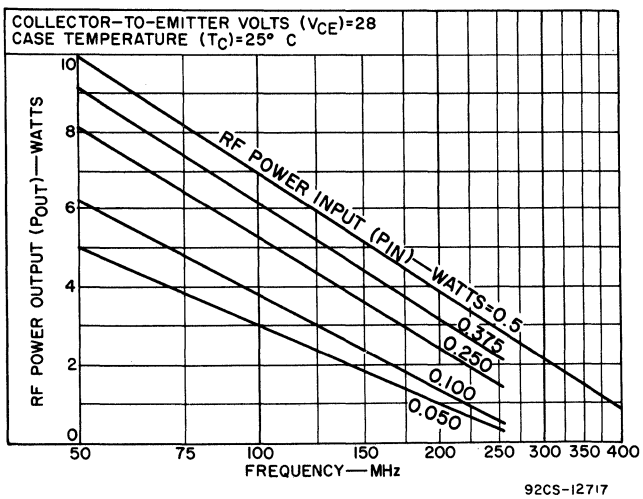
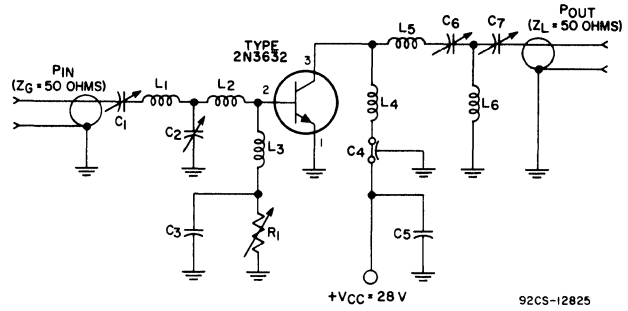


Fig.3

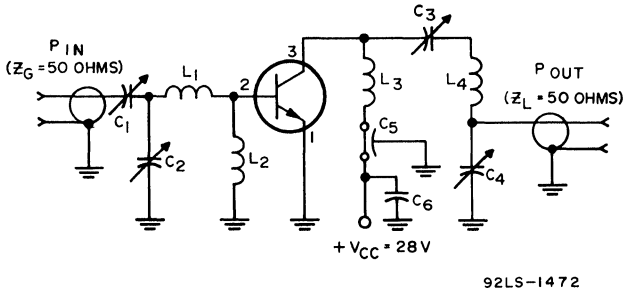
RF AMPLIFIER CIRCUIT FOR 2N3632 POWER-OUTPUT TEST (260-MHz Operation)



C_1: 3-35 pF
C_2, C_7: 8-60 pF
C_3, C_5: 0.005 µF, disc ceramic
C_4: 1000 pF
C_6: 1.5-20 pF
L_1: 3 turns No.18 wire, 1/4" ID, 1/4" long
L_2: 3/16" wide copper strip, 3/8" long
L_3: Ferrite choke, Z = 450 ohms
L_4: RF choke, 0.47 µH
L_5: 3-1/2 turns No.16 wire, 1/4" ID, 7/16" long
L_6: 1 turn No.16 wire, 1/4" ID, 3/8" long
R_1: 50 ohms

Fig.4

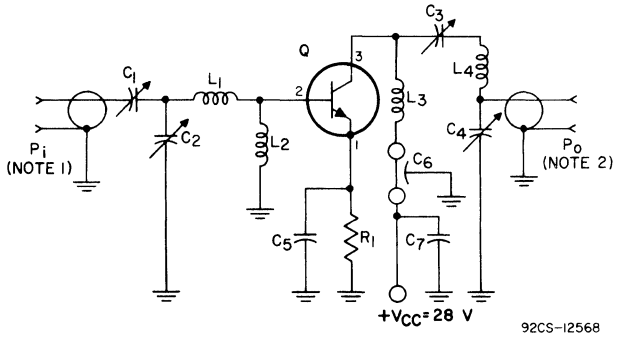
RF AMPLIFIER CIRCUIT FOR 2N3632 POWER-OUTPUT TEST (175-MHz Operation)



C_1, C_2, C_3, C_4: 7-100 pF
C_5: 1000 pF
C_6: 0.01 µF, disc ceramic
L_1: 1.5 turns No.16 wire, 3/16" ID, 5/16" long
L_2: Ferrite choke, Z = 450 ohms
L_3: 1 turn No.16 wire, 1/4" ID, 3/8" long
L_4: 2 turns No.16 wire, 1/4" ID, 1/4" long

Fig.5

RF AMPLIFIER CIRCUIT FOR 2N3375 POWER-OUTPUT TEST (260-MHz Operation)

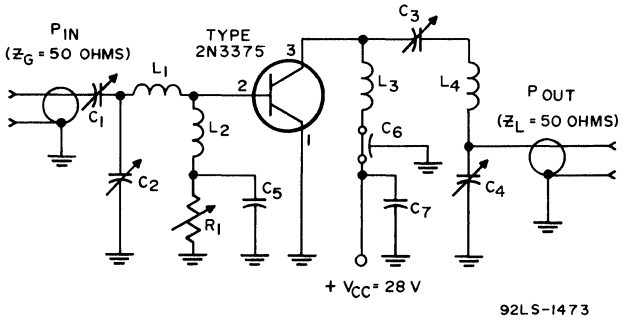


NOTE 1: GENERATOR IMPEDANCE = 50 OHMS.
NOTE 2: LOAD IMPEDANCE = 50 OHMS.

C_1: 2-25 pF
C_2, C_3, C_4: 4-40 pF
C_5: 50 pF, disc ceramic
C_6: 1500 pF
C_7: 0.005 µF, disc ceramic
L_1: 1 turn No.16 wire, 1/4" ID, 1/8" long
L_2: Ferrite choke, Z = 450 (±20%) ohms
L_3: 0.47-µH choke
L_4: 2 turns No.16 wire, 3/8" ID, 7/16" long
R_1: 1.35 ohms, non-inductive

Fig.6

RF AMPLIFIER CIRCUIT FOR 2N3375 POWER-OUTPUT TEST (100-MHz Operation)



C_1, C_2, C_3, C_4: 7-100 pF
C_5: 0.005 µF, disc ceramic
C_6: 1000 pF
C_7: 0.01 µF, disc ceramic
L_1: 2 turns No.16 wire, 3/8" ID, 3/4" long
L_2, L_3: 1.5 µH choke
L_4: 7 turns No.16 wire, 3/8" ID, 1" long
R_1: 1000 ohms, adjustable

Fig.7

RF AMPLIFIER CIRCUIT FOR 2N3375 POWER-OUTPUT TEST (400-MHz Operation)

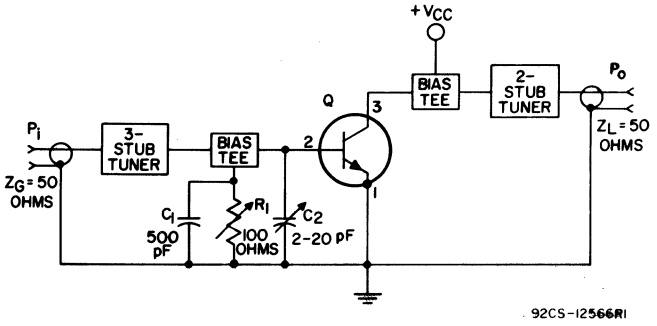


Fig.8

OSCILLATOR CIRCUIT FOR 2N3553 OR 2N3375 POWER-OUTPUT TEST (500-MHz Operation)

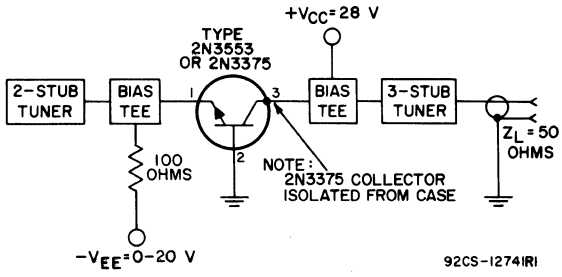
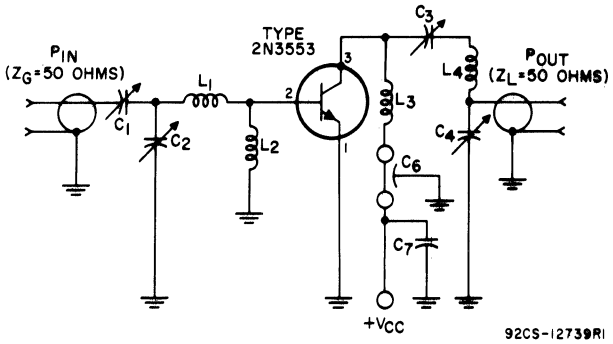


Fig.9

RF AMPLIFIER CIRCUIT FOR 2N3553 POWER-OUTPUT TEST (50- & 175-MHz Operation)



For 50-MHz Operation:

C_1, C_2: 24-200 pF
C_3: 32-250 pF
C_4: 7-100 pF
C_5: 1800 pF, disc ceramic
C_6: 2000 pF
C_7: 0.01 µF, disc ceramic

L_1: 5 turns No.16 wire, 1/4" ID, 1/2" long
L_2: Ferrite choke, Z = 450 ohms
L_3: 7 µH choke
L_4: 6 turns No.20 wire on 3/8" coil form (slug-tuned), 1-1/8" long
R_1: 1.35 ohms, non-inductive

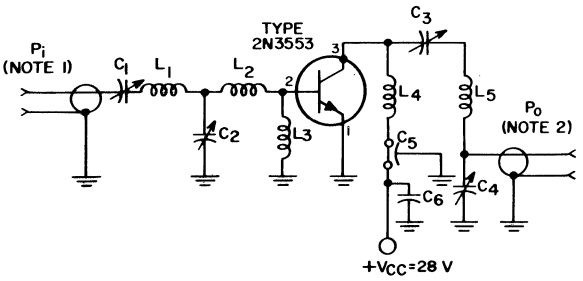
For 175-MHz Operation:

C_1: 2-25 pF
C_2: 4-40 pF
C_3: 1.5-20 pF
C_4: 1.5-20 pF
C_5: 100 pF, disc ceramic
C_6: 2000 pF
C_7: 0.01 µF, disc ceramic

L_1: 1-1/2 turns No.16 wire, 5/16" ID, 1/2" long
L_2: Ferrite choke, Z = 750 ohms
L_3: 4 turns No.16 wire, 5/16" ID, 1" long
L_4: 7 turns No.16 wire, 5/16" ID, 1-1/8" long
R_1: 1.35 ohms, non-inductive

Fig.10

RF AMPLIFIER CIRCUIT FOR 2N3553 POWER-OUTPUT TEST (260-MHz Operation)



C_1, C_4: 1.5-20 pF
C_2, C_3: 3-35 pF
C_5: 1,000 pF
C_6: 0.005 µF, disc ceramic

L_1: 4 turns No.16 wire, 3/8" ID, 3/8" long
L_2: 3/16" wide copper strip, 7/16" long
L_3: Ferrite choke, Z = 450 ohms
L_4: 1/2 turn 3/16" wide copper strip, 1/4" ID
L_5: 2 turns 3/16" wide copper strip, 1/4" ID, 1/2" long

Fig.11

TYPICAL 175-MHz AMPLIFIER CHAIN FOR P_{OUT} OF 25 TO 30 WATTS

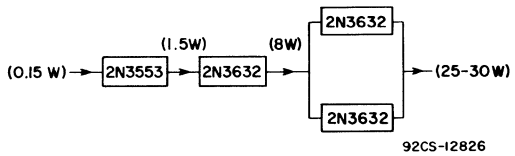


Fig.12

TYPICAL 260-MHz AMPLIFIER CHAIN FOR P_{OUT} OF 10 WATTS

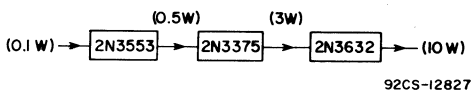


Fig.13

PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

FOR TYPE 2N3632

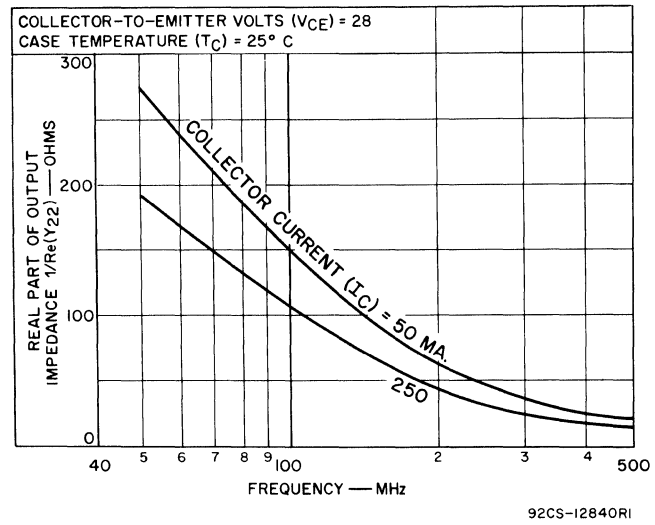


Fig.26

FOR TYPE 2N3375

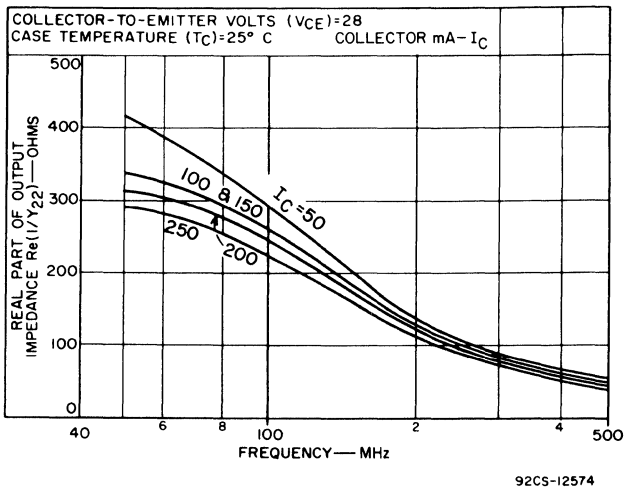


Fig.27

FOR TYPE 2N3553

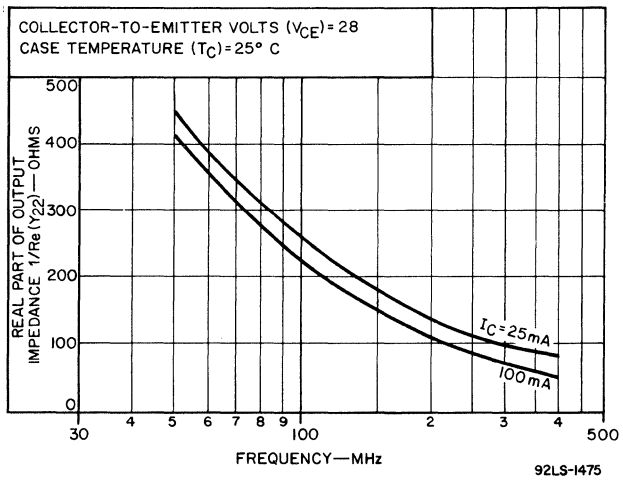


Fig.28

VARIATION OF COLLECTOR-TO-BASE CAPACITANCE

FOR TYPE 2N3632

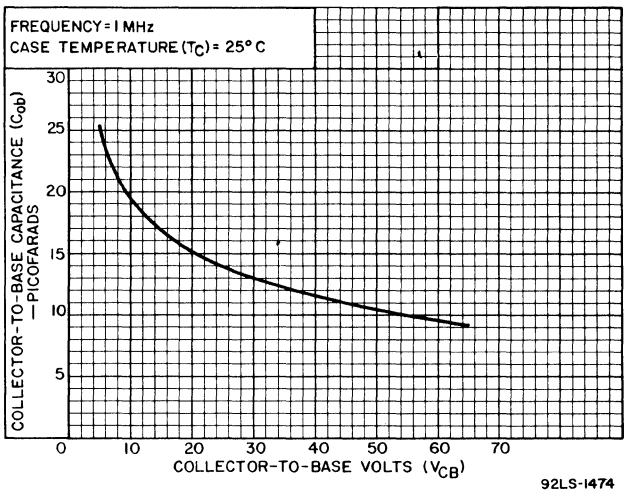


Fig.29

FOR TYPE 2N3553

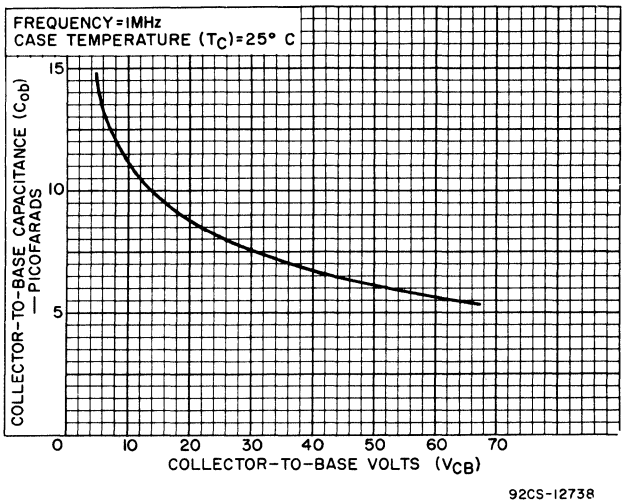
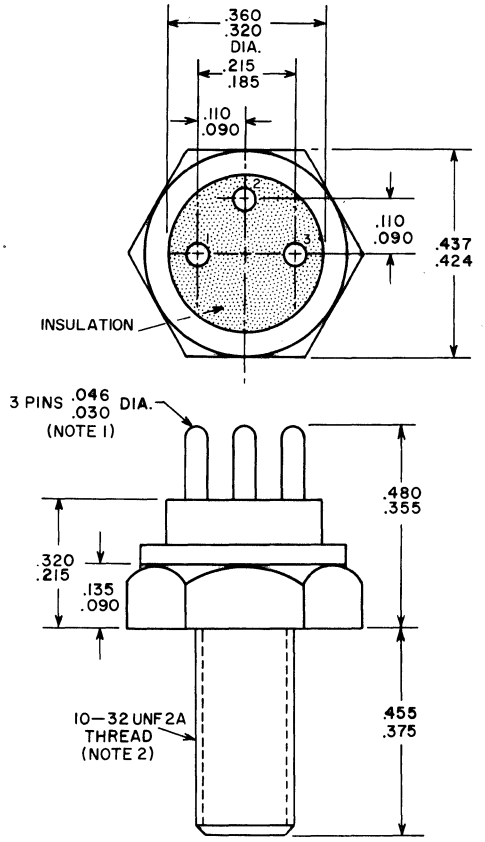


Fig.30

DIMENSIONAL OUTLINES

FOR TYPES 2N3632 & 2N3375 JEDEC TO-60



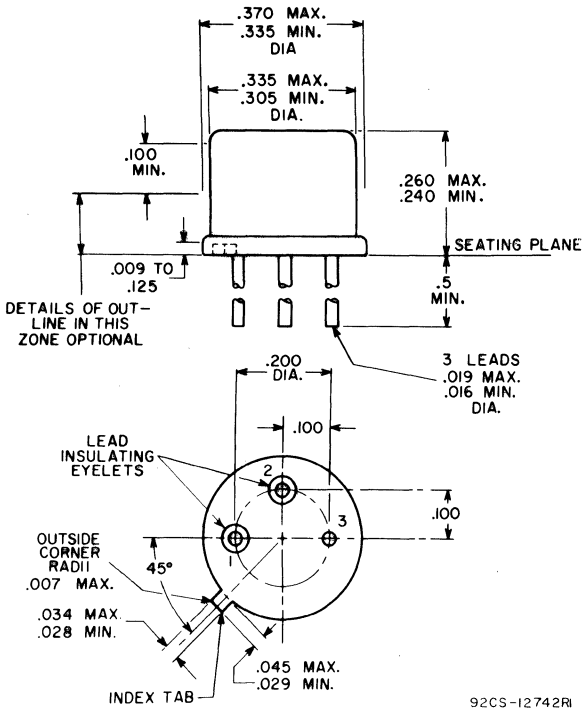
DIMENSIONS IN INCHES

NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200" AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.035" MIN., 0.045" MAX.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

NOTE 3: THIS DEVICE MAY BE OPERATED IN ANY POSITION.

FOR TYPE 2N3553 JEDEC TO-39



DIMENSIONS IN INCHES

TERMINAL CONNECTIONS

Pin or Lead No.1 - Emitter

Pin or Lead No.2 - Base

Pin or Lead No.3 - Collector (For 2N3632, 2N3375)
Collector, Case (For 2N3553)

GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

FOR TYPE 2N3632

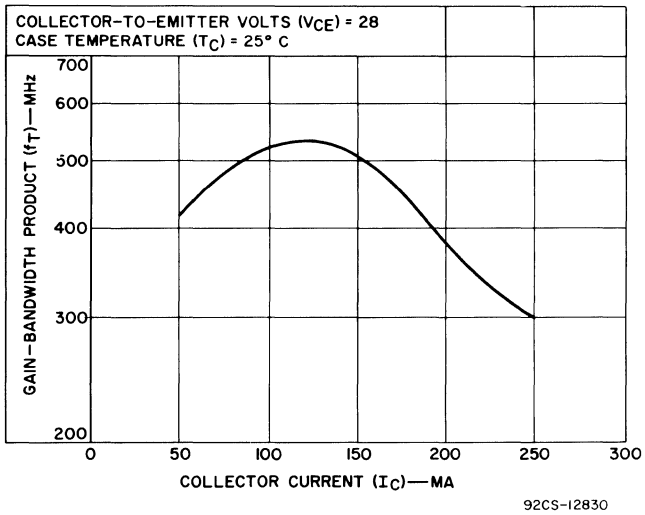


Fig.14

FOR TYPE 2N3375

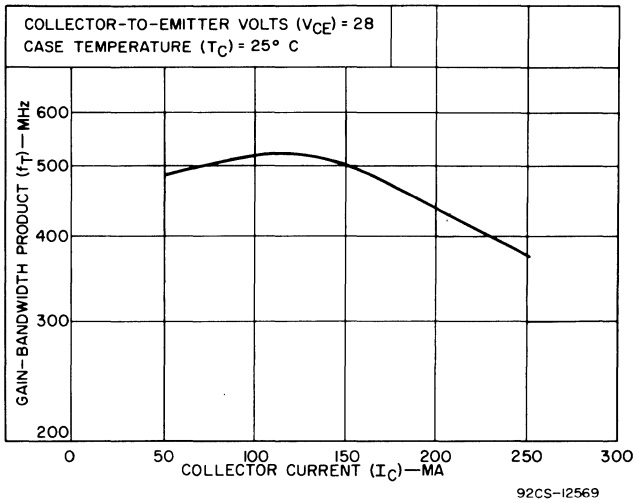


Fig.15

FOR TYPE 2N3553

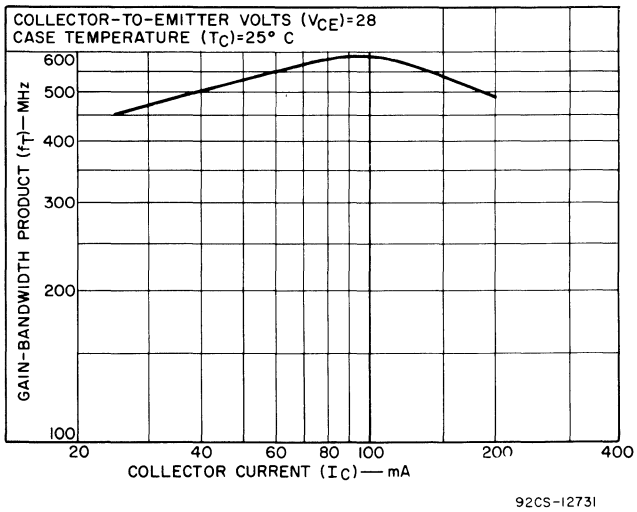


Fig.16

SERIES INPUT RESISTANCE vs. FREQUENCY

FOR TYPE 2N3632

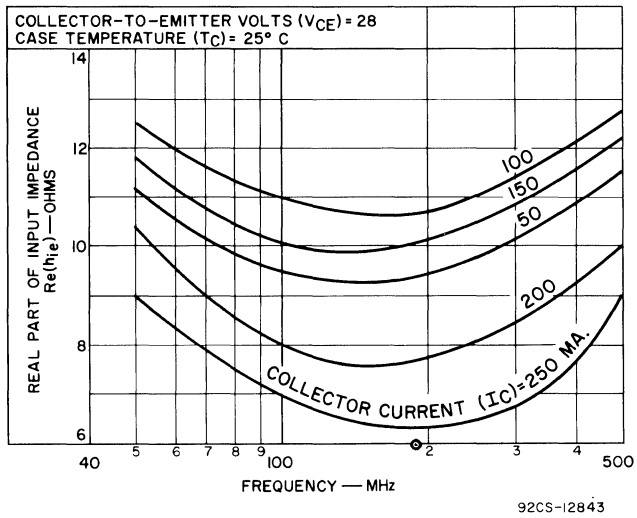


Fig.17

FOR TYPE 2N3375

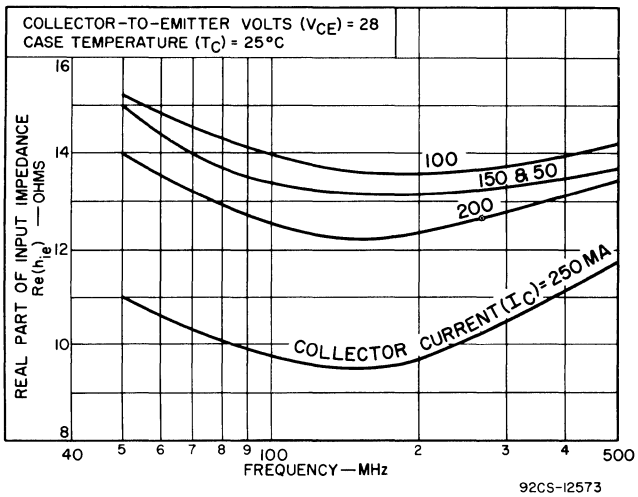


Fig.18

FOR TYPE 2N3553

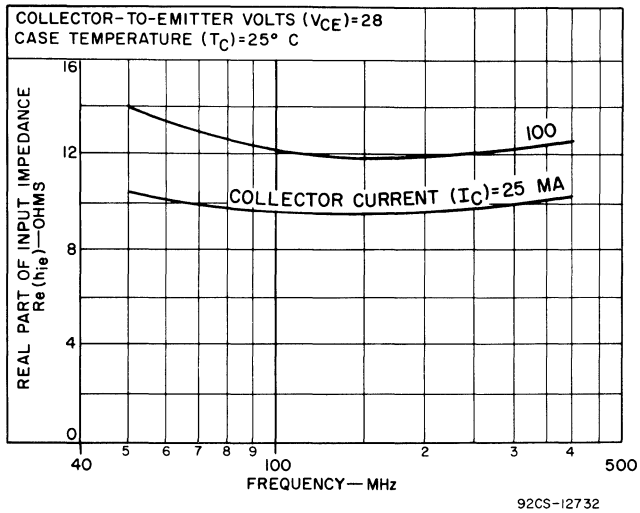


Fig.19

SERIES INPUT REACTANCE vs. FREQUENCY

FOR TYPE 2N3632

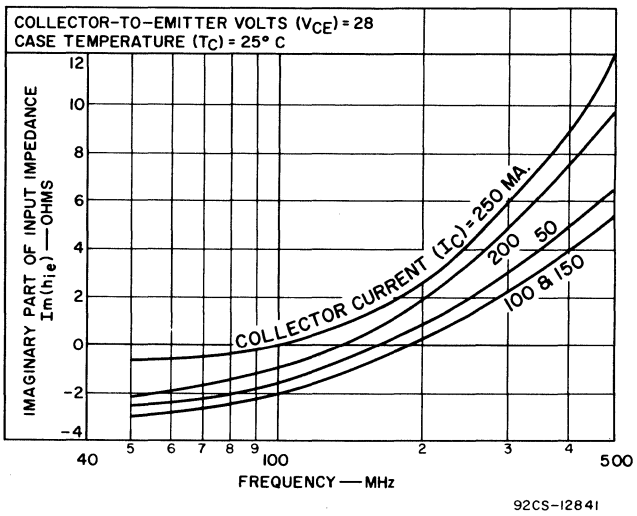


Fig.20

FOR TYPE 2N3375

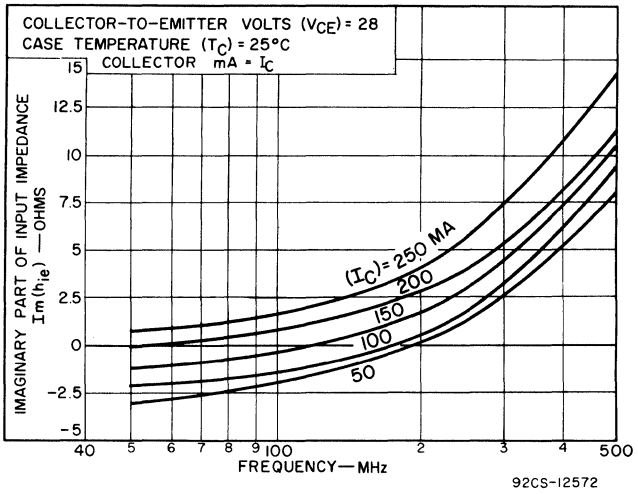


Fig.21

FOR TYPE 2N3553

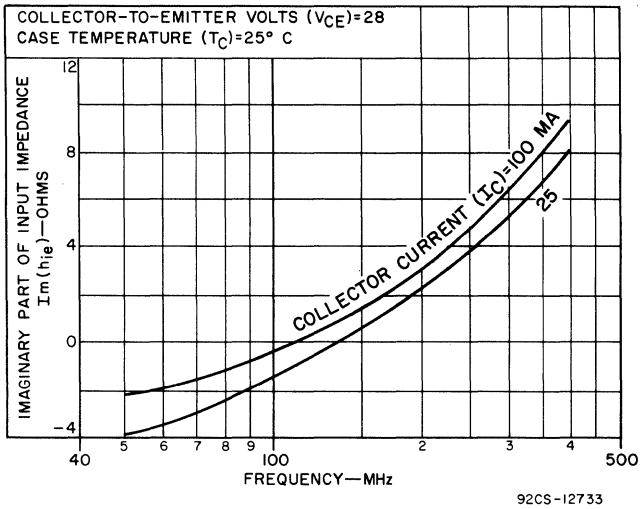


Fig.22

PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

FOR TYPE 2N3632

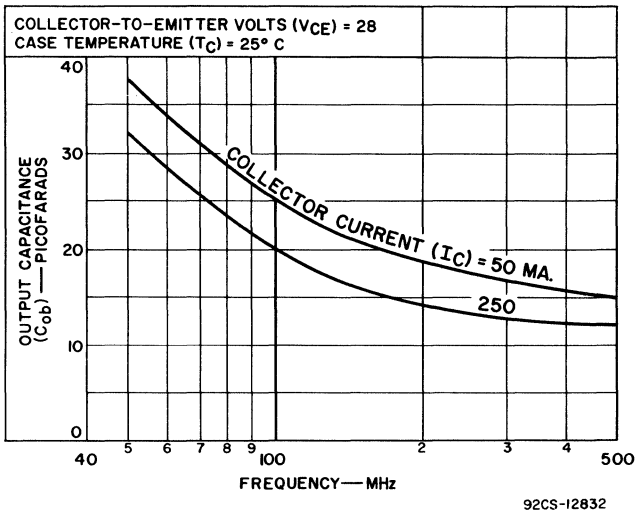


Fig.23

FOR TYPE 2N3375

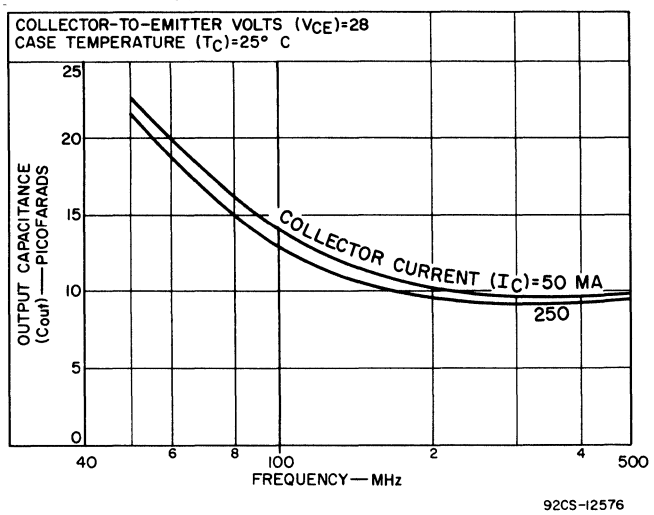


Fig.24

FOR TYPE 2N3553

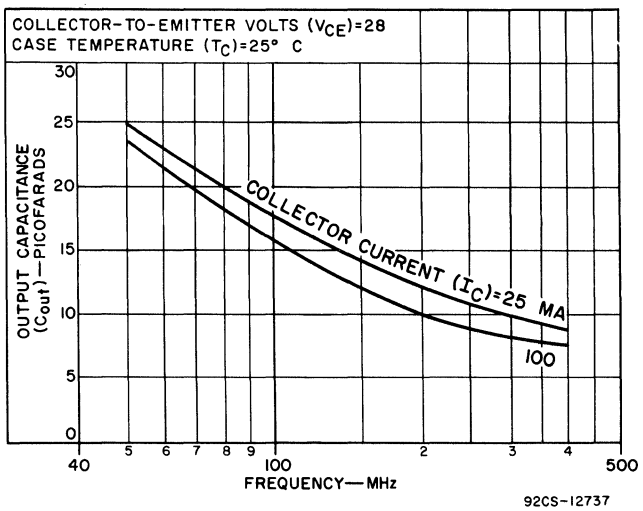


Fig.25

SILICON CONTROLLED-RECTIFIERS

2N3668–2N3670
2N4103

File No. 116

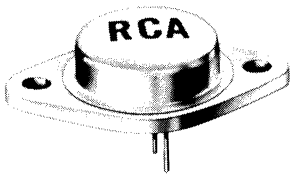
All-Diffused SCR's for Low-Cost Power-Control and Power-Switching Applications

RCA 2N3668*, 2N3669*, 2N3670*, and 2N4103* are all-diffused, three-junction, silicon controlled-rectifiers (SCR's▲). They are intended for use in power-control and power-switching applications requiring a blocking voltage capability of up to 600 volts and a forward-current capability of 12.5 amperes (rms value) or 8 amperes (average value) at a case temperature of 80°C.

The 2N3668 is designed for low-voltage power supplies, the 2N3669 for direct operation from 120-volt line supplies, the 2N3670 for direct operation from 240-volt line supplies, and the 2N4103 for high-voltage power supplies.

* Formerly Dev. Types TA2621, TA2598, TA2618, and TA2775, respectively.

▲ The silicon controlled-rectifier is also known as a reverse-blocking triode thyristor.



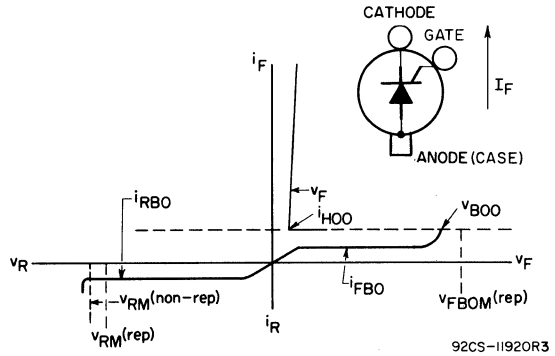
JEDEC TO-3

2N3668	For Low-Voltage Power Supplies
2N3669	For 120-Volt Line Operation
2N3670	For 240-Volt Line Operation
2N4103	For High-Voltage Power Supplies

FEATURES

- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- Designed especially for high-volume systems
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3668–2N3670,2N4103 5/66
Reprinted from 2N3668–2N3670,2N4103 2/66

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES				UNITS
	2N3668	2N3669	2N3670	2N4103	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)[a]	150	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)[b]	100	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)[c]	600	600	600	700	volts
Forward Current:					
For case temperature (T_C) of +80° C					
Average DC value at a conduction angle of 180°, I_{FAV}[d]	8	8	8	8	amperes
RMS value, I_{FRMS}[e]	12.5	12.5	12.5	12.5	amperes
For other conditions, see Fig. 8					
Peak Surge Current, i_{FM}(surge)[f]:					
For one cycle of applied voltage	200	200	200	200	amperes
For more than one cycle of applied voltage	See Fig. 10	See Fig. 10	See Fig. 10	See Fig. 10	
Sub-Cycle Surge (Non-Repetitive), I^2t[g]					
For a period of 1ms to 8.3ms	165	165	165	165	ampere^2 second
Rate of Change of Forward Current, di/dt[h] (V_{FB} = v_{BOO}(min. value), I_{GT} = 200mA, 0.5 μs rise time (See waveshapes of Fig. 1)	200	200	200	200	amperes/ microsecond
Gate Power*:					
Peak, Forward or Reverse, for 10 μs duration, P_{GM}[i] (See Figs. 5 and 6)	40	40	40	40	watts
Average, P_{GAV}[k]	0.5	0.5	0.5	0.5	watt
Temperature:					
Storage, T_{stg}●	−40 to +125	−40 to +125	−40 to +125	−40 to +125	°C
Operating (Case), T_C	−40 to +100	−40 to +100	−40 to +100	−40 to +100	°C

* Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

● Temperature reference point is within 1/8" of the center of the underside of unit.

WAVESHAPE OF di/dt RATING TEST

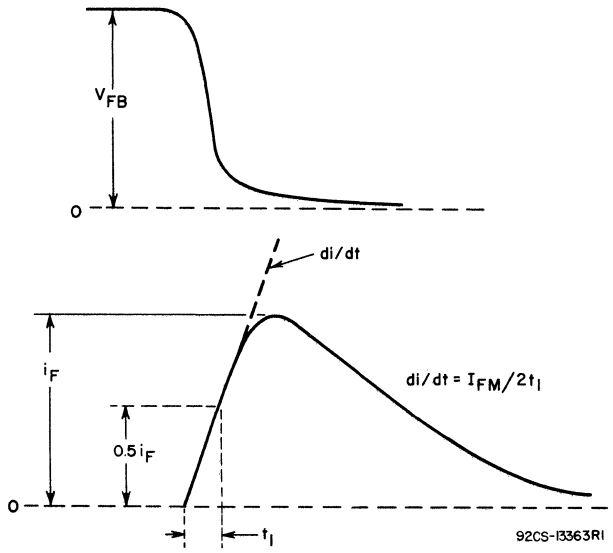


Fig. 1

WAVESHAPE OF CRITICAL dv/dt RATING TEST

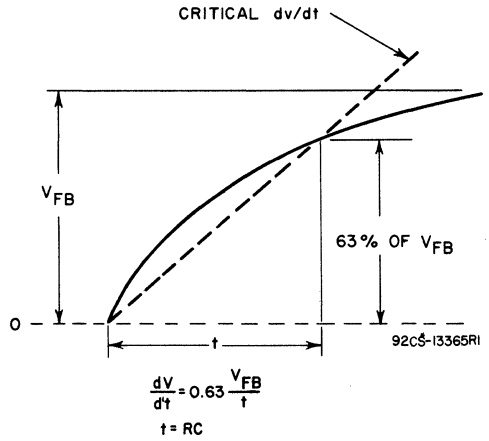


Fig. 2

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES												UNITS
	2N3668			2N3669			2N3670			2N4103			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, v_{BO}[m]													
At T_C = +100°C	100	–	–	200	–	–	400	–	–	600	–	–	volts
Peak Blocking Current, at T_C = +100°C:													
Forward, I_{FBOM}[n]	–	0.2	2	–	0.25	2.5	–	0.3	3	–	0.35	4	mA
V_{FBO}[p] = v_{BO}(min. value)													
Reverse, I_{RBOM}[q]	–	0.05	1	–	0.1	1.25	–	0.2	1.5	–	0.3	3	mA
V_{RBO}[p] = v_{RM}(rep) value													
Forward Voltage Drop, v_F[r]													
At a Forward Current of 25 amperes and a T_C = +25°C (See Fig. 11)	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	volts
DC Gate-Trigger Current, I_{GT}[s]:													
At T_C = +25°C (See Fig. 5)	1	20	40	1	20	40	1	20	40	1	20	40	mA(dc)
Gate-Trigger Voltage, V_{GT}[t]:													
At T_C = +25°C (See Fig. 5)	–	1.5	2	–	1.5	2	–	1.5	2	–	1.5	2	volts (dc)
Holding Current, i_{HOO}[u]:													
At T_C = +25°C	0.5	25	50	0.5	25	50	0.5	25	50	0.5	25	50	mA
Critical Rate of Applied Forward Voltage,													
Critical dv/dt[v]	10	100	–	10	100	–	10	100	–	10	100	–	volts/ microsecond
V_{FB} = v_{BO}(min.value), exponential rise, T_C = +100°C (See waveshape of Fig. 2)													
Turn-On Time, t_{on}[w], (Delay Time + Rise Time)	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	microseconds
V_{FB} = v_{BO}(min. value), i_F = 8 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C (See waveshapes of Fig. 3)													
Turn-Off Time, t_{off}[x], (Reverse Recovery Time +Gate Recovery Time)	–	20	50	–	20	50	–	20	50	–	20	50	microseconds
i_F = 8 amperes, 50 μs pulse width, dv_{FB}/dt = 20 v/μs, di_r/dt = 30 A/μs, I_{GT} = 200mA, T_C = +80°C (See waveshapes of Fig. 4)													
Thermal Resistance, Junction-to-Case	–	–	1.7	–	–	1.7	–	–	1.7	–	–	1.7	°C/W

WAVESHAPE OF t_{on} RATING TEST

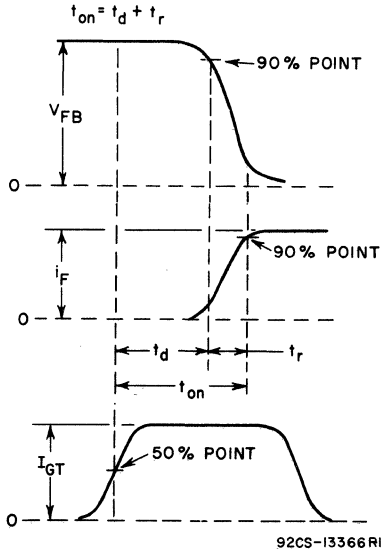


Fig. 3

WAVESHAPE OF t_{off} RATING TEST

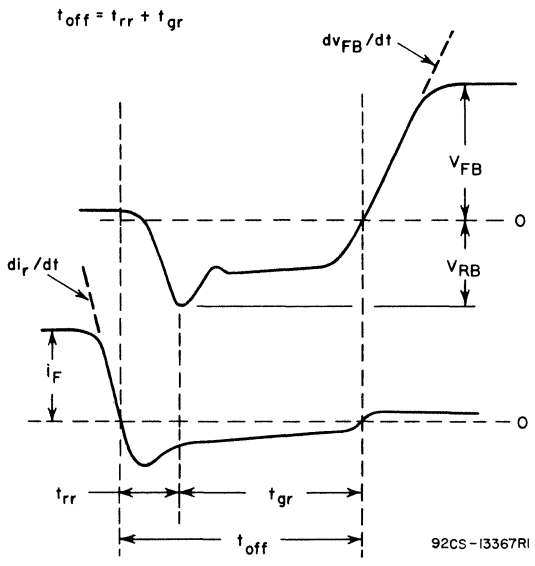


Fig. 4

FORWARD GATE CHARACTERISTICS

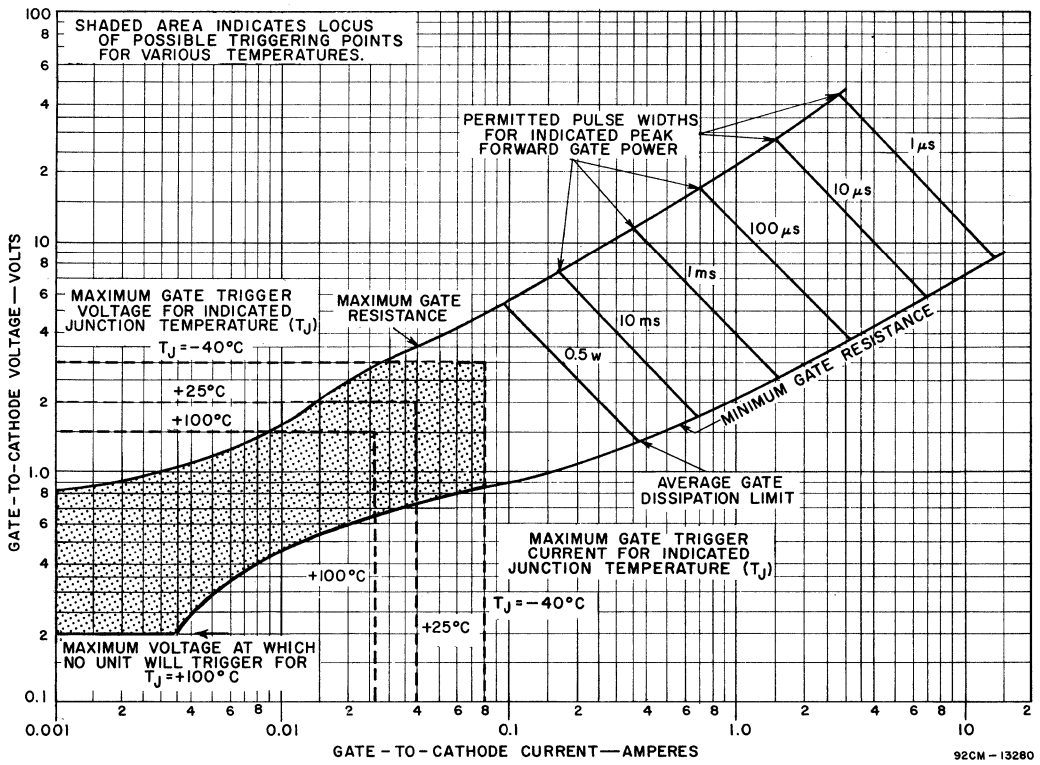


Fig. 5

REVERSE GATE CHARACTERISTICS

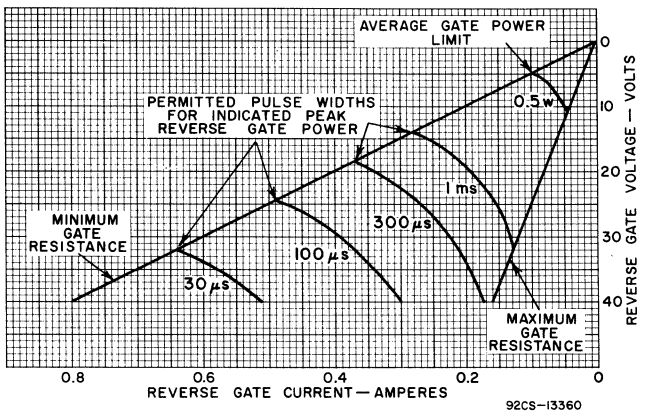
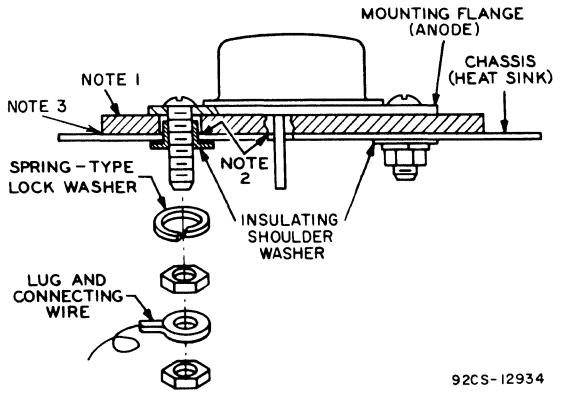


Fig. 6

TRIGGERING CONSIDERATIONS

The construction of the gate-cathode junction used in these devices provides a large periphery center gate. These devices also employ shorted-emitter construction which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown in Fig. 5. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown in Fig. 6 should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAV}) of 0.5 watt.

SUGGESTED INSULATED MOUNTING ARRANGEMENT

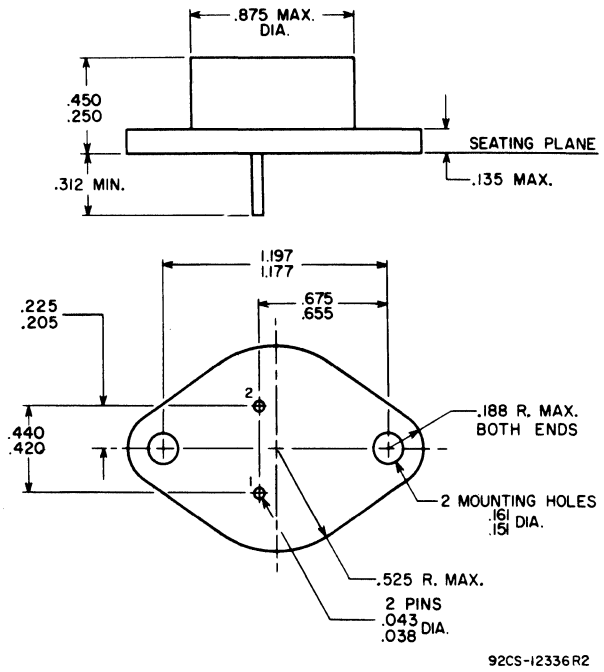


NOTE 1: 0.002'' MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

NOTE 3: DOW CORNING 340 SILICON HEAT SINK COMPOUND, OR EQUIVALENT.

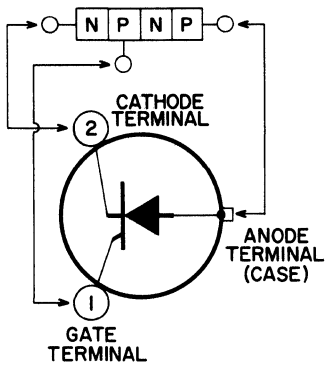
DIMENSIONAL OUTLINE JEDEC No. TO-3



Dimensions in Inches

NOTE: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050 TO .055 BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

TERMINAL DIAGRAM



PIN 1: GATE
PIN 2: CATHODE
CASE: ANODE

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CONTROLLED-RECTIFIER TERMS, SYMBOLS, AND DEFINITIONS

a **Transient Peak Reverse Voltage (Non-repetitive)** - v_{RM} (non-rep) - The maximum value of negative (reverse-blocking) voltage which may be applied between the anode and cathode for not more than 5 milliseconds when the gate is open (gate voltage is zero or negative with respect to cathode).

b **Peak Reverse Voltage (Repetitive)** - $v_{RM(rep)}$ - The maximum instantaneous value of negative (reverse-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

c **Peak Forward Blocking Voltage (Repetitive)** - $v_{FBOM(rep)}$ - The maximum instantaneous value of positive (forward-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

d **Average Forward Current** - I_{FAV} - The average (dc) value of the current flowing from anode to cathode in the device.

e **RMS Forward Current** - I_{FRMS} - The RMS value of the current flowing from anode to cathode in the device.

f **Peak Surge Current** - $i_{FM(surge)}$ - The maximum total instantaneous value of forward current which may be imposed during one forward half-cycle with the device operating within its specified maximum voltage, average-forward-current, gate-power, and temperature ratings in a single-phase circuit with 60-Hz supply and resistive load. The peak surge current may be repeated after sufficient time has elapsed for the device to return to pre-surge thermal equilibrium conditions.

g **Sub-Cycle Surge (Non-Repetitive)** - I^2t - The non-recurrent surge capability of the device for sub-cycle pulses where I is RMS amperes and t is pulse duration in seconds.

h **Rate of Change of Forward Current** - di/dt - The maximum rate of change of current which may be imposed on the device immediately after turn on by the gate from a forward blocking condition.

i **Peak Forward and Reverse Gate Power** - P_{GM} - The maximum instantaneous power dissipated between gate and cathode for a specified time duration.

k **Average Forward Gate Power** - P_{GAV} - The average power dissipated between gate and cathode.

m **Forward Breakover Voltage** - v_{BOO} - The value of positive anode voltage at which a controlled rectifier may switch into the conducting state when the gate is open.

n **Peak Forward Blocking Current** - I_{FBOM} - The maximum value of the forward blocking current of a controlled rectifier with gate open.

p **Forward and Reverse Blocking Voltage** - V_{FBO}, V_{RBO} - The value of voltage applied between anode and cathode with the gate open.

q **Peak Reverse Blocking Current** - I_{RBOM} - The maximum value of the reverse blocking current of a controlled rectifier with gate open.

r **Forward Voltage Drop** - v_F - The instantaneous voltage drop across a controlled rectifier at a given instantaneous forward current i_F and under steady-state conditions.

s **Gate-Trigger Current** - I_{GT} - The gate current required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

t **Gate-Trigger Voltage** - V_{GT} - The gate-to-cathode voltage required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

u **Holding Current** - i_{HOO} - The instantaneous value of forward current i_F below which a controlled rectifier with its gate open returns to its forward blocking state.

v **Critical Rate of Applied Forward Voltage** - Critical dv/dt - The critical rate of applied forward voltage is the minimum value of the rate of applied forward voltage which will cause switching from the off-state to the on-state under stated conditions.

w **Turn-On Time** - t_{on} - Turn-on time is the time interval between the initiation of the gate signal and the time when the resulting forward current reaches 90 per cent of its maximum value during switching from the off-state to the on-state under stated conditions.

x **Turn-Off Time** - t_{off} - Turn-off time is the time interval between the time when the forward current decreases to zero and the time when the device anode voltage reaches zero and is rising to a stated value of forward blocking voltage at a stated rate of rise without turning on during switching in the external anode circuit from the on-state to the off-state under stated conditions.

Turn-on times for different gate currents are shown in Fig. 7. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger pulse until the magnitude of the forward anode current has reached the latching current value. However, conservative design requires that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".

TURN-ON TIME CHARACTERISTICS

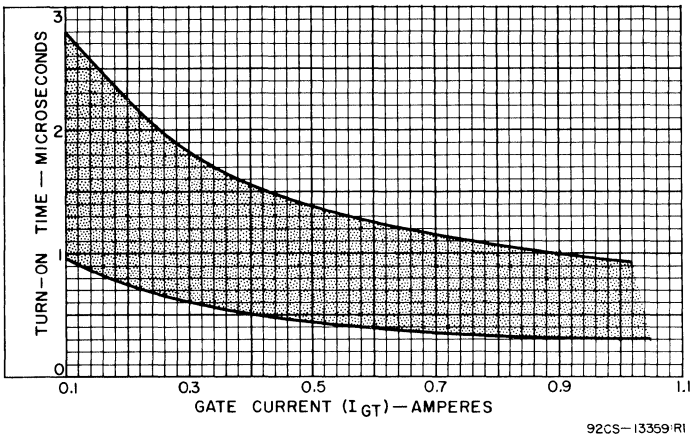


Fig. 7

RATING CHART (CASE TEMPERATURE)

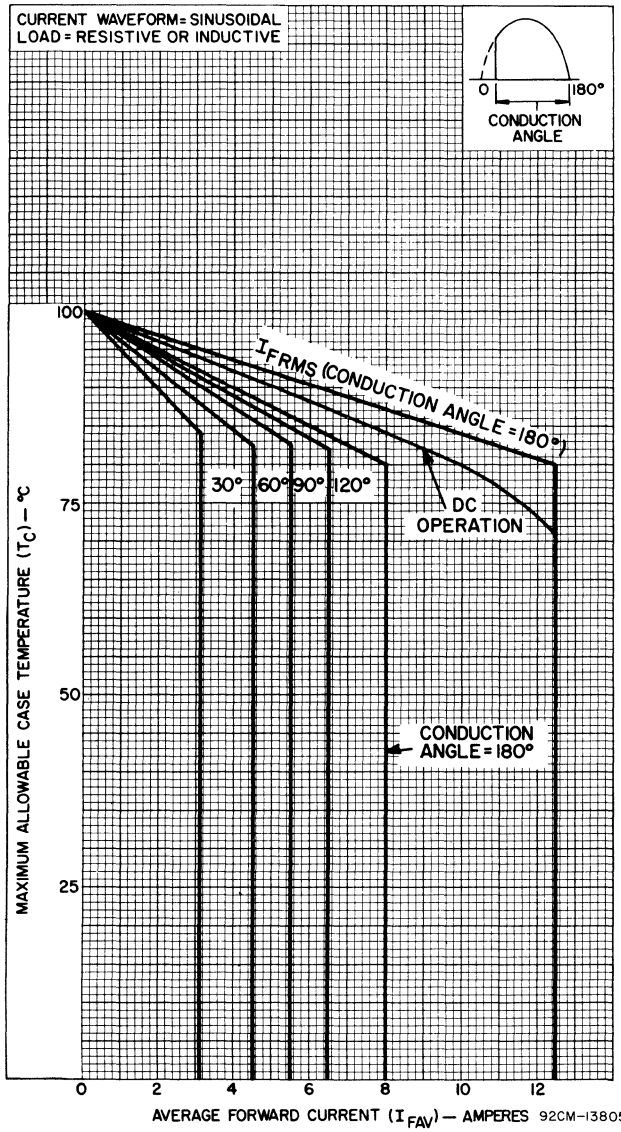


Fig. 8

POWER DISSIPATION

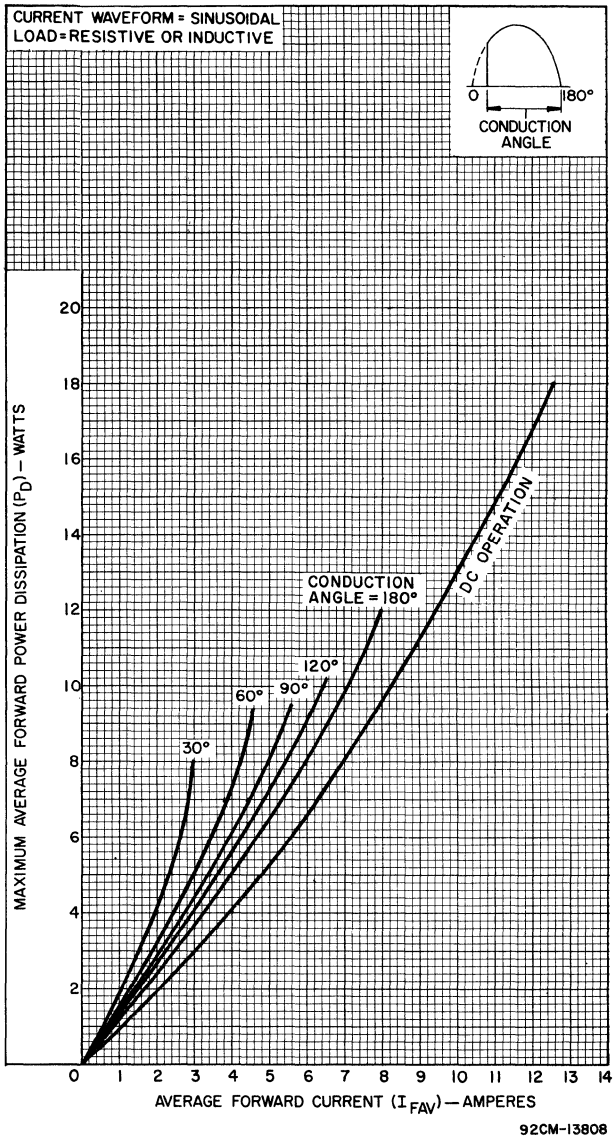


Fig. 9

SURGE CURRENT RATING

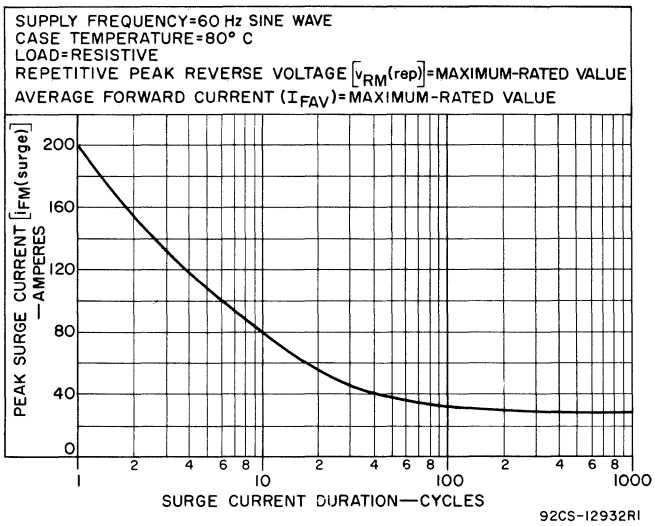


Fig. 10

FORWARD CHARACTERISTICS

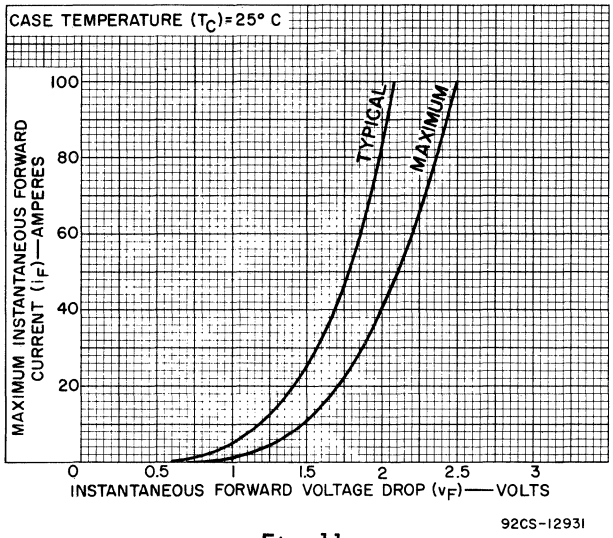


Fig. 11

NATURAL-AIR COOLING OPERATION GUIDANCE CHART

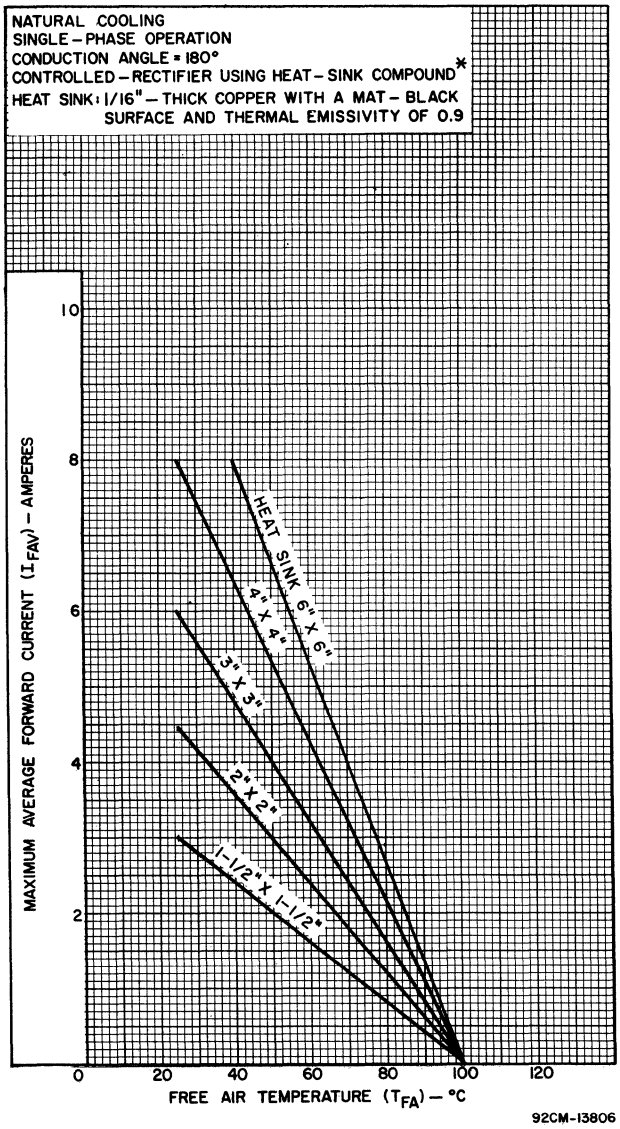


Fig. 12

FORCED-AIR COOLING OPERATION GUIDANCE CHART

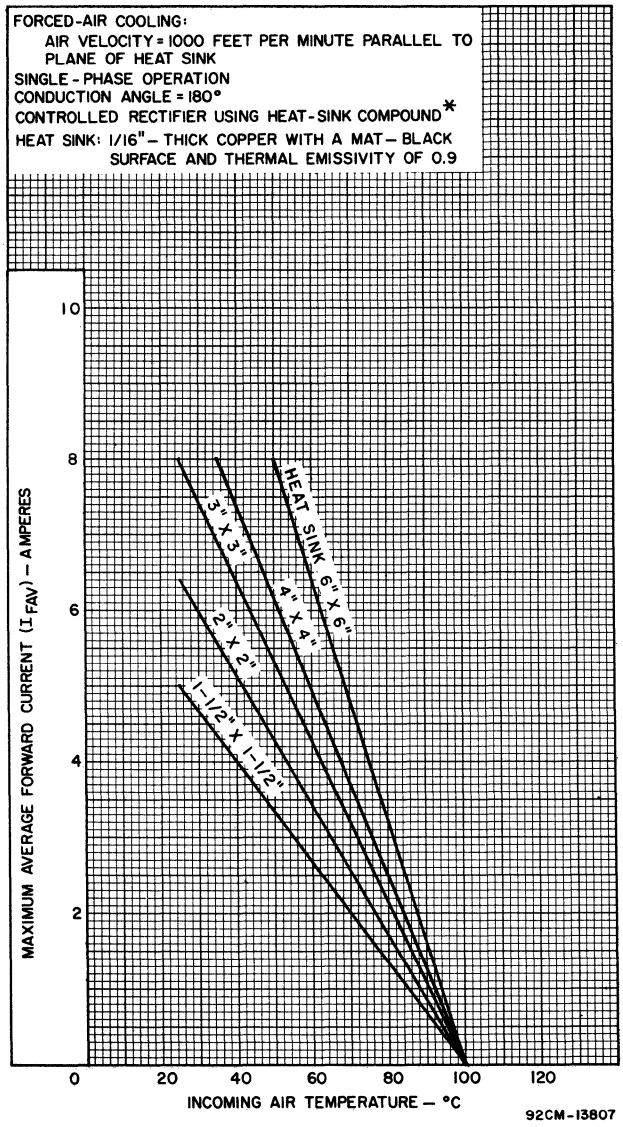


Fig. 13

*Dow Corning 340 Silicon Heat Sink Compound, or Equivalent.

RCA SOLID-STATE DEVICES

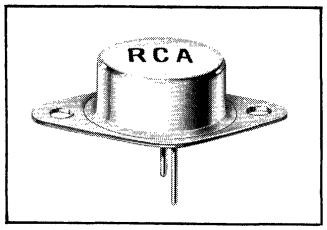
For TV Deflection Systems

2N3730 2N3731 2N3732 1N4785 40439 40440 40442

File No. 205

TRANSISTOR/DAMPER-DIODE COMPLEMENTS

For Television Deflection Systems



RCA-2N3730, 2N3731, 2N3732, 40439[a], 40440[b], and 40442[c] are germanium solid-state devices specifically designed for use in the deflection systems of commercial television receivers.

Types 2N3730, 2N3731, 2N3732, 40439, and 40440, are diffused-collector, graded-base power transistors of the germanium pnp type. Type 2N3730 is intended for use as a vertical-deflection output amplifier; type 2N3732 as a horizontal driver, and types 2N3731, 40439, and 40440 as horizontal output amplifiers.

Types 1N4785 and 40442 are diffused-germanium diodes for use in damper service in transistorized horizontal-deflection systems.

All seven devices are hermetically sealed in metal JEDEC TO-3 packages.

Horizontal-amplifier types 2N3731, 40439, and 40440, and damper-diode types 1N4785 and 40442 provide a choice of devices for use in deflection systems having different energy requirements and circuit configurations, and employing a wide range of dc supply voltages. Types 40439 and 1N4785, for example, are suitable for use in high-energy systems for picture tubes having deflection angles up to 114°, anode-voltage ratings up to 18 kV, and neck diameters up to 1-1/8 inches.

Types 2N3731, 40440, and 40442 are intended primarily for use in systems having lower energy requirements, particularly those for picture tubes having narrower deflection angles (up to 90°) and smaller neck diameters (20mm). Because of their high voltage ratings, types 2N3731 and 1N4785 can also be used in systems employing B+ boost arrangements.

[a] Formerly Dev. No.TA2928.
[b] Formerly Dev. No.TA2921.
[c] Formerly Dev. No.TA2929.

- for picture tubes with deflection angles to 114°, anode-voltage ratings to 18 kV, neck dia. to 1-1/8"
- high breakdown-voltage capabilities:

BV_{CES} = { -320 min. V for 40439, 2N3731 horizontal-output types; -200 min. V for 40440 horizontal-output and 2N3730 vertical-output types; -100 min. V for 2N3732 horizontal-driver type }

- high collector-current capabilities:

I_C = { -10 max. A for 2N3731, 40439, 40440 horizontal-output types; -3 max. A for 2N3730 vertical-output and 2N3732 horizontal-driver types }

- low collector-saturation voltages:

$V_{CE(sat)}$ = { -0.75 max. V for 40440; -1.5 max. V for 2N3731, 40439; -2 max. V for 2N3730, 2N3732 }

- short turn-off time in typical horizontal-deflection output circuits:

t_{off} = { 0.75 max. μs for 40439; 1.2 max. μs for 2N3731, 40440 }

- high voltage and current capabilities for damper diodes:

peak reverse voltage = { 320 max. V for 1N4785; 200 max. V for 40442 }

continuous reverse voltage = { 60 max. V for 1N4785; 40 max. V for 40442 }

peak forward current = { 10 max. A for 1N4785 and 40442 }

average forward current = { 7 max. A for 1N4785 and 40442 }

- hermetically sealed JEDEC TO-3 package

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2N3730, 2N3731, 2N3732, 1N4785, 40439, 40440, 40442 6-66
Supersedes 1CE321 dated 6-65

TELEVISION DEFLECTION SERVICE

Absolute Maximum Ratings:

	Vertical Output Amplifier	Horizontal Output Amplifiers			Horizontal Driver	Damper Diodes		
	Type 2N3730	Type 2N3731	RCA 40439	RCA 40440	Type 2N3732	Type 1N4785	RCA 40442	
COLLECTOR-TO-BASE VOLTAGE:								
PEAK, V_{CBO}	-200	-320	-320	-200	-100	-	-	max. V
CONTINUOUS, V_{CB}	-60	-60	-60	-40	-60	-	-	max. V
COLLECTOR CURRENT, I_C	-3	-10	-10	-10	-3	-	-	max. A
BASE CURRENT, I_B	±0.5	+4,-1	+4,-1	+4,-1	±0.5	-	-	max. A
TRANSISTOR DISSIPATION, P_T:								
For mounting-flange temperatures* up to 55°C	10	5	5	5	3	-	-	max. W
For mounting-flange temperatures* above 55°C	← Derate linearly to zero watts at 85°C →					-	-	
REVERSE VOLTAGE:								
PEAK, PRV	-	-	-	-	-	320	200	max. V
CONTINUOUS, RV	-	-	-	-	-	60	40	max. V
PEAK FORWARD CURRENT, I_{FM}	-	-	-	-	-	10	10	max. A
AVERAGE FORWARD CURRENT, I_{FA}	-	-	-	-	-	7	7	max. A
TEMPERATURE RANGE:								
Storage and operating (junction)	← -65 to +85 →							°C
LEAD TEMPERATURE (During soldering):								
At distances not closer than 1/32 inch to seating surface for 10 seconds max.	← 230 →							max. °C

*Measured at center of seating surface.

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

HORIZONTAL-OUTPUT-AMPLIFIER TYPES

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS									UNITS
							HORIZONTAL OUTPUT AMPLIFIERS									
							RCA 40439			Type 2N3731			RCA 40440			
		V_{CB}	V_{EB}	I_B	I_C	I_E										
		V	V	A	A	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-10					-	-	-200	-	-	-200	-	-	-200	μA
Collector-to-Emitter Breakdown Voltage	BV_{CES}		0		-0.025		-320	-	-	-320	-	-	-200	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}		*		0	-100	-2	-	-	-2	-	-	-2	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			-0.4	-6		-	-	-1.5	-	-	-1.5	-	-	-0.75	V
				-0.2	-3		-	-	-	-	-	-1.5	-	-	-0.75	V
Base-to-Emitter Voltage	V_{BE}			-0.4	-6		-	-	-0.8	-	-	-0.8	-	-	-1	V
Turn-Off Time▲	t_{off}	See Fig.1					-	-	0.75	-	-	1.2	-	-	1.2	μs
Thermal Resistance: Junction to Case	θ_{J-C}						-	-	1.5	-	-	1.5	-	-	1.5	°C/W

▲"Turn-Off Time" t_{off} as used in this bulletin is the time required for the Collector Current I_C to decrease to -100 milliamperes AFTER the Collector-to-Emitter voltage V_{CE} has risen 2 volts into its "flyback" excursion. In a circuit of the type shown in Fig.1 the collector current may be determined by measuring the base and emitter currents simultaneously with the aid of a current-transformer-type probe.

* Momentary operation in breakdown is permissible.

ELECTRICAL CHARACTERISTICS, at $T_A = 25°C$

VERTICAL-OUTPUT-AMPLIFIER AND HORIZONTAL-DRIVER TYPES

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS					LIMITS						UNITS
		V_{CB}	V_{EB}	I_B	I_C	I_E	VERTICAL OUTPUT AMPLIFIER TYPE 2N3730			HORIZONTAL DRIVER TYPE 2N3732			
		V	V	A	A	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-10					-	-	-200	-	-	-200	μA
Collector-to-Emitter Breakdown Voltage	BV_{CES}		0		-0.005		-200	-	-	-100	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					-100	-0.5	-	-	-0.5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			-0.02 -0.005	-0.7 -0.05		- -	- -	-2 -1	- -	- -	-2 -	V V
Base-to-Emitter Voltage	V_{BE}			-0.02	-0.7		-	0.5	-	-	0.5	-	V
Thermal Resistance: Junction to Case	θ_{J-C}						-	-	1.5	-	-	1.5	°C/W

DAMPER-DIODE TYPES

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS	LIMITS				UNITS
			DAMPER DIODES				
			TYPE 1N4785		RCA 40442		
			Min.	Max.	Min.	Max.	
Peak Reverse Voltage	PRV	Peak Reverse Current (I_{RM}) = 1 mA	320	-	200	-	V
Static Reverse Current	I_R	Static Reverse Voltage (V_R) = 10 V	-	150	-	150	μA
Static Forward Voltage Drop	V_F	Average Forward Current (I_F) = 7 A	-	0.77	-	0.77	V

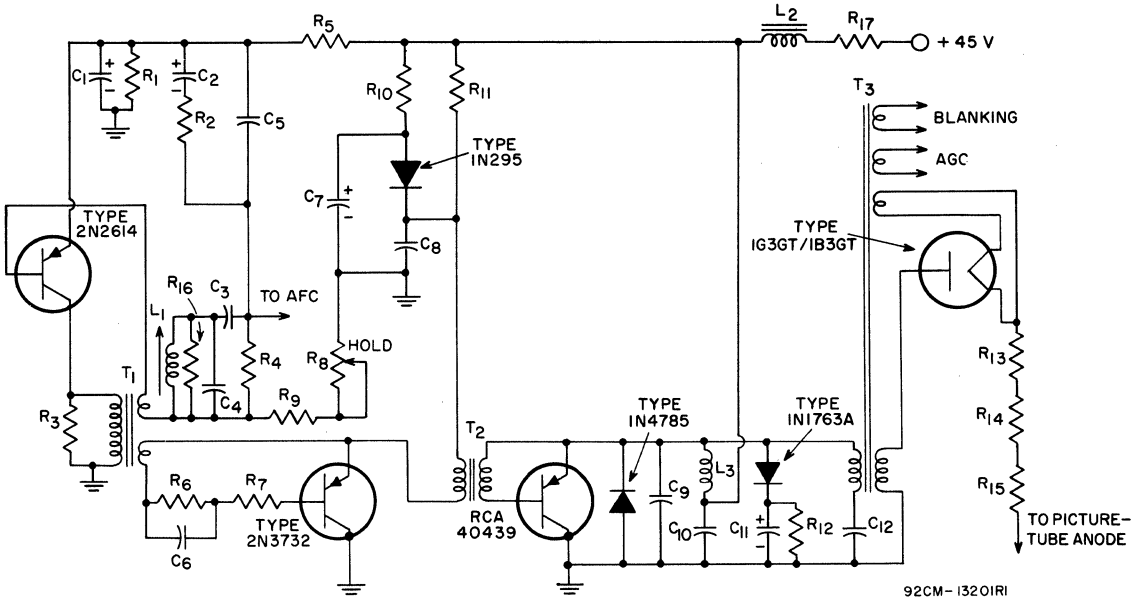


Fig.1 - Typical Horizontal Deflection and High-Voltage Circuit Using Types 40439, 2N3732, and 1N4785.

PARTS LIST FOR FIG.1

C_1 = 50 μF, 12 V, electrolytic
C_2 = 2 μF, 3 V, electrolytic
C_3 = 0.008 μF, mica
C_4 = 0.01 μF, mica
C_5 = 0.2 μF
C_6 = 0.1 μF, 3 V
C_7 = 10 μF, 15 V, electrolytic
C_8 = 0.05 μF, 50 V
C_9 = 0.05 μF, 300 V
C_{10} = 4 μF, 25 V
C_{11} = 10 μF, 300 V, electrolytic
C_{12} = 0.15 μF, 400 V
L_1 = Sine-wave coil (see below for design data)
L_2 = Choke, 2 mH at 2 A
L_3 = Horizontal-deflection windings of yoke – Inductance = 200 μH

R_1, R_{16} = 560 Ω
R_2 = 2.2 K Ω
R_3, R_5 = 1 K Ω
R_4 = 15 K Ω
R_6 = 4.7 Ω
R_7 = 10 Ω
R_8 = Hold control, potentiometer, 10 K Ω
R_9 = 22 K Ω
R_{10} = 2.7 K Ω
R_{11} = 560 Ω, 1W
R_{12} = 1 M Ω
R_{13}, R_{14}, R_{15} = 27 K Ω
R_{17} = 15 Ω, 10 W

T_1 = Blocking-oscillator transformer, Columbus Process Co., Columbus, Ind. Part No.CPX9372, or equivalent (see design data)
T_2 = Driver transformer, Columbus Process Co., Columbus, Ind. Part No.CPX9370 or equivalent (see design data)
T_3 = Horizontal-deflection output and high-voltage transformer, F.W. Sickles Co., Div. of General Instruments Corp., Chicopee, Mass. Part No.18428-4 or equivalent.

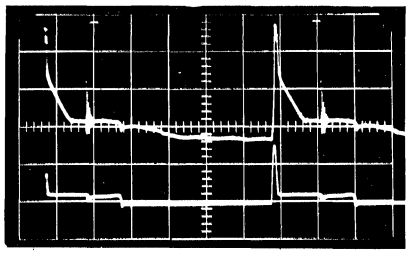
TYPICAL PERFORMANCE DATA FOR HORIZONTAL-DEFLECTION AND HIGH-VOLTAGE CIRCUIT SHOWN IN FIG.1

DC Supply Voltage	+45	V	Peak collector-to-emitter voltage for Type 40439	260	V
Average Supply Current	0.55	A	DC high-voltage output:		
Input Power:			at beam) = 0	18	kV
Oscillator and driver circuits	1.5	W	current) = 200 μA	17	kV
Output circuit:			Yoke current (peak-to-peak)	10	A
at beam) = 0	18	W	Peak yoke energy	2.5	mJ
current) = 200 μA	22	W	Retrace time	11.5	μs

DESIGN DATA FOR TRANSFORMERS SHOWN IN FIG.1

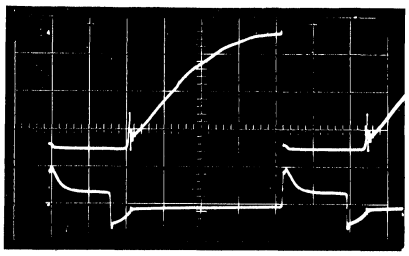
L_1 — Sine-Wave Coil:

Form – Tapped or embossed to accommodate 1/4 – 28 threaded slug.
Slug – General Ceramics Type Q material or equivalent, 5/8 inch long.
Winding – 350 turns No.7/41 Litz wire (Cam = 0.5 inch).



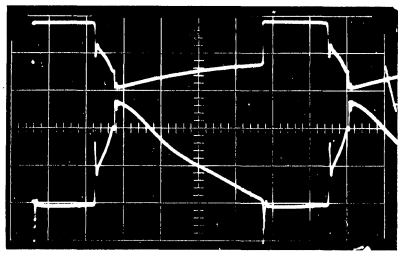
Upper Trace: V_{BE}, 2 V/div.
Lower Trace: I_B, 2 A/div.
Time Base: 10 μs/div.

J - 40439 Output Transistor Base-to-Emitter Voltage and Base Current



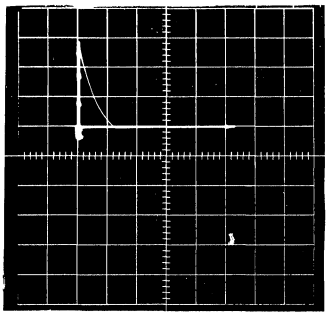
Upper Trace: V_{CE}, 10 V/div.
Lower Trace: I_B, 100 mA/div.
Time Base: 10 μs/div.

K - 2N3732 Driver Transistor Collector-to-Emitter Voltage and Base Current



Upper Trace: V_{CE}, 10 V/div.
Lower Trace: V_{BE}, 2 V/div.
Time Base: 10 μs/div.

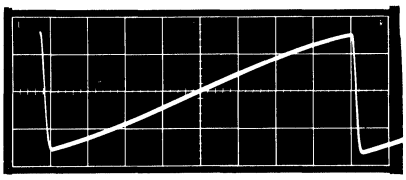
L - 2N2614 Oscillator Transistor Collector-to-Emitter Voltage and Base-to-Emitter Voltage



Ordinate: I_C, 2 A/div.
Abscissa: V_{CE}, 50 V/div.

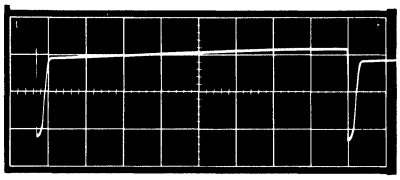
M - 40439 Output Transistor Load Line (Collector Current vs. Collector-to-Emitter Voltage)

Fig.4 - Typical Waveforms for Horizontal-Deflection Circuit Shown in Fig.1.



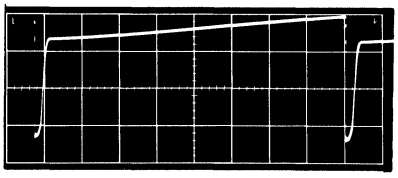
Ordinate: I, 400 mA/div.
Abscissa: Time, 2000 μs/div.

A - Y (Yoke) Current



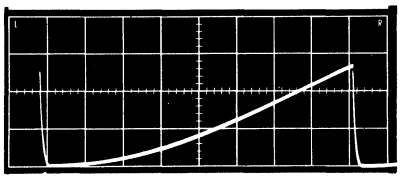
Ordinate: V, 20 V/div.
Abscissa: Time, 2000 μs/div.

B - Y (Yoke) Voltage



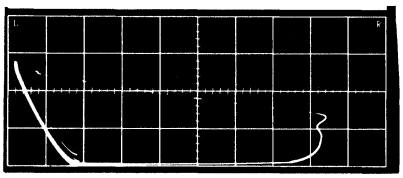
Ordinate: V_{CE}, 50 V/div.
Abscissa: Time, 2000 μs/div.

C - 2N3730 Vertical Output Transistor Collector-to-Emitter Voltage



Ordinate: I_C, 200 mA/div.
Abscissa: Time, 2000 μs/div.

D - 2N3730 Vertical Output Transistor Collector Current



Ordinate: I_C, 200 mA/div.
Abscissa: V_{CE}, 20 V/div.

E - 2N3730 Vertical Output Transistor Load Line (I_C vs. V_{CE})

Fig.5 - Typical Waveforms for Vertical-Deflection Circuit Shown in Fig.2

OPERATING CONSIDERATIONS

Because the metal shells of the 2N3730, 2N3731, 2N3732, 40439, and 40440 operate at the collector voltage, and those of the 1N4785 and 40442 at the anode voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the devices.

These devices can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the device.

It is essential that the mounting flange which serves as the collector or anode terminal be securely fastened to a heat sink, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE DEVICE.

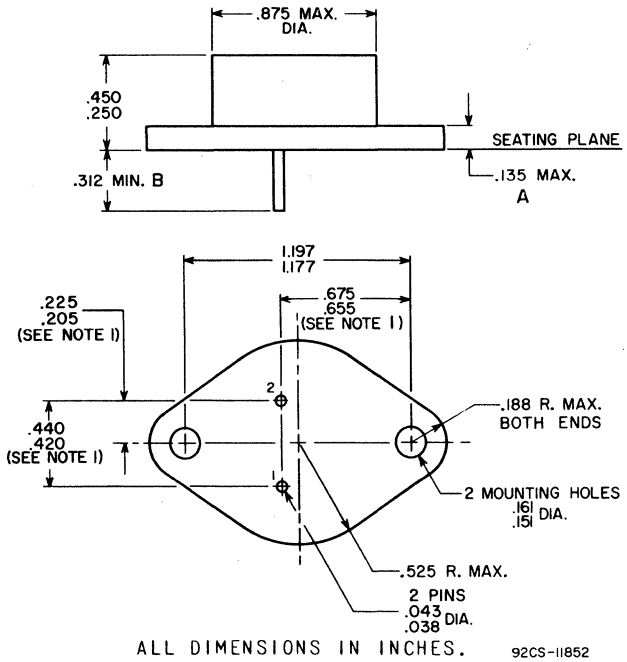
The mounting-flange temperatures of these devices will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capability to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use either an anodized aluminum insulator having high thermal conductivity, or a mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the terminal pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that a fibre washer be used between each bolt and the chassis.

DIMENSIONAL OUTLINE

JEDEC No.TO-3



NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

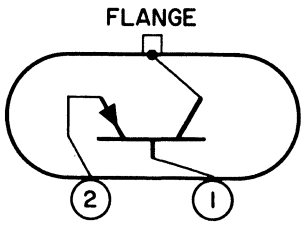
For RCA-2N3730, 2N3731, 2N3732, 1N4785, 40439, 40440, and 40442

Mounting-Flange Thickness (A) = 0.050" max.

Pin Length (B) = 0.440" min. / 0.480" max.

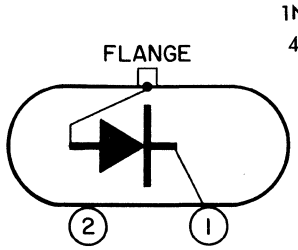
TERMINAL CONNECTIONS

2N3730, 2N3731, 2N3732
40439, 40440



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

1N4785
40442



Pin 1 - Cathode
Pin 2 - No Connection
Mounting Flange - Anode, Case

DESIGN DATA FOR TRANSFORMERS SHOWN IN FIG.1 cont'd

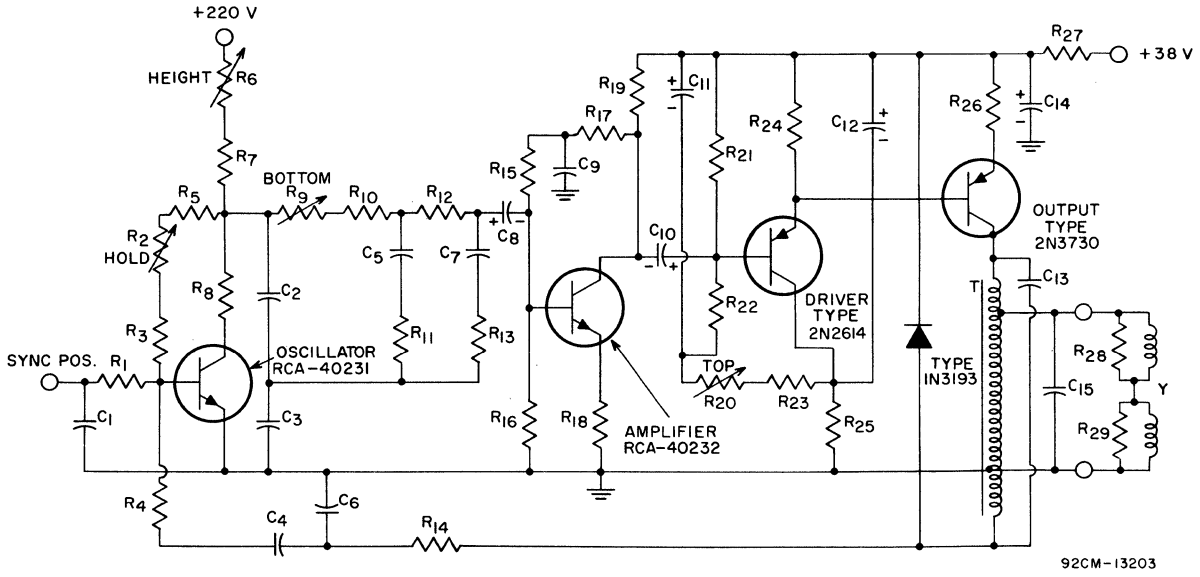
T_1 — Blocking-Oscillator Transformer:

Cup core: Indiana General Corp., Keasbey, N.J. Part No.F912-03 or equivalent.
Cup-core cover: Indiana General Corp., Keasbey, N.J., Part No. F913-03 or equivalent.
Nylon bobbin: American Molded Products, Chicago 22, Ill., Part No.5661 or equivalent.
Gap: 1.5-mil paper
Windings:
Primary - 135 turns No.34 FORMVAR* wire
Secondary - 35 turns No.30 FORMVAR wire
Feedback - 45 turns No.30 FORMVAR wire
Wind 45 turns of primary; then trifilar-wind secondary and feedback windings with remainder of primary to assure tight coupling.

T_2 — Driver Transformer:

Cup core, Cup-core cover, Nylon bobbin, Gap } Same as for T_1
Windings:
Primary - 80 turns No.30 FORMVAR wire
Secondary - 20 turns No.24 FORMVAR wire
Wind 30 turns of primary; then bifilar-wind secondary winding with remainder of primary to assure tight coupling.

* Trade Mark, Shawinidan Products Corp.



C_1, C_{13} = 0.005 μF
C_2 = 1 μF, paper
C_3 = 4 μF, paper
C_4 = 0.05 μF
C_5, C_7 = 0.25 μF, paper
C_6 = 0.02 μF
C_8 = 2 μF, 25 V, electrolytic
C_9 = 0.1 μF
C_{10}, C_{11}, C_{12} = 25 μF, 25 V, electrolytic
C_{14} = 500 μF, 50 V, electrolytic
C_{15} = 0.22 μF
R_1 = 15 KΩ

R_2 = Hold control, potentiometer, 250 KΩ
R_3, R_5 = 82 KΩ
R_4 = 18 KΩ
R_6 = Height control, potentiometer, 500 KΩ
R_7 = 270 KΩ
R_8 = 220 Ω
R_9, R_{20} = Linearity control, potentiometer, 25 KΩ
R_{10} = 22 KΩ
R_{11}, R_{13} = 4.7 KΩ
R_{12} = 10 KΩ
R_{14}, R_{23} = 3.3 KΩ

R_{15} = 150 KΩ
R_{16}, R_{17} = 100 KΩ
R_{18} = 470Ω
R_{19} = 2.7 KΩ
R_{21} = 1.5 KΩ
R_{22} = 3.9 KΩ
R_{24} = 150Ω
R_{25} = 680Ω
R_{26} = 5.6Ω
R_{27} = 50Ω, 10W
R_{28}, R_{29} = 56Ω

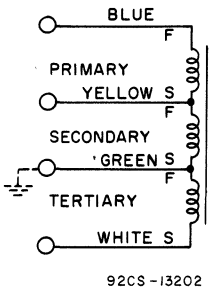
All capacitors are disc ceramic type, unless otherwise specified.

All resistors are 0.5-Watt, composition type, unless otherwise specified.

T = Vertical-deflection output transformer: Better Coil & Transformer Corp., Goodlands, Ind. Part NO.99A20, or equivalent. (See Fig.3 for design data)

Y = Vertical-deflection windings of yoke: Inductance = 5 mH, resistance = 5Ω

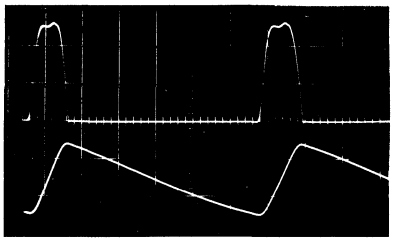
Fig.2 - Typical Vertical Deflection Circuit Using Type 2N3730.



Core: 3/4" square "E-I" stack, 25-mil laminations
Gap: 5-mil paper
Windings (in order of winding on bobbin):
1 - Tertiary = 115 turns No.34 Heavy FORMVAR* or equivalent
2 - Secondary = 160 turns No.22 Heavy FORMVAR or equivalent
3 - Primary = 350 turns No.30 Heavy FORMVAR or equivalent

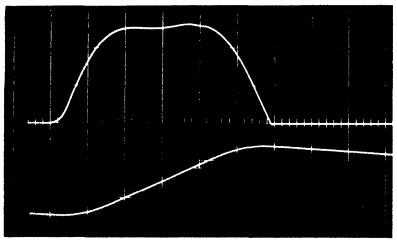
* Trade Mark, Shawinidan Products Corp.

Fig.3 - Design Data for Vertical Deflection Output Transformer Shown in Fig.2.



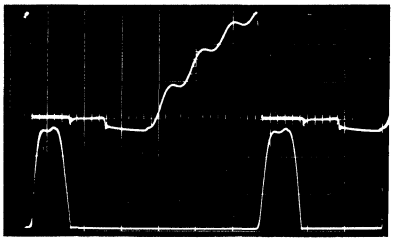
Upper Trace: Yoke Voltage, 100 V/div.
Lower Trace: Yoke Current, 5 A/div.
Time Base: 10 μs/div.

A - L_3 (Yoke) Voltage and Current



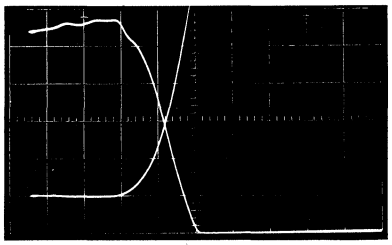
Upper Trace: Yoke Voltage, 100 V/div.
Lower Trace: Yoke Current, 5 A/div.
Time Base: 2 μs/div.

B - L_3 (Yoke) Voltage and Current (Expanded Trace)



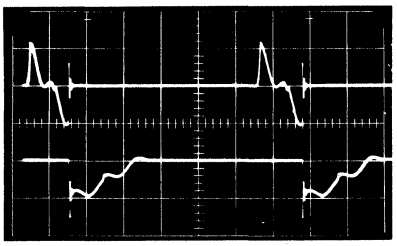
Upper Trace: I_C, 2 A/div.
Lower Trace: V_{CE}, 100 V/div.
Time Base: 10 μs/div.

C - 40439 Collector Voltage and Current



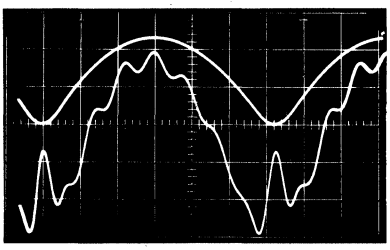
Upper Trace: I_C, 1 A/div.
Lower Trace: V_{CE}, 10 V/div.
Time Base: 0.5 μs/div.

D - 40439 Collector Voltage and Current (Expanded Trace)



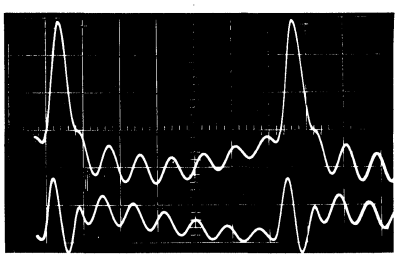
Upper Trace: C_9 Current, 5 A/div.
Lower Trace: 1N4785 Current, 5 A/div.
Time Base: 10 μs/div.

E - (C_9) Flyback-Capacitor Current 1N4785 Damper Diode Current



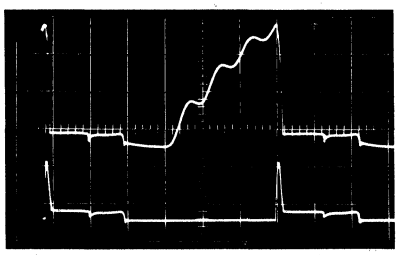
Upper Trace: C_{10} Voltage, 10 V/div.
Lower Trace: C_{12} Voltage, 20 V/div.
Time Base: 10 μs/div.

F - (C_{10}) "S"-Shaping Capacitor Voltage and (C_{12}) Flyback-Coupling Capacitor Voltage



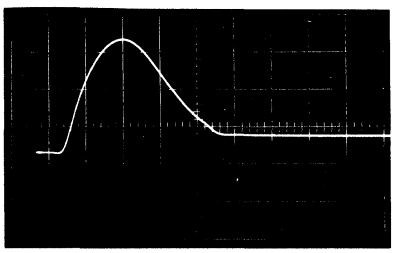
Upper Trace: Secondary Voltage, 5000 V/div.
Lower Trace: Primary Current, 2 A/div.
Time Base: 10 μs/div.

G - T_3 (Output Transformer) Secondary Voltage and Primary Current



Upper Trace: I_C, 2 A/div.
Lower Trace: I_B, 2 A/div.
Time Base: 10 μs/div.

H - 40439 Output Transistor Collector and Base Currents



Amplitude Scale: 1 A/div.
Time Scale: 0.5 μs/div.

I - Expanded Trace of 40439 Output Transistor Base Current Pulse Shown in H

Fig.4 - Typical Waveforms for Horizontal-Deflection Circuit Shown in Fig.1.

RCA SOLID-STATE DEVICES
For High-Energy Deflection Systems

2N3730 2N4346
2N3732 1N4785

File No. 206

RCA-2N3730, 2N4346,▲ 2N3732, and 1N4785 are a complement of germanium solid-state devices specifically designed for use in high-energy deflection systems for television monitors and other equipment required to provide highly reliable performance.

Types 2N3730, 2N4346, and 2N3732 are diffused-collector, graded-base power transistors of the germanium pnp type. Type 2N3730 is intended for use as a vertical-deflection output amplifier; types 2N4346 and 2N3732 are for use respectively as a horizontal output amplifier and horizontal driver.

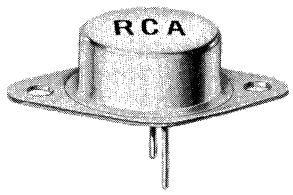
Type 1N4785 is a diffused-germanium diode for use in damper service in transistorized horizontal deflection systems.

All four devices are hermetically sealed in metal JEDEC TO-3 packages.

▲ Formerly Dev. No. TA2920.

TRANSISTOR/DAMPER-DIODE COMPLEMENT

For High-Reliability High-Energy Deflection Systems



- short turn-off time in typical horizontal deflection circuits:
  t_{off} = 0.75 max. μs for 2N4346
- high minimum beta at high collector current:
  h_{FE} = 25 min. at I_C = 6 A for 2N4346
- high breakdown-voltage capabilities:
  BV_{CES} = -320 min V for 2N4346 horizontal-output type; -200 min. V for 2N3730 vertical-output type; -100 min. V for 2N3732 horizontal-driver type

DEFLECTION SERVICE

Absolute Maximum Ratings:	2N3730	2N4346	2N3732	1N4785		
COLLECTOR-TO-BASE VOLTAGE:						
PEAK, V_{CBO}	-200	-320	-100	-	max.	V
CONTINUOUS, V_{CB}	-60	-60	-60	-	max.	V
COLLECTOR CURRENT, I_C	-3	-10	-3	-	max.	A
BASE CURRENT, I_B	±0.5	+4, -1	±0.5	-	max.	A
TRANSISTOR DISSIPATION, P_T:						
For mounting-flange temperatures* up to 55°C.	10	5	3	-	max.	W
For mounting-flange temperatures* above 55°C.	Derate linearly to zero watts at 85°C					
REVERSE VOLTAGE:						
PEAK, PRV	-	-	-	320	max.	V
CONTINUOUS, RV	-	-	-	60	max.	V
PEAK FORWARD CURRENT, i_{FM}	-	-	-	10	max.	A
AVERAGE FORWARD CURRENT, I_{FA}	-	-	-	7	max.	A
TEMPERATURE RANGE:						
Storage and operating (junction)	← -65 to +85 →					°C
LEAD TEMPERATURE (During soldering):						
At distances not closer than 1/32 inch to seating surface for 10 seconds max.	← 230 →				max.	°C

*Measured at center of seating surface.

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3730, 2N4346, 2N3732, 1N4785 6-66

ELECTRICAL CHARACTERISTICS, at an Ambient Temperature (T_A) of 25°C

Characteristics	Symbols and Units	LIMITS												TEST CONDITIONS				
		Vertical Output Amplifier 2N3730			Horizontal Output Amplifier 2N4346			Horizontal Driver 2N3732			Damper Diode 1N4785			V_{CB}	V_{EB}	I_C	I_B	I_E
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	V	V	A	A	mA
Collector-Cutoff Current	I_{CBO} μA	-	-	-200	-	-	-200	-	-	-200	-	-	-	-10				0
Collector-to-Emitter Breakdown Voltage	BV_{CES} volts	-	-	-	-320	-	-	-	-	-	-	-	-		0	-0.025		
		-200	-	-	-	-	-	-100	-	-	-	-	-		0	-0.005		
Emitter-to-Base Breakdown Voltage	BV_{EBO} volts	0.5	-	-	-2	-	-	0.5	-	-	-	-	-			0		-100
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$ volts	-	-	-	-	-	-0.75	-	-	-	-	-	-			-6	-0.4	
		-	-	-2	-	-	-	-	-	-2	-	-	-			-0.7	-0.02	
		-	-	-1	-	-	-	-	-	-	-	-	-			-0.05	-0.005	
Base-to-Emitter Voltage	V_{BE} volts	-	-	-	-	0.8	-	-	-	-	-	-	-			-6	-0.4	
		-	0.5	-	-	-	-	-	0.5	-	-	-	-			-0.7	-0.02	
Turn-off Time△	t_{off} μs	-	-	-	-	-	0.75	-	-	-	-	-	-	See *Fig.1*				
Thermal Resistance Junction to Case	θJC °C/W	-	-	1.5	-	-	1.5	-	-	1.5	-	-	-					
Peak Reverse Voltage	PRV volts	-	-	-	-	-	-	-	-	-	320	-	-	Reverse Current I_R = 1 mA				
Static Reverse Current	I_R μA	-	-	-	-	-	-	-	-	-	-	-	150	DC Reverse Voltage V_R = 10 V				
Static Forward Voltage Drop	V_F volts	-	-	-	-	-	-	-	-	-	-	-	0.77	DC Forward Current I_F = 7 A				

△ "Turn-Off Time" t_{off} as used in this bulletin is the time required for the Collector Current I_C to decrease to -100 milliamperes **after** the Collector-to-Emitter voltage V_{CE} has risen 2 volts into its "flyback" excursion. In a circuit of the type shown in Fig.1 the collector current may be determined by measuring the base and emitter currents simultaneously with the aid of a current-transformer-type probe.

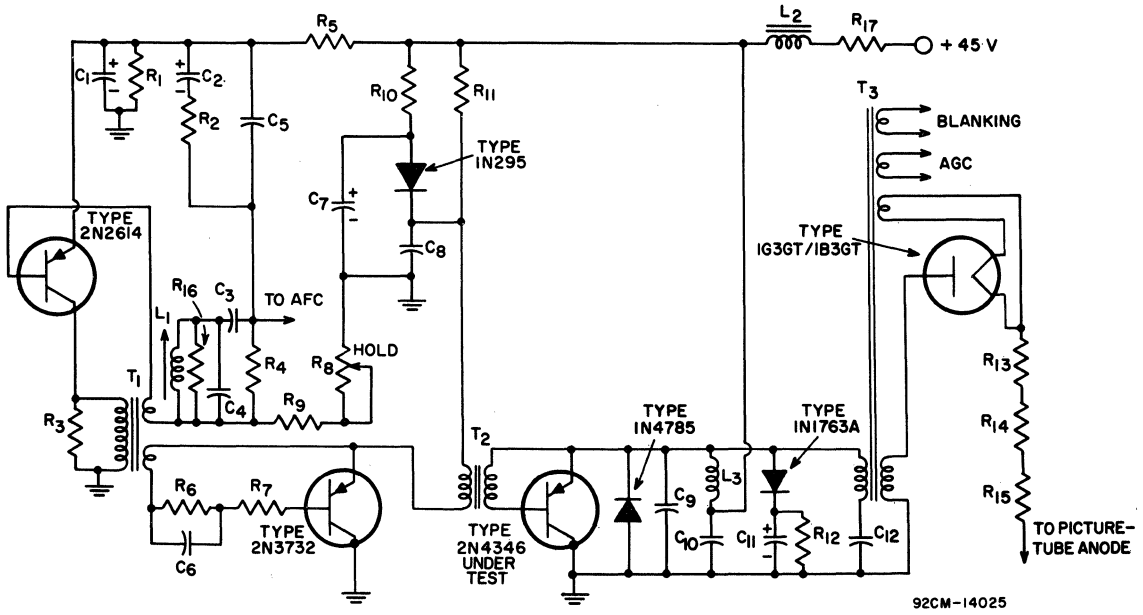


Fig.1 - Circuit of Turn-Off-Time Test-Set for RCA-2N4346.

PARTS LIST FOR FIG. 1

C_1 = 50 μF, 12 V, electrolytic
C_2 = 2 μF, 3 V, electrolytic
C_3 = 0.008 μF, mica
C_4 = 0.01 μF, mica
C_5 = 0.2 μF
C_6 = 0.1 μF, 3 V
C_7 = 10 μF, 15 V, electrolytic
C_8 = 0.05 μF, 50 V
C_9 = 0.05 μF, 300 V
C_{10} = 4 μF, 25 V
C_{11} = 10 μF, 300 V, electrolytic
C_{12} = 0.15 μF, 400 V
L_1 = Sine-wave coil (see below for design data)
L_2 = Choke, 2 mH at 2 A
L_3 = Horizontal-deflection windings of yoke – Inductance = 200 μH
R_1, R_{16} = 560 Ω
R_2 = 2.2 KΩ
R_3, R_5 = 1 KΩ
R_4 = 15 KΩ
R_6 = 4.7 Ω
R_7 = 10 Ω
R_8 = Hold control, potentiometer, 10 KΩ
R_9 = 22 KΩ
R_{10} = 2.7 KΩ
R_{11} = 560 Ω, 1W
R_{12} = 1 MΩ
R_{13}, R_{14}, R_{15} = 27 KΩ
R_{17} = 15 Ω, 10 W

T_1 = Blocking-oscillator transformer, Columbus Process Co., Columbus, Ind. Part No.CPX9372, or equivalent (see design data)
T_2 = Driver transformer, Columbus Process Co., Columbus, Ind. Part No.CPX9370 or equivalent (see design data)
T_3 = Horizontal-deflection output and high-voltage transformer, F.W. Sickles Co., Div. of General Instruments Corp., Chicopee, Mass. Part No.18428-4 or equivalent.

TYPICAL PERFORMANCE DATA FOR TURN-OFF-TIME TEST-SET CIRCUIT SHOWN IN FIG. 1

DC Supply Voltage	+45	V	Peak collector-to-emitter voltage for Type 2N4346	260	V
Average Supply Current	0.55	A	DC high-voltage output:		
Input Power:			at beam) = 0	18	kV
Oscillator and driver circuits	1.5	W	current) = 200 μA	17	kV
Output circuit:			Yoke current (peak-to-peak)	10	A
at beam) = 0	18	W	Peak yoke energy	2.5	mJ
current) = 200 μA	22	W	Retrace time	11.5	μs

DESIGN DATA FOR TRANSFORMERS SHOWN IN FIG. 1

L_1 — Sine-Wave Coil:

Form – Tapped or embossed to accommodate 1/4 – 28 threaded slug.
Slug – General Ceramics Type Q material or equivalent, 5/8 inch long.
Winding – 350 turns No.7/41 Litz wire (Cam = 0.5 inch).

T_1 — Blocking-Oscillator Transformer:

Cup core: Indiana General Corp., Keasbey, N.J. Part No.F912-03 or equivalent.
Cup-core cover: Indiana General Corp., Keasbey, N.J., Part No. F913-03 or equivalent.
Nylon bobbin: American Molded Products, Chicago 22, Ill., Part No.5661 or equivalent.
Gap: 1.5-mil paper
Windings:
Primary – 135 turns No.34 FORMVAR* wire
Secondary – 35 turns No.30 FORMVAR wire
Feedback – 45 turns No.30 FORMVAR wire
Wind 45 turns of primary; then trifilar-wind secondary and feedback windings with remainder of primary to assure tight coupling.

T_2 — Driver Transformer:

Cup core, Cup-core cover, Nylon bobbin, Gap } Same as for T_1

Windings:
Primary – 80 turns No.30 FORMVAR wire
Secondary – 20 turns No.24 FORMVAR wire
Wind 30 turns of primary; then bifilar-wind secondary winding with remainder of primary to assure tight coupling.

* Trade Mark, Shawinidan Products Corp.

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OPERATING CONSIDERATIONS

Because the metal shells of the 2N3730, 2N4346 and 2N3732 operate at the collector voltage, and that of the 1N4785 at the anode voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the devices.

These devices can be installed in commercially available sockets. Electrical connection to the terminal pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the device.

It is essential that the mounting flange which serves as the collector or anode terminal be securely fastened to a heat sink, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE DEVICE.

The mounting-flange temperature of the 2N3730, 2N4346, 2N3732, or 1N4785 will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capability to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use either an anodized aluminum insulator having high thermal conductivity, or a mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the terminal pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that a fibre washer be used between each bolt and the chassis.

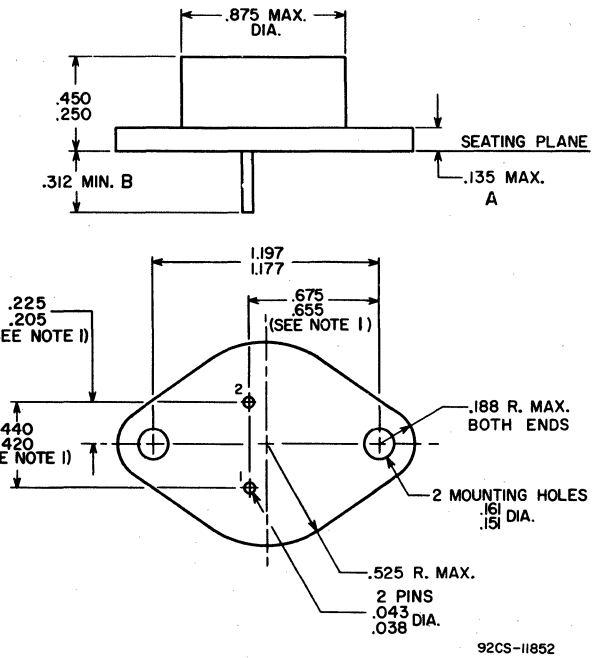
DIMENSIONAL OUTLINE

JEDEC No. TO-3

For RCA-2N3730, 2N4346, 2N3732, 1N4785

Mounting-Flange Thickness (A) = 0.050" max.

Pin Length (B) = 0.440" min. / 0.480" max.

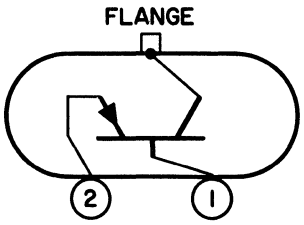


ALL DIMENSIONS IN INCHES.

NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

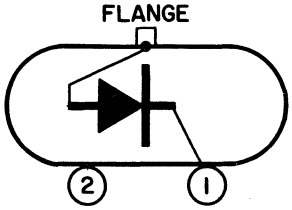
TERMINAL CONNECTIONS

2N3730, 2N4346, 2N3732



Pin 1 – Base
Pin 2 – Emitter
Mounting Flange – Collector, Case

1N4785



Pin 1 – Cathode
Pin 2 – No Connection
Mounting Flange – Anode, Case

SILICON N-P-N "overlay" TRANSISTOR

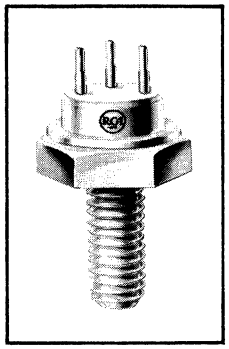
2N3733

File No. 72

RCA-2N3733 is an epitaxial silicon n-p-n planar transistor. This device is intended for class A, B, & C amplifier, frequency multiplier, or oscillator operation. The 2N3733 was developed for VHF-UHF applications.

The transistor employs the new "overlay" concept in emitter-electrode design -- an emitter electrode consisting of many microscopic areas connected together through the use of a diffused-grid structure and an overlay of metal which is applied on the silicon wafer by means of a photo-etching technique. This arrangement provides the very high emitter periphery-to-emitter area ratio required for high efficiency at high frequencies.

For LargeSignal High-Power VHF-UHF Applications in Military and Industrial Communications Equipment



JEDEC TO-60

RF SERVICE

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO} . . .	65 volts
COLLECTOR-TO-EMITTER VOLTAGE:	
With base open, V_{CEO}	40 volts
With V_{BE} = −1.5 volts, V_{CEV}	65 volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4 volts
PEAK COLLECTOR CURRENT	3.0 amperes
TRANSISTOR DISSIPATION, P_T:	
At case temperatures up to 25°C	23 watts
At case temperatures above 25°C.	Derate linearly to 0 watts at 200°C
TEMPERATURE RANGE:	
Storage	−65 to 200°C
Operating (Junction)	−65 to 200°C
PIN TEMPERATURE (During soldering): At distances ≥ 1/32" from insulating wafer for 10 sec. max.	230 max. °C

FEATURES

- High Power Output, Unneutralized Class C Amplifier
  at 400 Mc — 10 W minimum
  at 260 Mc — 14.5 W typical
- High Voltage Ratings --
  V_{CBO} = 65 volts max.
  V_{CEV} = 65 volts max.
  V_{CEO} = 40 volts max.
- 100 per cent tested to assure freedom from second breakdown for operation in class-A applications
- Low Thermal Resistance ($\theta_{J\text{-}C}$) --
  High thermal-conductivity ceramic insulation between collector and mounting stud
- New Package Design -- TO-60
  All three electrodes electrically isolated from case -- for design flexibility

  Heavy copper mounting stud -- for effective contact with heat sink

  Pin terminals arranged on a .200" pin-circle diameter -- fit commercially available sockets

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3733 5/66
Reprinted from 2N3733 4/65

ELECTRICAL CHARACTERISTICS
Case Temperature = 25°C

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	0.25	ma
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.5	65	–	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	0 to 200*	40**	–	volts
	BV_{CEV}			−1.5			0 to 200*	65**	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.25		0	4	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					100	500	–	1	volt
Collector-to-Base Capacitance Measured at 1 Mc	C_{ob}	30			0			–	20	pf
RF Power Output Amplifier, Unneutralized At 260 Mc (See Fig. 3) 400 Mc (See Fig. 2)	P_{OUT}		28 28					14.5● (typ.) 10▲	–	watts
Gain-Bandwidth Product	f_T		28				150	400 (typ.)		Mc
Base-Spreading Resistance Measured at 200 Mc	$r_{bb'}$		28				250	6.5 (typ.)		ohms
Collector-to-Case Capacitance	C_s							–	6	pf

* Pulsed through an inductor (25 mh); duty factor = 50%.
** Measured at a current where the breakdown voltage is a minimum.
● For P_{IN} = 4.0 w; minimum efficiency = 60%.
▲ For P_{IN} = 4.0 w; minimum efficiency = 45%.

POWER OUTPUT vs. FREQUENCY FOR TYPE 2N3733

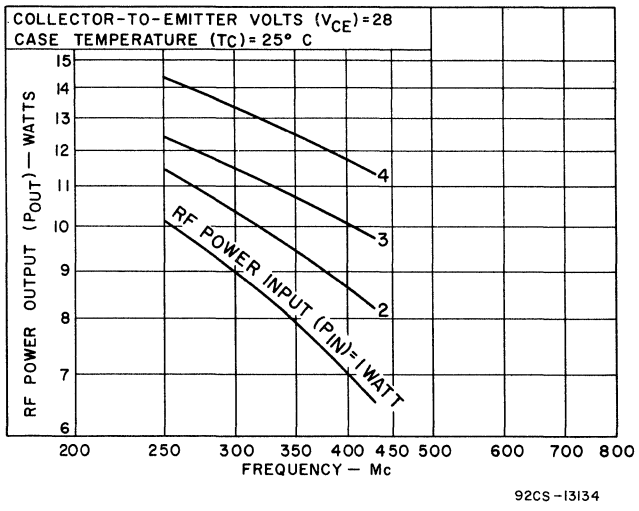
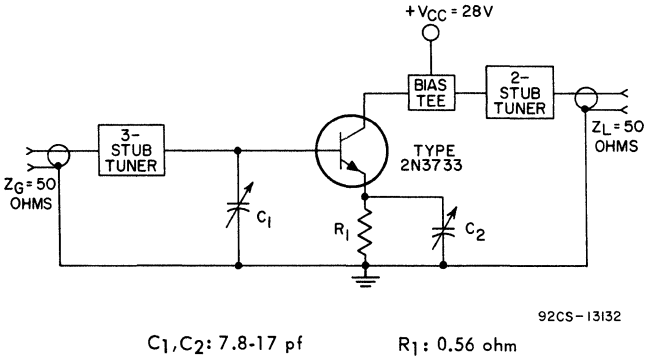


Fig. 1

RF AMPLIFIER CIRCUIT FOR 2N3733 POWER-OUTPUT TEST (400-Mc Operation)



C_1, C_2: 7.8-17 pf R_1: 0.56 ohm

Fig. 2

RF AMPLIFIER CIRCUIT FOR 2N3733 POWER OUTPUT TEST (260-Mc Operation)

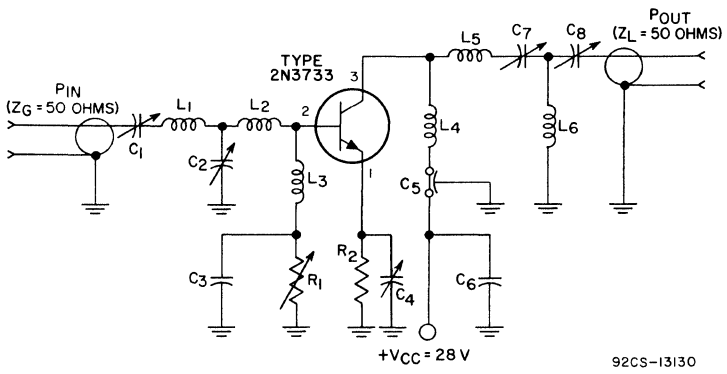


Fig. 3

C_1: 3-35 pf

C_2, C_4, C_8: 8-60 pf

C_3, C_6: 0.005 μf, disc ceramic

C_5: 1,000 pf

C_6: 1.5-20 pf

L_1: 3 turns No.18 wire, 1/4" ID, 1/4" long

L_2: 3/16" wide copper strip, 3/8" long

L_3: Ferrite choke, Z = 450 ohms

L_4: RF choke, 0.47 μh

L_5: 3-1/2 turns No.16 wire, 1/4" ID, 7/16" long

L_6: 1 turn No.16 wire, 1/4" ID, 3/8" long

R_1: 50 ohms

R_2: 0.56 ohms

GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT FOR TYPE 2N3733

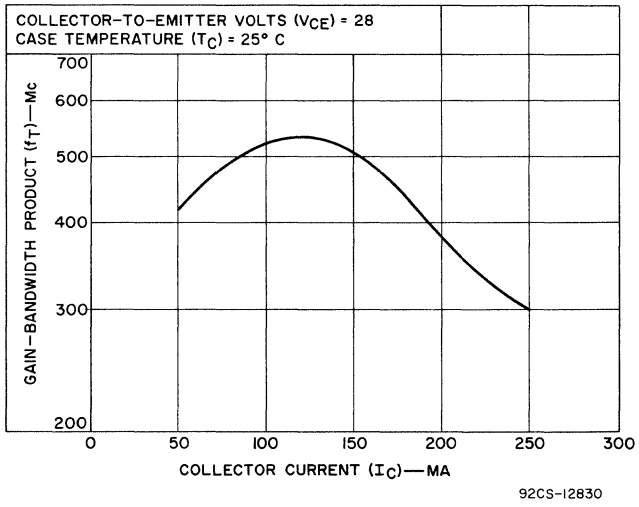


Fig. 4

SERIES INPUT RESISTANCE vs. FREQUENCY FOR TYPE 2N3733

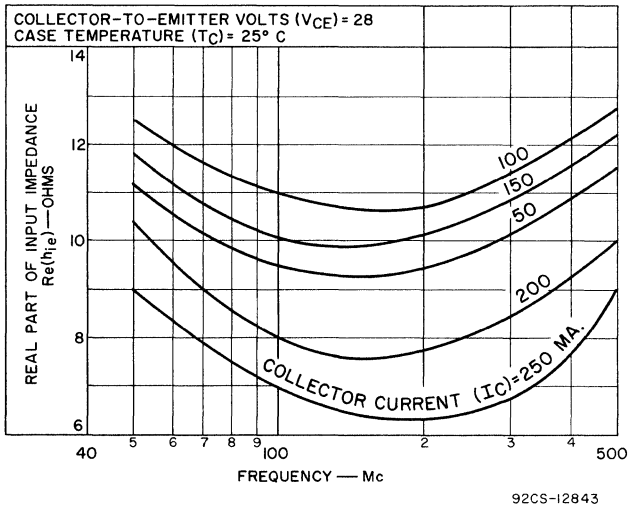


Fig. 6

SERIES INPUT REACTANCE vs. FREQUENCY FOR TYPE 2N3733

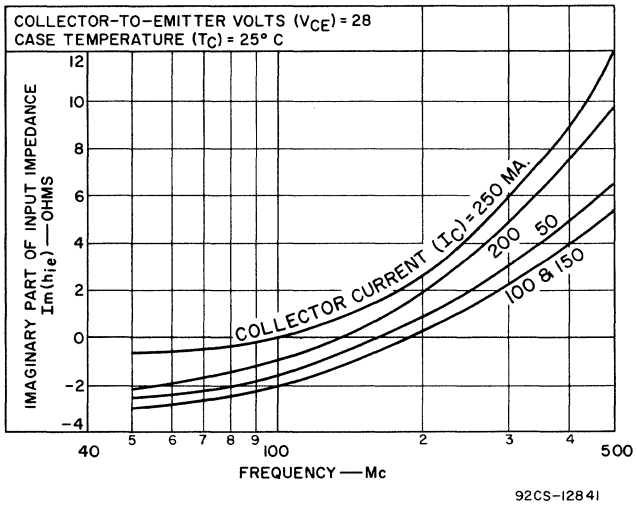


Fig. 5

OUTPUT CAPACITANCE vs. FREQUENCY FOR TYPE 2N3733

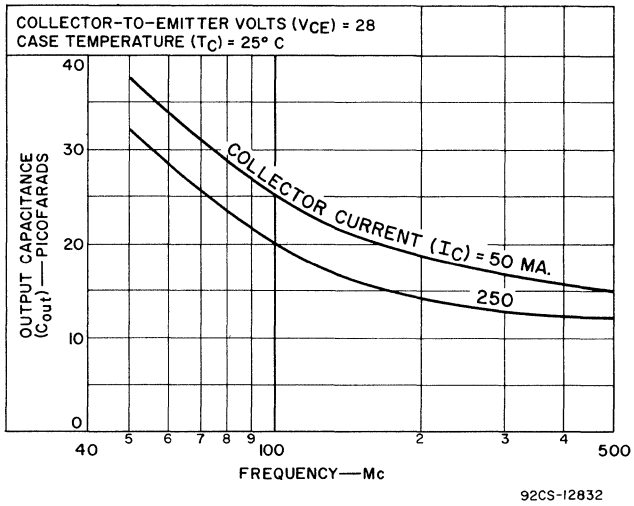


Fig. 7

OUTPUT RESISTANCE vs. FREQUENCY FOR TYPE 2N3733

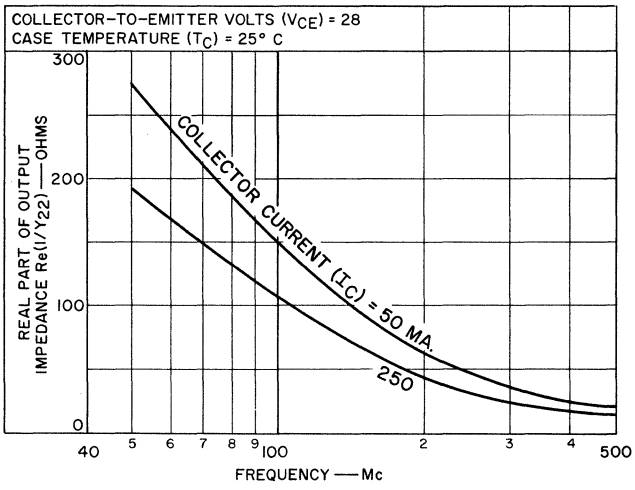


Fig. 8

VARIATION OF COLLECTOR-TO-BASE CAPACITANCE FOR TYPE 2N3733

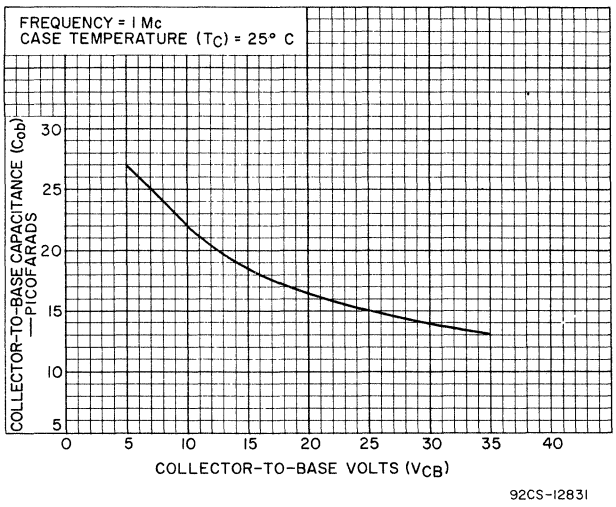
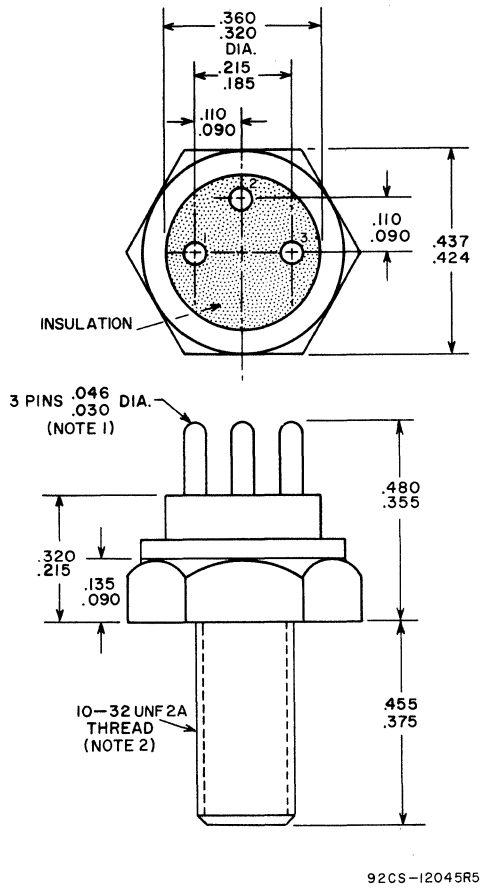


Fig. 9

DIMENSIONAL OUTLINE FOR TYPE 2N3733 JEDEC TO-60



Dimensions in Inches

NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200" AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.035" MIN., 0.045" MAX.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

NOTE 3: THIS DEVICE MAY BE OPERATED IN ANY POSITION.

TERMINAL CONNECTIONS

Pin No. 1 - Emitter
Pin No. 2 - Base
Pin No. 3 - Collector

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RCA POWER TRANSISTORS

2N3771
2N3772

"HOMETAXIAL"-BASE* SILICON N-P-N HIGH-CURRENT HIGH-POWER TYPES

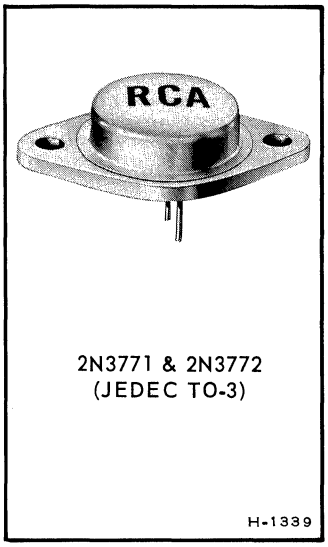
RCA-2N3771 and 2N3772** are Hometaxial-base*, silicon n-p-n transistors intended for a wide variety of high-power, high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

Both devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage and current.

*"Hometaxial" was coined by RCA from "homogeneous" and "axial" to describe a single-diffused transistor with a base region of homogeneous resistivity silicon in the axial direction (emitter-to-collector).

**Formerly Dev. Type Nos. TA2650 and TA2544, respectively.

General-Purpose Transistors for Industrial, Commercial, and Military Equipment



2N3771 & 2N3772
(JEDEC TO-3)

H-1339

2N3771

- **High dissipation capability — 150 W**
- **$V_{CEX}(sus)$ = 50 V min. at 3 A**
- **15-A specification for: h_{FE}, V_{BE}, & $V_{CE}(sat)$**
- **Low saturation voltage with high beta**

2N3772

- **High dissipation capability — 150 W**
- **$V_{CEX}(sus)$ = 90 V min. at 3 A**
- **10-A specification for: h_{FE}, V_{BE}, & $V_{CE}(sat)$**
- **Low saturation voltage with high beta**

MAXIMUM RATINGS

		2N3771	2N3772	
Absolute-Maximum Values:				
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	100	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With -1.5 V (V_{BE}) & R_{BE} = 100Ω	V_{CEX}	50	90	V
With base open	V_{CEO}	40	60	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	30	20	A
PEAK COLLECTOR CURRENT		30	30	A
CONTINUOUS BASE CURRENT	I_B	7.5	5	A
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25° C.		150	150	W
At case temperatures above 25° C		*See Figs. 7 & 8.*		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		-65 to 200		°C
PIN TEMPERATURE (During soldering):				
At distance ≥ 1/32" from seating plane for 10 s max.		230		°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3771 & 2N3772 1/67
Supersedes 2N3771 & 2N3772 data included in 2N3771 bulletin dated 6765

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) of 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS				Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Type 2N3771		Type 2N3772		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	50					0		–	2	–	–	mA
		100					0		–	–	–	5	
	I_{CEV}		50		−1.5				–	2	–	–	mA
			100		−1.5				–	–	–	5	
	I_{CEO}		30					0	–	10	–	–	mA
			50					0	–	–	–	10	
	I_{CBO}[c]	30					0		–	10	–	10	mA
	I_{CEV}[c]		30		−1.5				–	10	–	10	mA
Emitter-Cutoff Current	I_{EBO}			5		0			–	5	–	–	mA
				7		0			–	–	–	5	
DC forward-Current Transfer Ratio	h_{FE}		4			15[b]			15	60	–	–	
			4			10[b]			–	–	15	60	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 3 & 4)*	$V_{CEX}(sus)$			−1.5		0.2			50[a]		80[a]		V
With base-emitter junction reverse biased (& R_{BE} = 100Ω)				− 1.5		3			50[a]	–	90[a]	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$					0.2			45	–	70	–	V
With base open	$V_{CEO}(sus)$					0.2		0	40	–	60	–	V
Base-to-Emitter Voltage	V_{BE}		4			15[b]			–	2.7	–	–	V
			4			10[b]			–	–	–	2.2	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					15[b]		1.5	–	2.0	–	–	V
						10[b]		1.0	–	–	–	1.4	
Power Rating Test	PRT		33.5			4.5			1[d]	–	1[d]	–	s
Gain-Bandwidth Product	f_T		4.0			1.0			800	–	800	–	kHz
Thermal Resistance Junction-to-Case	θ_{J-C}								–	1.17	–	1.17	°C/W

[a] **CAUTION:** The sustaining voltage $V_{CEV}(sus)$ **MUST NOT** be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in *Fig. 3.*

[b] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz.

[c] At T_C = 150° C.

[d] At 150 W.

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SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3771

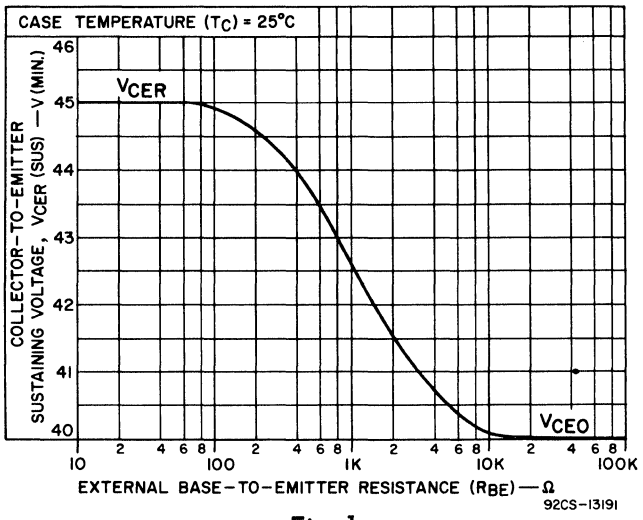


Fig. 1

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3772

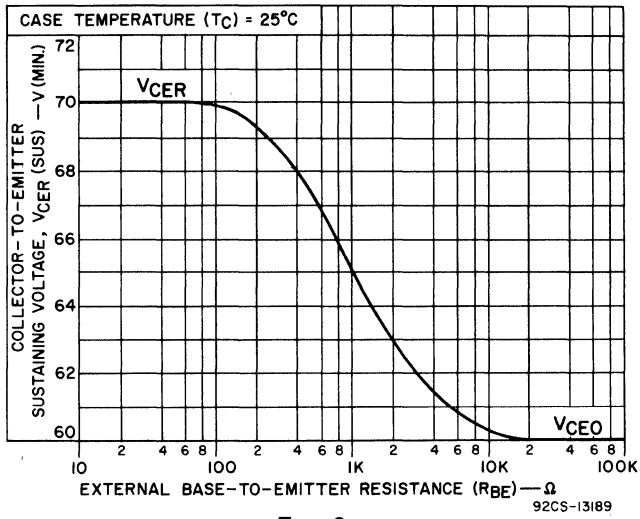


Fig. 2

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGE V_{CEX}(sus) FOR TYPES 2N3771 & 2N3772

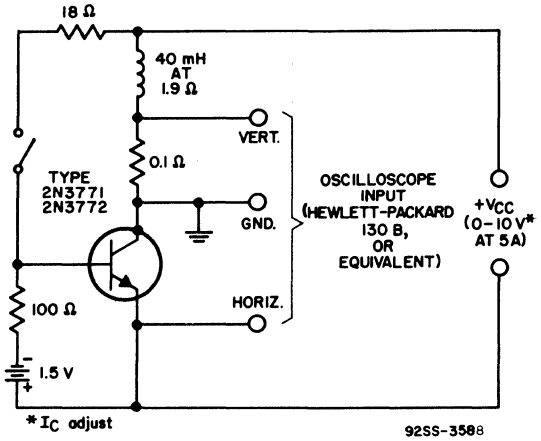
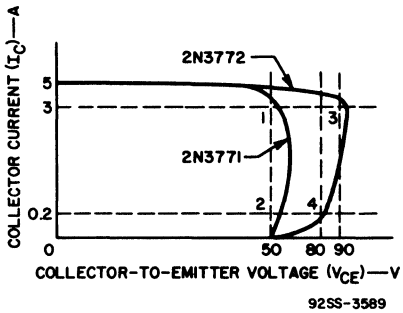


Fig. 3

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN IN FIG. 3)



The sustaining voltage V_{CEX}(sus) is acceptable when the trace falls to the right and above points 1 & 2 for type 2N3771 or falls to the right and above points 3 & 4 for type 2N3772. (For values of current and voltage, see Electrical Characteristics).

Fig. 4

TYPICAL DC-BETA CHARACTERISTICS FOR TYPES 2N3771 & 2N3772

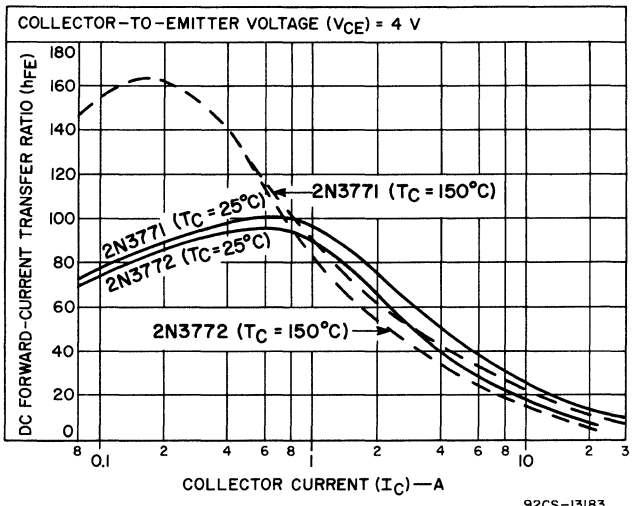


Fig. 5

TYPICAL GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT FOR TYPES 2N3771 & 2N3772

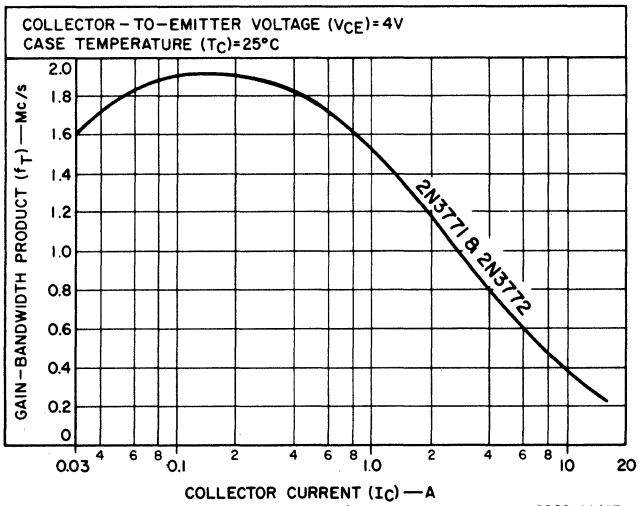


Fig. 6

MAXIMUM AREA-OF-OPERATION

Figure 8 shows the maximum operating area curve for types 2N3771 and 2N3772 (DC, pulse, and second-breakdown limitations) at a case temperature of 25° C. The curves, shown on a log-log plot, have slopes equal to −1 when thermal (dissipation) limitation exists and approximately −2 when second-breakdown limitation exists. The dashed line, extending the dissipation limitation line, assists in determining the normalized power multiplier value.

Non-Repetitive Pulse. *Figure 8* allows direct calculation of types 2N3771 and 2N3772 maximum dissipation limits when only a single pulse condition occurs.

Repetitive Pulse. The collector-current limitation values and the normalized power multiplier values, shown in *Figure 8*, must be reduced when repetitive pulses are applied to types 2N3771 and 2N3772. The amount of current derating is determined by the slope of the dissipation derating curve *(Figure 7)* where T_{EFF} is the effective case temperature produced by the pulses.

The effective case temperature may be calculated by using the following equation:

$$T_{EFF} = T_C + (P_{AVG})\,(\theta_{J\text{-}C})$$

Where:

T_C = Case temperature, °C

P_{AVG} = Average power of the applied repetitive pulses, W

$\theta_{J\text{-}C}$ = Junction-to-case thermal resistance, °C/W.

For types 2N3771 and 2N3772, only dissipation-limited boundary lines and their dashed line extensions need derating when the effective case temperature increases. The second-breakdown portions of the curves, shown in *Figure 8* do not require derating.

DISSIPATION DERATING CURVE
FOR TYPES 2N3771 & 2N3772

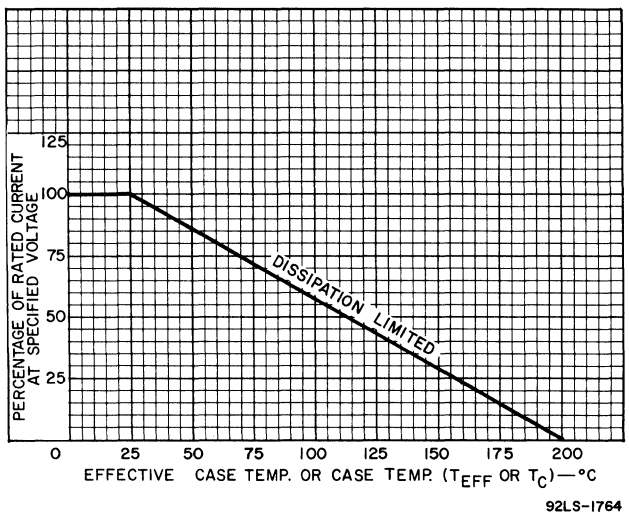


Fig. 7

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3771

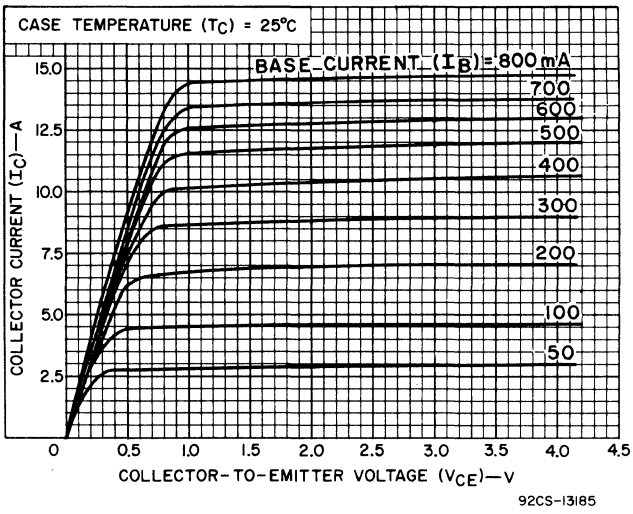


Fig. 10

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N3772

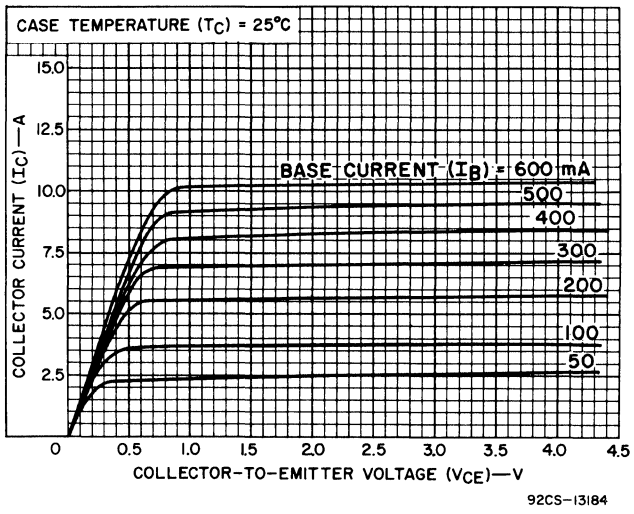


Fig. 11

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3771

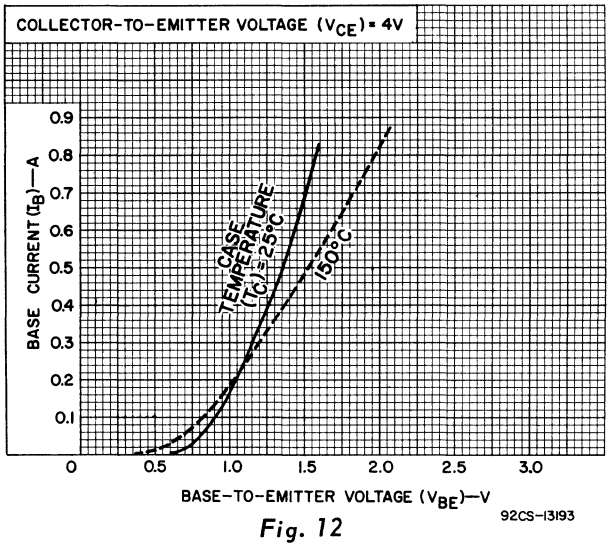


Fig. 12

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3772

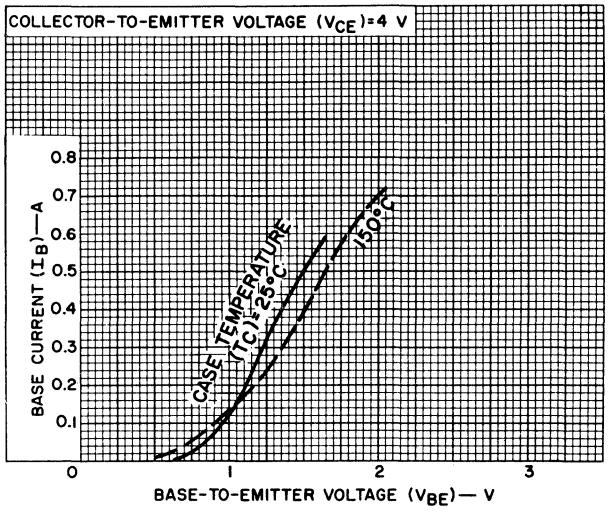


Fig. 13

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS FOR TYPE 2N3771

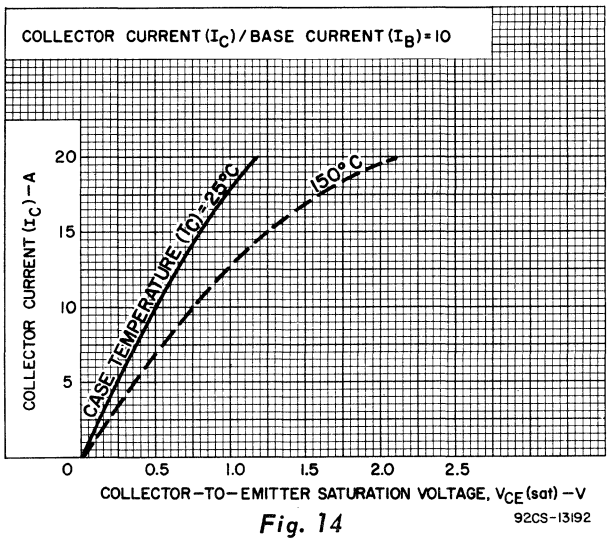


Fig. 14

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS FOR TYPE 2N3772

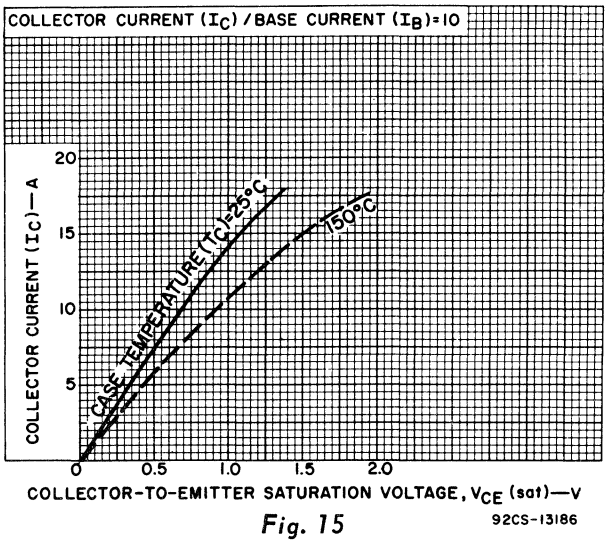


Fig. 15

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPE 2N3771

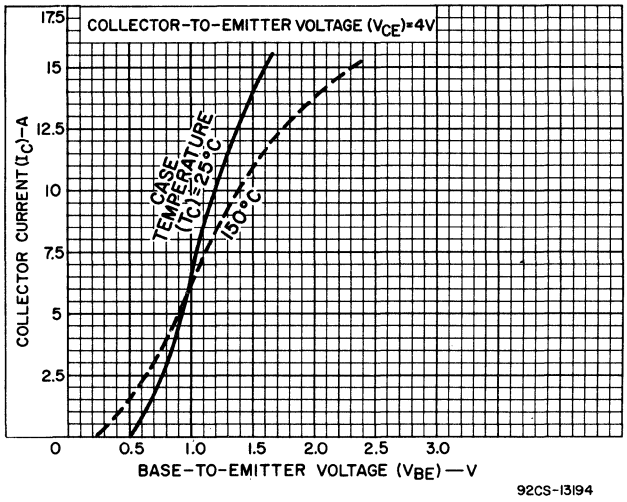


Fig. 16

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPE 2N3772

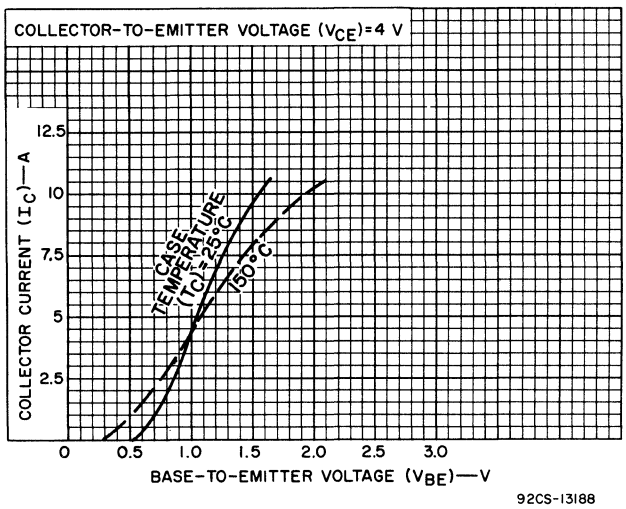
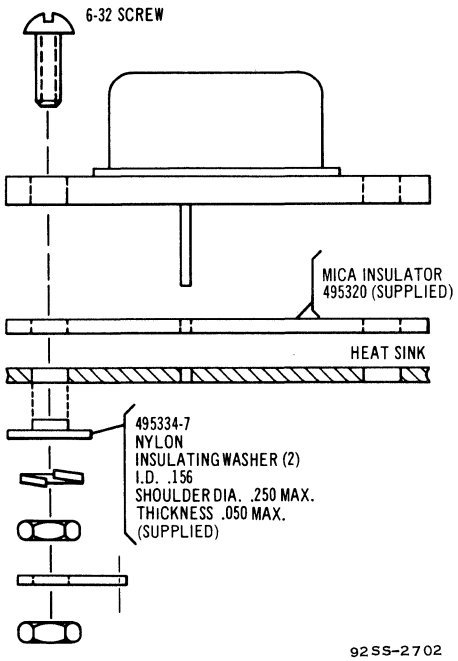
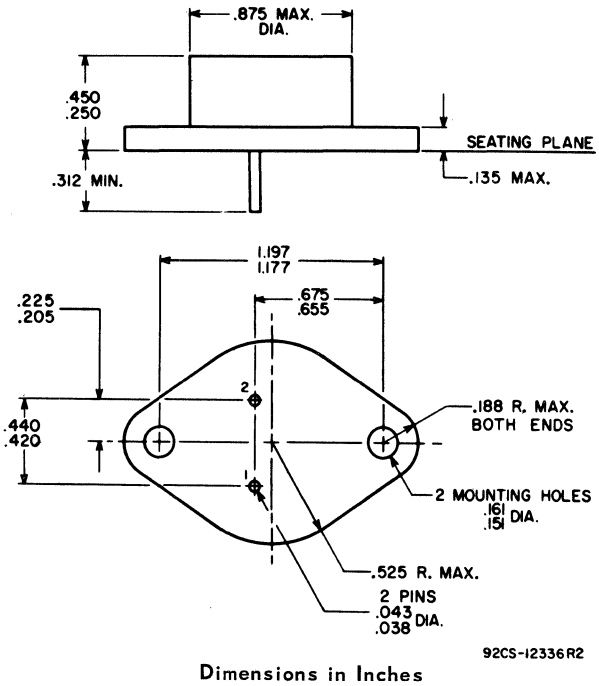


Fig. 17

SUGGESTED HARDWARE
FOR TYPES 2N3771 AND 2N3772



DIMENSIONAL OUTLINE
FOR TYPES 2N3771 AND 2N3772
JEDEC TO-3



Dimensions in Inches

TERMINAL CONNECTIONS

Pin 1 - Base
Pin 2 - Emitter
Case, Flange - Collector

MAXIMUM OPERATING AREAS
FOR TYPES 2N3771 & 2N3772

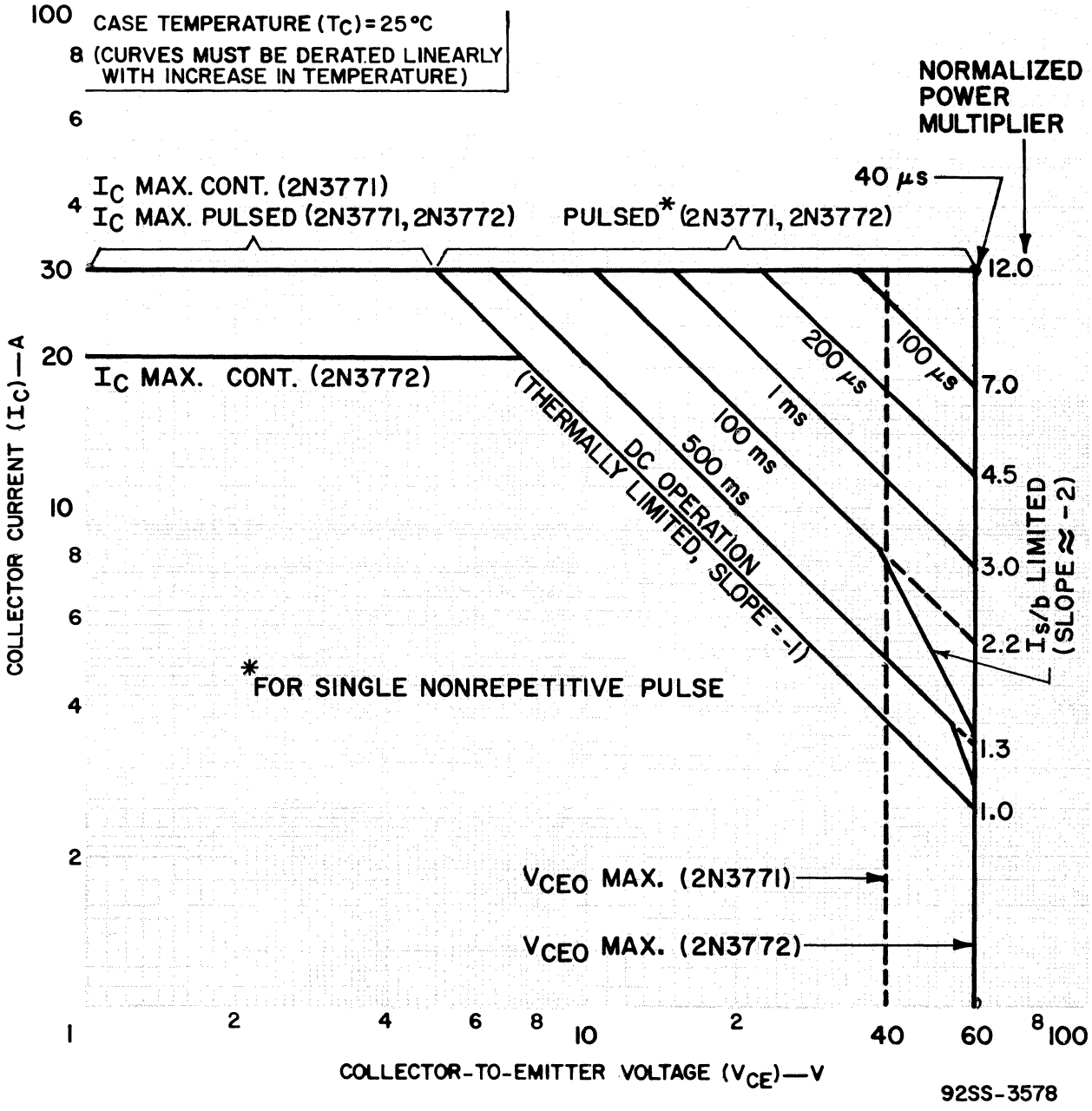


Fig. 8

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

Figure 8 shows the DC and pulse current derating curves applicable to types 2N3771 and 2N3772. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant with voltage). That portion where the slope is approximately -2 shows the region where the device is second breakdown limited, i.e., the allowable power dissipation depends on the voltage but is not constant.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the "on" condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in *Figure 9* should prove useful in the design of circuits having inductance loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. Also, these curves can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers).

In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore, the allowable energy shown in the above mentioned curves (calculated from $E_{S/b} = \frac{1}{2}LI^2$, where L is a series load or leakage inductance and I is the peak collector current from the curves) will be conservative for smaller inductive loads. For further information on second breakdown, write for RCA publication ST-3186 "Second-Breakdown Effects on Transistor Applications" or consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPES 2N3771 & 2N3772

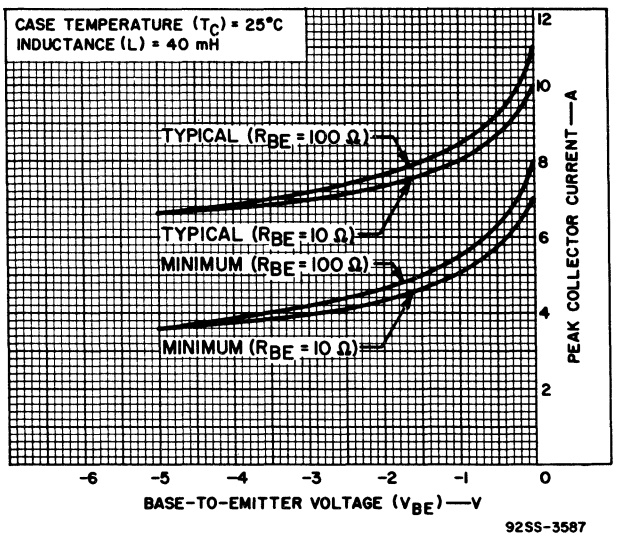


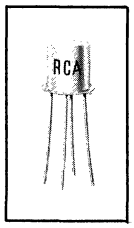
Fig. 9

RCA RF TRANSISTORS
For Low-Noise UHF Applications

2N3839

File No. 229

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-72

For Low-Noise UHF Applications in Industrial and Military Equipment

RCA-2N3839* is a double-diffused epitaxial planar transistor of the silicon n-p-n type. It is extremely useful in low-noise-amplifier, oscillator, and converter applications at frequencies up to 500 MHz in the common-emitter configuration, and up to 1200 MHz, in the common-base configuration.

The 2N3839 is mechanically and electrically like the 2N2857, but has a substantially lower noise figure.

The 2N3839 utilizes a hermetically sealed four-lead JEDEC TO-72 package. All active elements of the transistor are insulated from the case, which may be grounded by means of the fourth lead in applications requiring shielding of the device.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max.	V
COLLECTOR CURRENT, I_C	40 max.	mA
TRANSISTOR DISSIPATION, P_T:		
For operation with heat sink:		
At case temperatures** up to 25°C	300 max.	mW
At case temperatures** above 25°C	Derate at 1.72	mW/°C
For operation at ambient temperatures:		
At ambient temperatures up to 25°C	200 max.	mW
At ambient temperatures above 25°C	Derate at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage and Operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32 inch from seating surface for 10 seconds max.	265 max.	°C

* Formerly Dev. No. TA-2363

** Measured at center of seating surface.

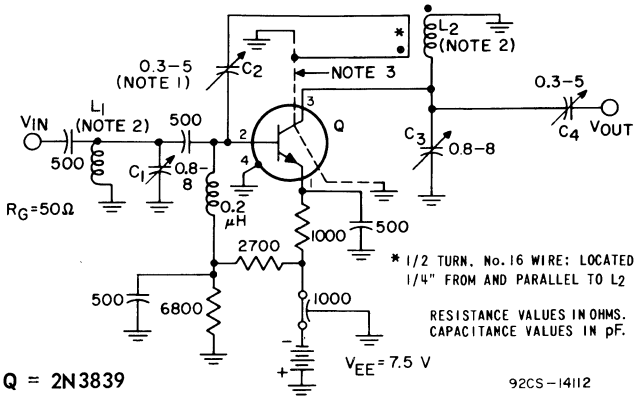


Fig.1 - Neutralized amplifier circuit used to measure 450-MHz power gain and noise figure for type 2N3839.

FEATURES

- very low device noise figure — NF = 3.4 dB max. as 450-MHz amplifier
- high gain-bandwidth product — f_T = 1000 MHz min.
- high converter (450-to-30 MHz) gain — G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz
- high power gain as neutralized amplifier — G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz
- high power output as UHF oscillator — P_o = 30 mW min., 40 mW typ. at 500 MHz = 20 mW typ. at 1 GHz
- low collector-to-base time constant — $r_b' C_c$ = 7 ps typ.
- low collector-to-base feedback capacitance — C_{cb} = 0.6 pF typ.

NOTE 1: (NEUTRALIZATION PROCEDURE): (A) CONNECT A 450-MHz SIGNAL GENERATOR (WITH R_g = 50 OHMS) TO THE INPUT TERMINALS OF THE AMPLIFIER. (B) CONNECT A 50-OHM RF VOLTMETER ACROSS THE OUTPUT TERMINALS OF THE AMPLIFIER. (C) APPLY V_{EE}, AND WITH THE SIGNAL GENERATOR ADJUSTED FOR 5 mV OUTPUT FROM THE AMPLIFIER, TUNE C_1, C_3, AND C_4 FOR MAXIMUM OUTPUT. (D) INTERCHANGE THE CONNECTIONS TO THE SIGNAL GENERATOR AND THE RF VOLTMETER. (E) WITH SUFFICIENT SIGNAL APPLIED TO THE OUTPUT TERMINALS OF THE AMPLIFIER, ADJUST C_2 FOR A MINIMUM INDICATION AT THE INPUT. (F) REPEAT STEPS (A), (B), AND (C) TO DETERMINE IF RETUNING IS NECESSARY.

NOTE 2: L_1 & L_2—SILVER-PLATED BRASS ROD, 1-1/2" LONG x 1/4" DIA. INSTALL AT LEAST 1/2" FROM NEAREST VERTICAL CHASSIS SURFACE.

NOTE 3: EXTERNAL INTERLEAD SHIELD TO ISOLATE THE COLLECTOR LEAD FROM THE EMITTER AND BASE LEADS.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N3839 10-66

ELECTRICAL CHARACTERISTICS, *At an Ambient Temperature, T_A, of 25°C, Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS							LIMITS			UNITS
		FREQUENCY f	DC COLLECTOR-TO-BASE VOLTAGE V_{CB}	DC COLLECTOR-TO-EMITTER VOLTAGE V_{CE}	DC EMITTER-TO-BASE VOLTAGE V_{EB}	DC EMITTER CURRENT I_E	DC BASE CURRENT I_B	DC COLLECTOR CURRENT I_C	TYPE 2N3839			
		MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current T_A = 25°C T_A = 150°C	I_{CBO}		15 15			0 0			- -	- -	10 1.0	nA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}					0		0.001	30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}						0	3	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0.01		0	2.5	-	-	V
Static Forward Current-Transfer Ratio	h_{FE}			1				3	30	-	150	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	0.001[c] 100[c]		6 6				2 5	50 10	- -	220 20	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1.0[b]	10			0			-	0.6	1.0	pF
Input Capacitance	C_{ib}	0.1 to 1.0			0.5			0	-	1.4	-	pF
Collector-to-Base Time Constant	$r_b' C_c$	31.9[c]	6			-2			1	7	15	ps
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit (See *Fig.1*)	G_{pe}	450[c]		6				1.5	12.5	-	19	dB
Power Output as Oscillator (See *Fig 2*)	P_o	≥500[a]	10			-12			30	-	-	mW
UHF Measured Noise Figure (See *Fig.1*)	NF	450[c,d]		6				1.5	-	-	3.9	dB
UHF Device Noise Figure	NF	450[c,d,f]		6				1.5	-	-	3.4	dB
VHF Measured Noise Figure	NF	60[c,e]		6				1	-	2	-	dB

[a] Lead No.4 (case) not connected.

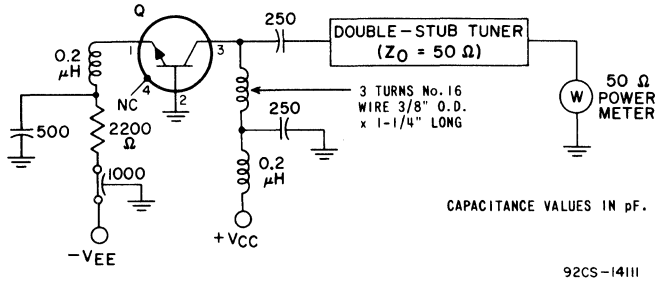
[b] 3-terminal measurement with emitter and case connected to guard terminal.

[c] Lead No.4 (case) grounded.

[d] Generator resistance, R_g = 50 ohms.

[e] Generator resistance, R_g = 400 ohms.

[f] Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test circuit (0.25 dB) and the contribution of the following stages in the test setup (0.25 dB).



Q = 2N3839

Fig.2 - Oscillator circuit used to measure 500-MHz power output for type 2N3839.

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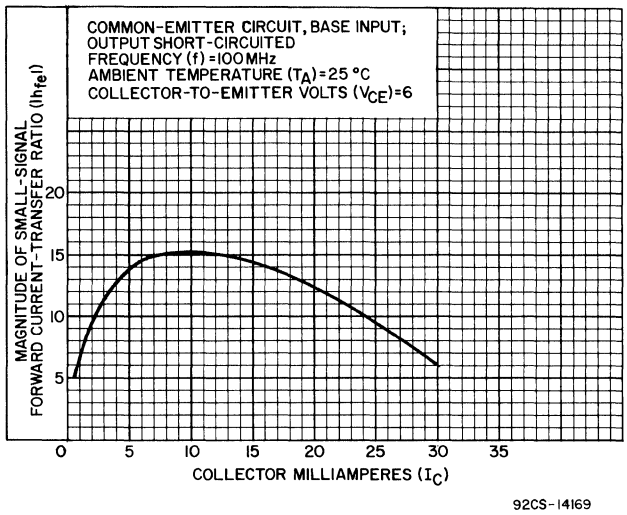


Fig.3 - Small-Signal Beta Characteristic for Type 2N3839.

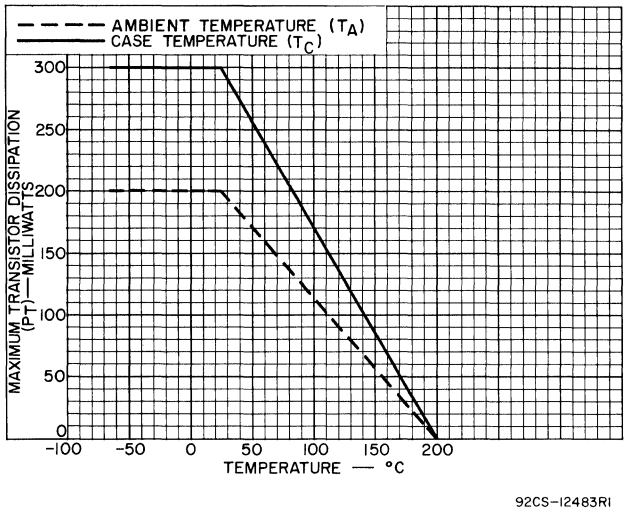


Fig.4 - Rating Chart for Type 2N3839.

TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF COLLECTOR CURRENT (I_C)

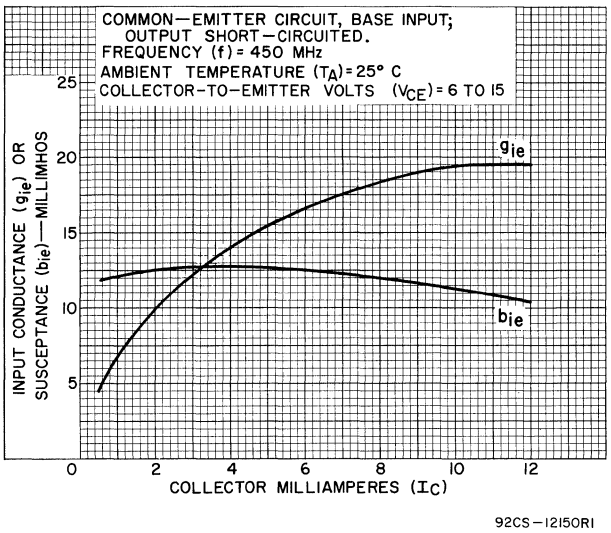


Fig.5 - Input Admittance (y_{ie}).

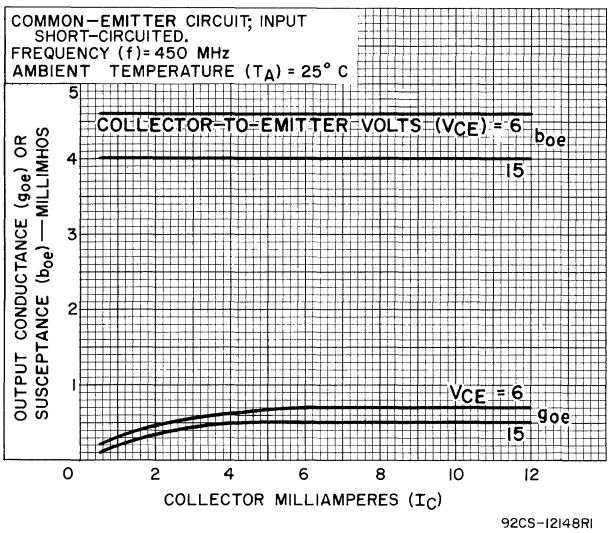


Fig.6 - Output Admittance (y_{oe}).

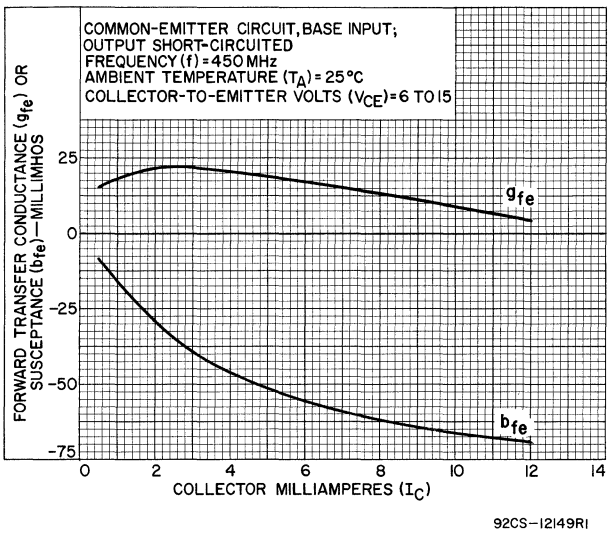


Fig.7 - Forward Transadmittance (y_{fe}).

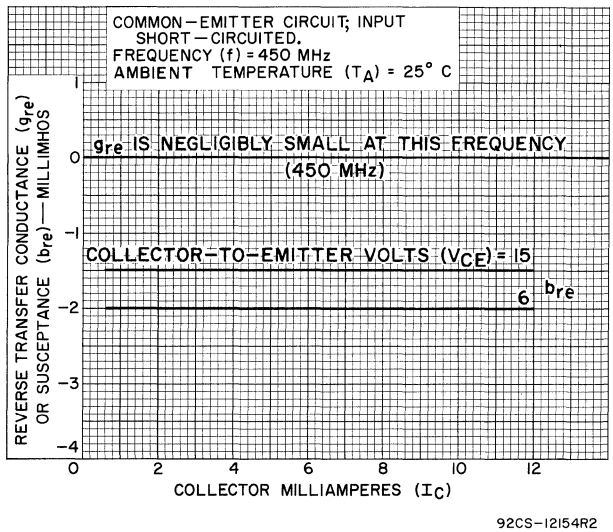


Fig.8 - Reverse Transadmittance (y_{re}).

TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF FREQUENCY (f)

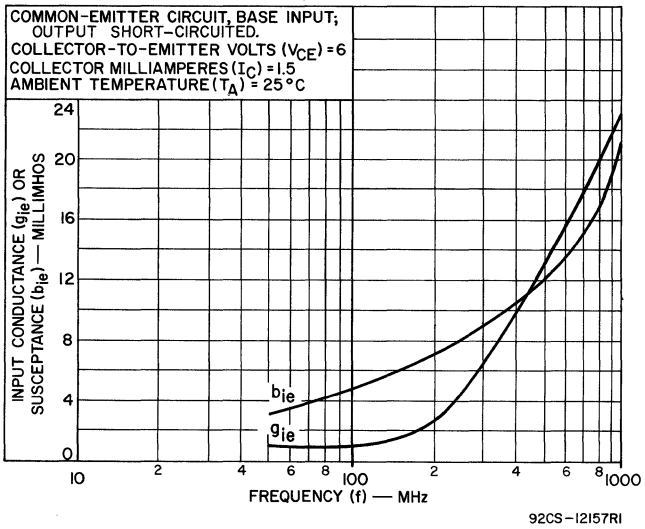


Fig.9 - Input Admittance (y_{ie}).

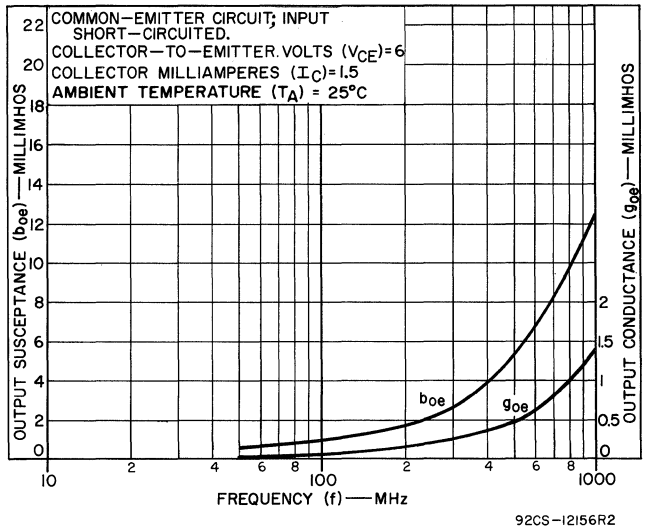


Fig.10 - Output Admittance

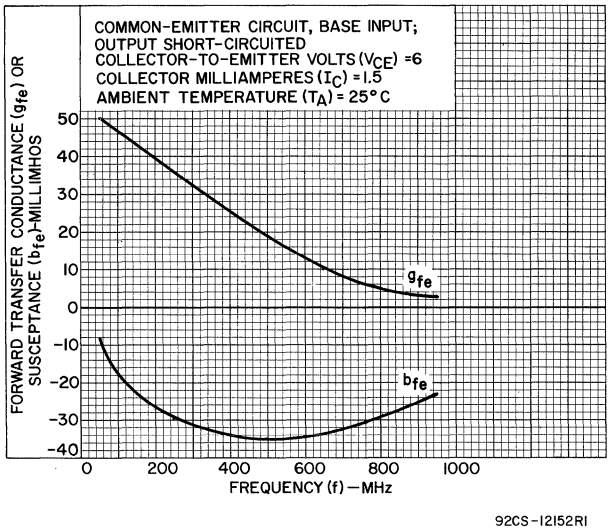


Fig.11 - Forward Transadmittance (y_{fe}).

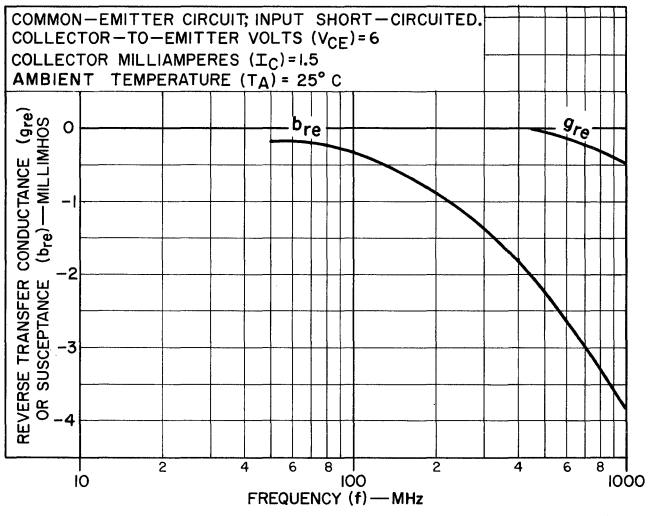
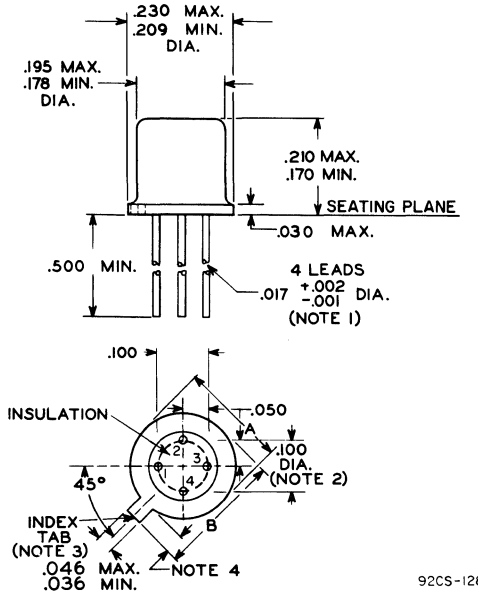
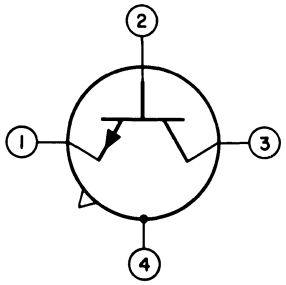


Fig.12 - Reverse Transadmittance (y_{re}).

DIMENSIONAL OUTLINE
JEDEC TO-72



TERMINAL DIAGRAM Bottom View



LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR
LEAD 4 - CONNECTED TO CASE

Note 1: The specified lead diameter applies in the zone between 0.050" and 0.250" from the seating plane. From 0.250" to the end of the lead a maximum diameter of 0.021" is held. Outside of these zones, the lead diameter is not controlled.

Note 2: Maximum diameter leads at a gauging plane 0.054" + 0.001" - 0.000" below seating plane to be within 0.007" of their true location relative to max. width tab and to the maximum 0.230" diameter measured with a suitable gauge. When gauge is not used, measurement will be made at seating plane.

Note 3: For visual orientation only.

Note 4: Tab length to be 0.028" minimum - 0.048" maximum, and will be determined by subtracting diameter A from dimension B.

SILICON N-P-N "overlay" TRANSISTOR

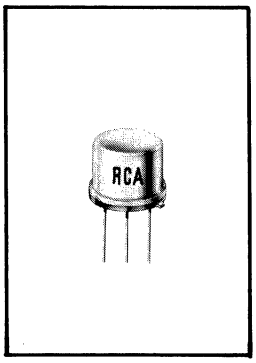
2N3866

File No. 80

RCA-2N3866 is an epitaxial silicon n-p-n planar transistor employing an advanced version of the RCA-developed "overlay" emitter-electrode design. This electrode consists of many isolated emitter sites connected together through the use of a diffused-grid structure and a metal overlay which is deposited on a silicon oxide insulating layer by means of a photo-etching technique. This overlay design provides a very high emitter periphery-to-emitter area ratio resulting in low output capacitance, high RF current handling capability, and substantially higher power gain.

The 2N3866 is intended for class-A, -B, or -C amplifier, frequency-multiplier, or oscillator circuits; it may be used in output, driver, or pre-driver stages in VHF and UHF equipment.

High-Gain Driver for VHF-UHF Applications in Military and Industrial Communications Equipment



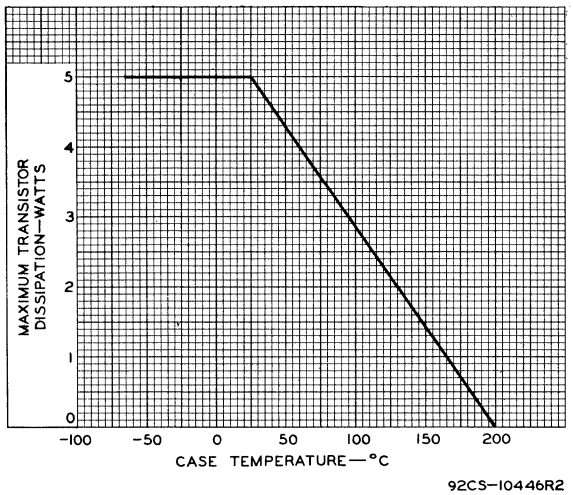
JEDEC TO-39

- High Power Gain, Unneutralized Class-C Amplifier
  At 400 Mc/s, 1 W output with 10 dB gain (min.)
  250 Mc/s, 1 W output with 15 dB gain (typ.)
  175 Mc/s, 1 W output with 17 dB gain (typ.)
  100 Mc/s, 1 W output with 20 dB gain (typ.)
- Low Output Capacitance
  C_{ob} = 3.0 pF (max.)
- High Voltage Ratings
  V_{CBO} = 55 V (max.)
  V_{CER} = 55 V (max.)
  V_{CEO} = 30 V (max.)
- High Power-Dissipation Capability
  P_T = 5 W (max.)

MAXIMUM RATINGS

RF Service, *Absolute-Maximum Values:*		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	55	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With external base-to-emitter resistance, V_{CER}	55	volts
R_{BE} = 10 ohms		
With base open, V_{CEO}	30	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3.5	volts
COLLECTOR CURRENT, I_C	0.4	ampere
TRANSISTOR DISSIPATION, P_T:		
At case temperatures up to 25° C	5	watts
At case temperatures above 25° C	See Fig.1.	
TEMPERATURE RANGE:		
Storage & Operating (Junction)	-65 to 200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32 in. from seating plane for 10 s max	230	°C

DISSIPATION DERATING CURVE FOR TYPE 2N3866



92CS-10446R2

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N3866 5/66
Reprinted from 2N3866 10/65

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (mA)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		28			0		-	20	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	55	-	V
Collector-to-Emitter Voltage (Sustaining)	$V_{CER}(sus)$*						5	55	-	V
	$V_{CEO}(sus)$					0	5	30	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	3.5	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					20	100	-	1.0	V
Collector-to-Base Capacitance (Measured at 1 Mc/s)	C_{ob}	30			0			-	3.0	pF
RF Power Output Class-C Amplifier, Unneutralized At 100 Mc/s At 250 Mc/s At 400 Mc/s (See Fig.3)	P_{OUT}		$28^{\#}$ $28^{\#}$ $28^{\#}$					1.8 (typ.)● 1.5 (typ.)▲ 1.0■		W
Gain-Bandwidth Product	f_T		15				25	800 (typ.)		Mc/s

* With external base-emitter resistance (R_{BE}) = 10 Ω.

\# V_{CC} value.

● For P_{IN} = 0.05 W; minimum efficiency = 60%.

▲ For P_{IN} = 0.1 W; minimum efficiency = 50%.

■ For P_{IN} = 0.1 W; minimum efficiency = 45%.

POWER OUTPUT vs. FREQUENCY FOR TYPE 2N3866

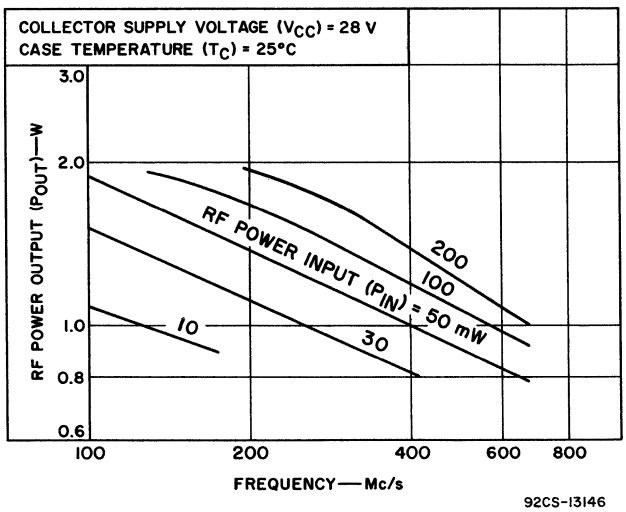
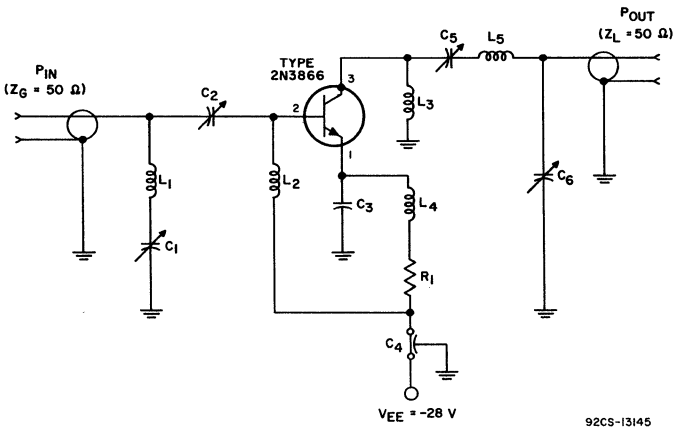


Fig.2

RF AMPLIFIER CIRCUIT FOR 2N3866 POWER-OUTPUT TEST (400-Mc/s Operation)



C_1: 3-35 pF
C_2, C_5: 8-60 pF
C_3: 12 pF
C_4: 1,000 pF
C_6: 0.9-7 pF
L_1: 2 turns No.18 wire, 1/4" ID, 1/8" long
L_2: Ferrite rf choke, 1 turn, Z = 450 Ω
L_3, L_4: RF choke, 0.1 μH
L_5: 2-1/2 turns, No.18 wire, 1/4" ID, 3/16" long
R_1: 5.6 Ω, 1 W

Fig.3

GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

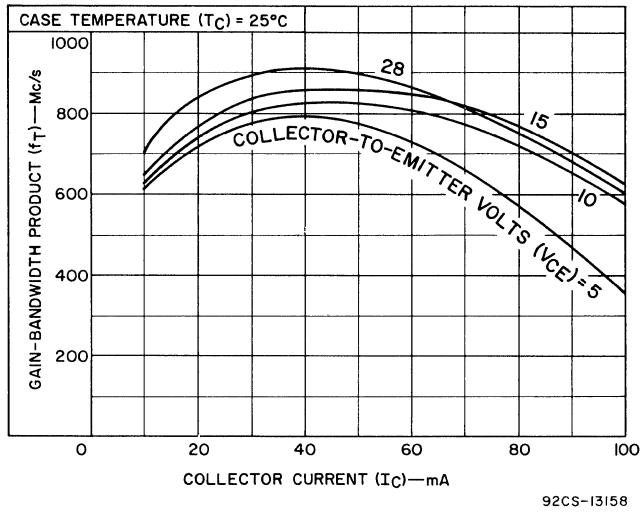


Fig.4

SERIES INPUT RESISTANCE vs. FREQUENCY

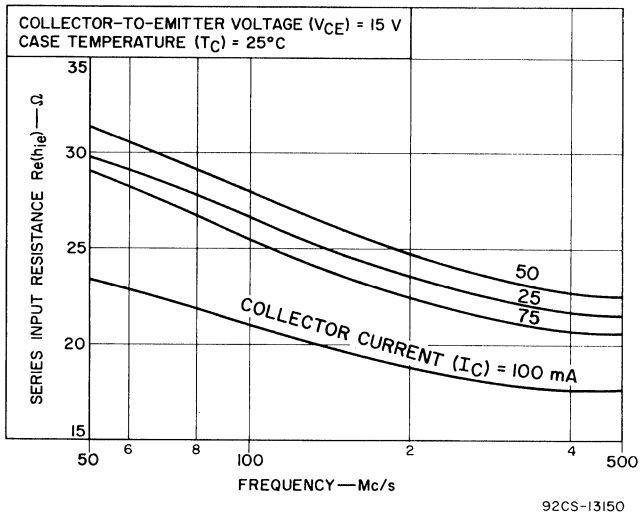


Fig.5

SERIES INPUT REACTANCE vs. FREQUENCY

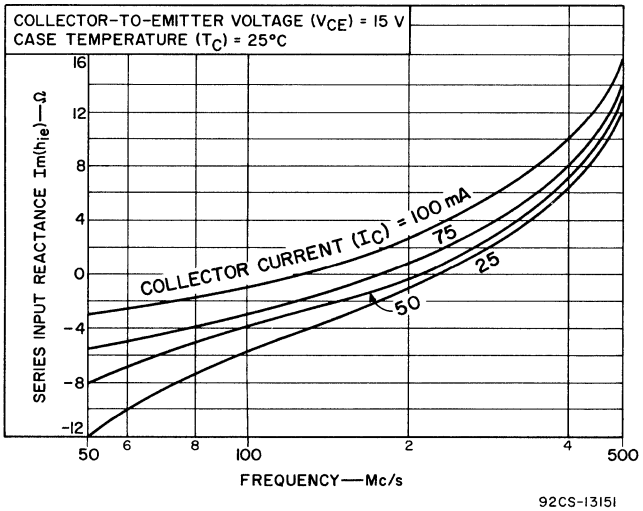


Fig.6

SERIES INPUT RESISTANCE & REACTANCE vs. FREQUENCY

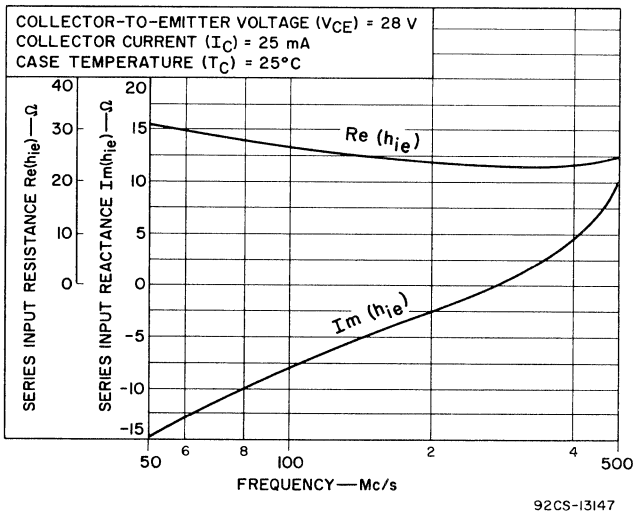


Fig.7

PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

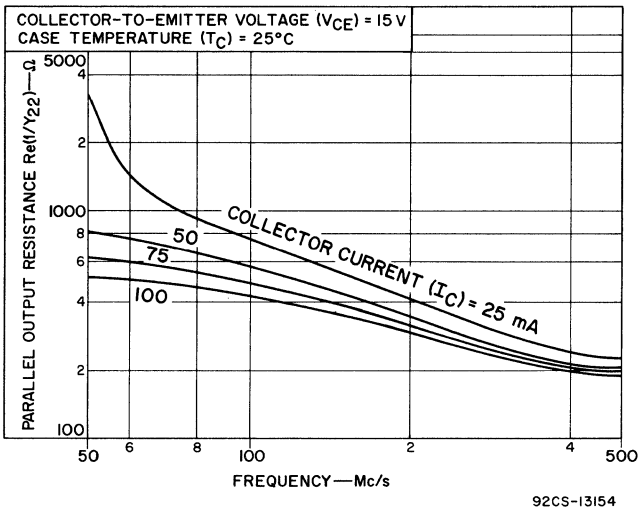


Fig.8

PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

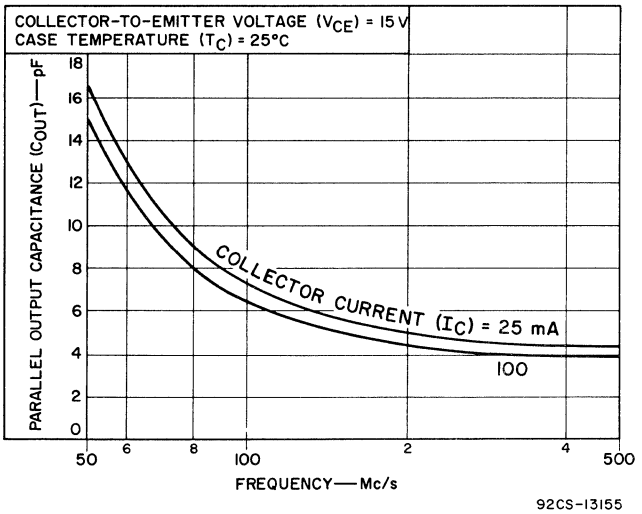


Fig.9

PARALLEL OUTPUT RESISTANCE & CAPACITANCE vs. FREQUENCY FOR TYPE 2N3866

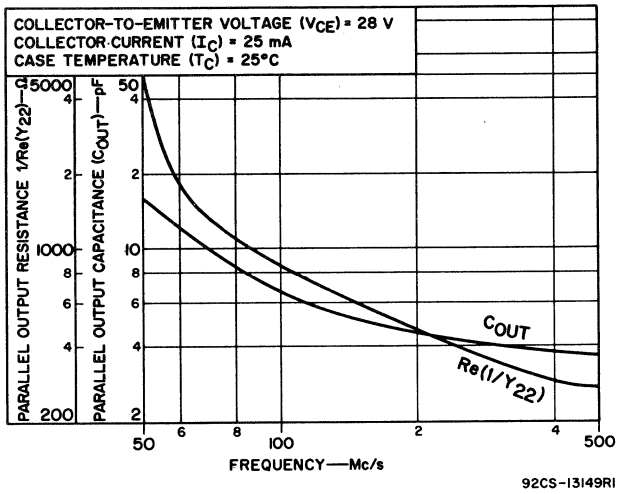


Fig.10

VARIATION OF COLLECTOR-TO-BASE CAPACITANCE FOR TYPE 2N3866

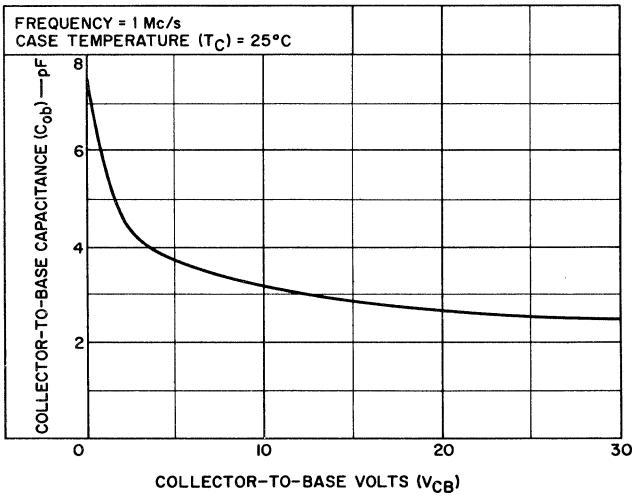
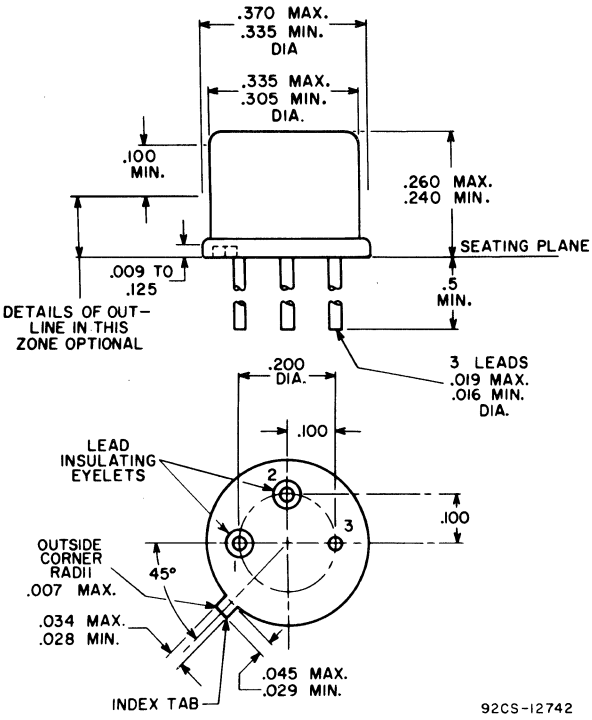


Fig.11

DIMENSIONAL OUTLINE FOR TYPE 2N3866 JEDEC TO-39



Dimensions in Inches

TERMINAL CONNECTIONS

Lead No.1 - Emitter

Lead No.2 - Base

Case, Lead No.3 - Collector

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SILICON CONTROLLED-RECTIFIERS

2N3870–2N3873
2N3896–2N3899

File No. 94

RCA-2N3870* through 2N3873* and 2N3896● through 2N3899● are all-diffused, three-junction silicon controlled-rectifiers (SCR's▲). Types 2N3870 through 2N3873 are press-fit while 2N3896 through 2N3899 are stud-mounted types. They are intended for use in power-control and power-switching applications requiring a blocking voltage capability of up to 700 volts and a forward current capability of 35 amperes (rms) or 22 amperes (average value) at a case temperature of 65° C.

▲ The silicon controlled-rectifier is also known as a reverse-blocking triode thyristor.

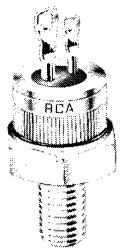
* Formerly Dev. Types TA2442, TA2444, TA2447, and and TA2705, respectively.

● Formerly Dev. Types TA2694, TA2695, TA2696, and TA2707, respectively.

All-Diffused SCR's for Low-Cost Power-Control and Power-Switching Applications



PRESS-FIT
2N3870-2N3873



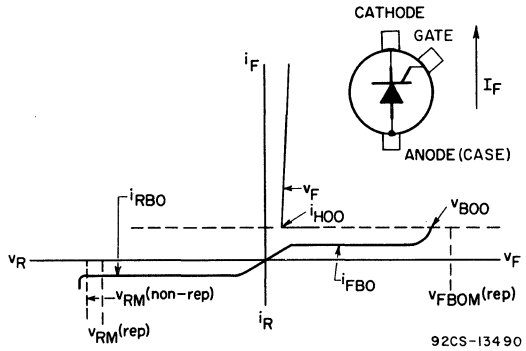
STUD-MOUNTED
2N3896-2N3899

FEATURES

- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted-emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- Designed especially for high-volume systems
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

2N3870 2N3896	For Low-Voltage Power Supplies
2N3871 2N3897	For 120-Volt Line Operation
2N3872 2N3898	For 240-Volt Line Operation
2N3873 2N3899	For High-Voltage Power Supplies

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



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Printed in U.S.A.
2N3870–2N3873, 2N3896–2N3899 6/66
Reprinted from 2N3870–2N3873, 2N3896–2N3899 10/65

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 cps, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES				UNITS
	2N3870 2N3896	2N3871 2N3897	2N3872 2N3898	2N3873 2N3899	
Transient Peak Reverse Voltage (Non-Repetitive), $v_{RM(non\text{-}rep)}$[a]	150	330	660	700	volts
Peak Reverse Voltage (Repetitive), $v_{RM(rep)}$[b]	100	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), $v_{FBOM(rep)}$[c]	700	700	700	700	volts
Forward Current:					
For case temperature (T_C) of +65° C					
Average DC value at a conduction angle of 180°, I_{FAV}[d]	22	22	22	22	amperes
RMS value, I_{FRMS}[e]	35	35	35	35	amperes
For other conditions, see Fig.9					
Peak Surge Current, $i_{FM(surge)}$[f]:					
For one cycle of applied voltage	350	350	350	350	amperes
For more than one cycle of applied voltage	See Fig.11	See Fig.11	See Fig.11	See Fig.11	
Rate of Change of Forward Current, di/dt[g]	200	200	200	200	amperes/ microsecond
V_{FB} = v_{BOO} (min. value) I_{GT} = 200 mA, 0.5 μs min. rise time (See waveshapes of Fig.1)					
Gate Power★:					
Peak, Forward or Reverse, for 10 μs duration, P_{GM}[h] (See Figs. 6 and 7)	40	40	40	40	watts
Average, P_{GAV}[i]	0.5	0.5	0.5	0.5	watt
Temperature:					
Storage, T_{stg}	-40 to +125	-40 to +125	-40 to +125	-40 to +125	°C
Operating (Case), T_C	-40 to +100	-40 to +100	-40 to +100	-40 to +100	°C

★ Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

WAVESHAPE OF di/dt RATING TEST

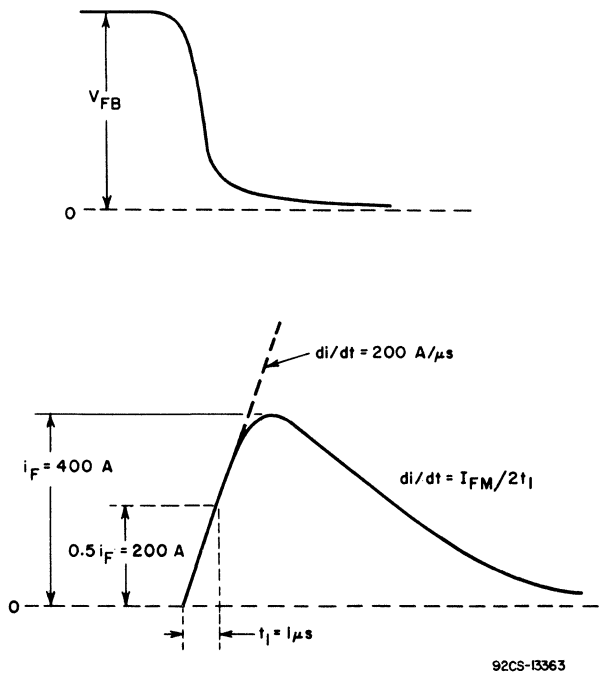


Fig. 1

WAVESHAPE OF v_f (initial) RATING TEST

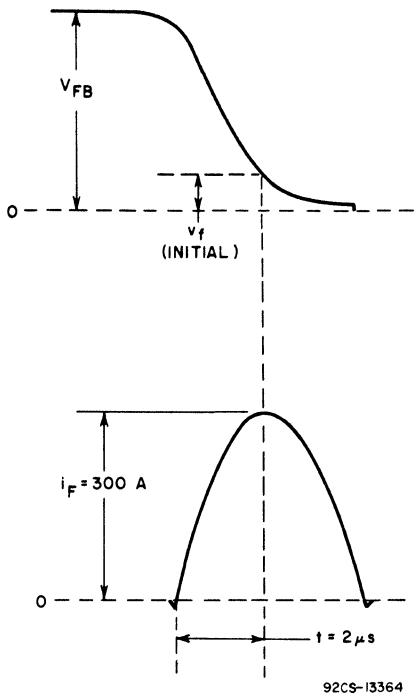


Fig. 2

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES												UNITS
	2N3870 2N3896			2N3871 2N3897			2N3872 2N3898			2N3873 2N3899			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, $v_{BO}{}^k$: At T_C = +100° C	100	–	–	200	–	–	400	–	–	600	–	–	volts
Peak Blocking Current, at T_C = +100° C: Forward, $I_{FBOM}{}^m$ $V_{FBO}{}^n = v_{BO}$ (min. value)	–	0.2	2	–	0.25	2.5	–	0.3	3	–	0.35	4	mA
Reverse, $I_{RBOM}{}^p$ $V_{RBO}{}^n = V_{RM}$ (rep) value	–	–	3	–	–	3	–	–	3	–	–	3	mA
Forward Voltage Drop, $v_F{}^q$: At a Forward Current of 100 amperes and a T_C = +25° C (See Fig.12)	–	1.7	2.1	–	1.7	2.1	–	1.7	2.1	–	1.7	2.1	volts
Initial Forward Voltage Drop, v_F (initial)^r i_F = 300 amperes, t = 2 μs $V_{FB} = v_{BO}$ (min. value), I_{GT} = 200 mA (See waveshapes of Fig.2)	–	15	25	–	15	25	–	15	25	–	15	25	volts
DC Gate-Trigger Current, $I_{GT}{}^s$: At T_C = +25° C (See Fig.6)	1	25	40	1	25	40	1	25	40	1	25	40	mA(dc)
Gate-Trigger Voltage, $V_{GT}{}^t$: At T_C = +25° C (See Fig.6)	–	1.1	2	–	1.1	2	–	1.1	2	–	1.1	2	volts(dc)
Holding Current, $i_{HOO}{}^u$: At T_C = +25° C	0.5	20	70	0.5	20	70	0.5	20	70	0.5	20	70	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt^v $V_{FB} = v_{BO}$ (min. value), exponential rise, T_C = 100° C (See waveshape of Fig.3)	10	100	–	10	100	–	10	100	–	10	100	–	volts/ microsecond
Turn-On Time, $t_{on}{}^w$, (Delay Time + Rise Time). . . $V_{FB} = v_{BO}$ (min. value), i_F = 30 amperes, I_{GT} = 200 mA, 0.1 μs min. rise time, T_C = 25° C (See waveshapes of Fig.4)	0.75	1.25	2	0.75	1.25	2	0.75	1.25	2	0.75	1.25	2	microseconds
Turn-Off Time, $t_{off}{}^x$ (Reverse Recovery Time + Gate Recovery Time) i_F = 18 amperes, 50 μs pulse width, dv_{FB}/dt = 20 v/μs, di_r/dt = 30 A/μs, I_{GT} = 200 mA, T_C = 80° C (See waveshapes of Fig.5)	15	20	40	15	20	40	15	20	40	15	20	40	microseconds

WAVESHAPE OF CRITICAL dv/dt RATING TEST

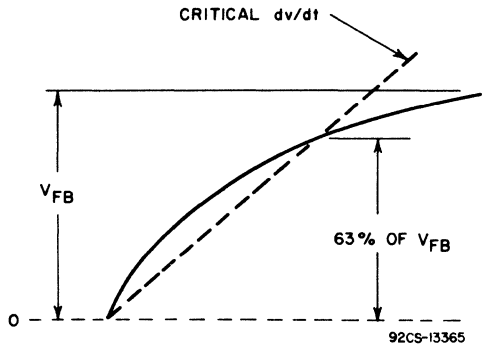


Fig.3

WAVESHAPE OF t_{on} RATING TEST

$t_{on} = t_d + t_r$

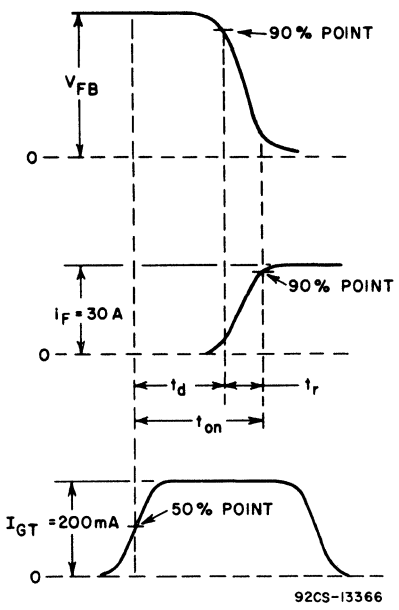


Fig.4

WAVESHAPE OF t_{off} RATING TEST

$t_{off} = t_{rr} + t_{gr}$

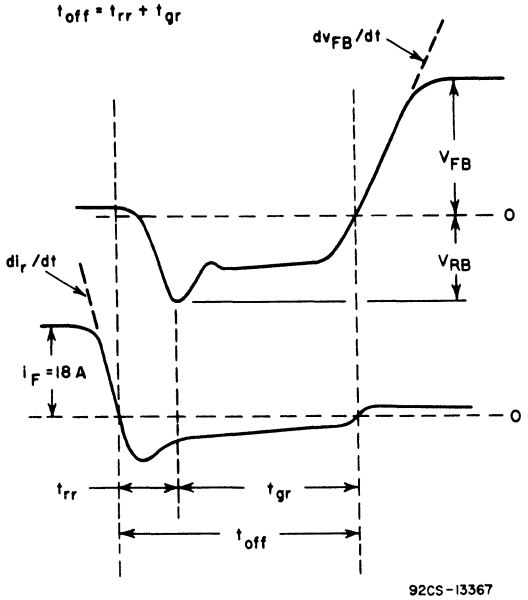


Fig.5

FORWARD GATE CHARACTERISTICS

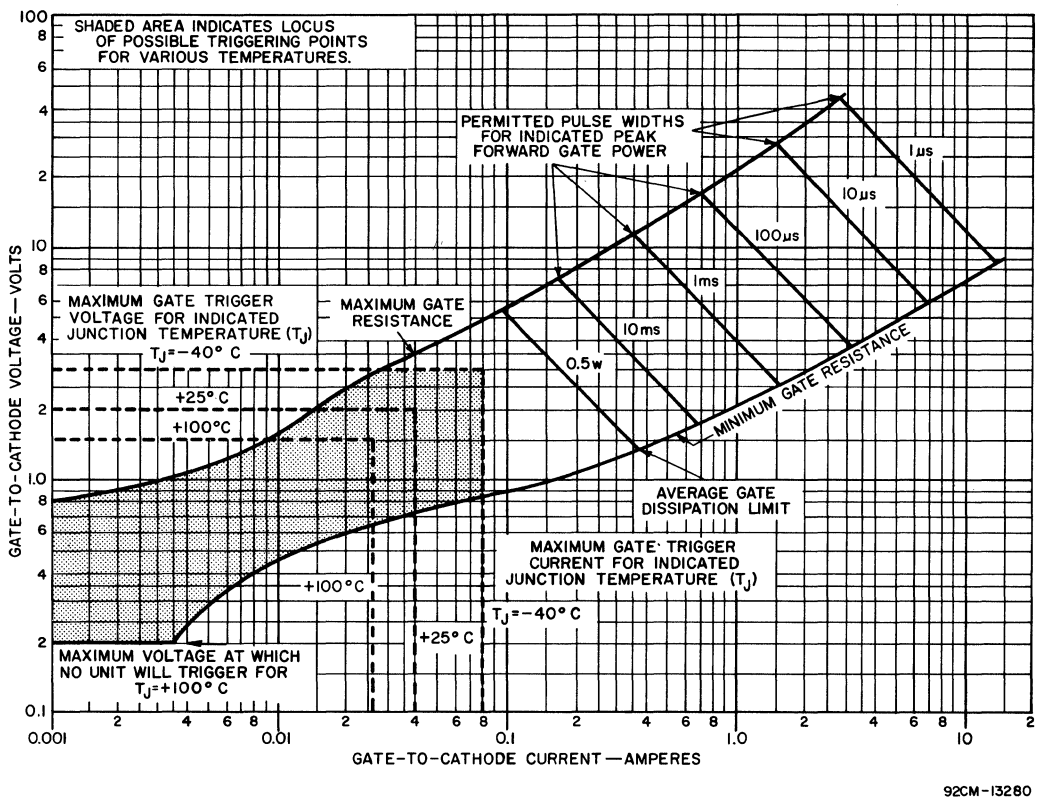


Fig. 6

REVERSE GATE CHARACTERISTICS

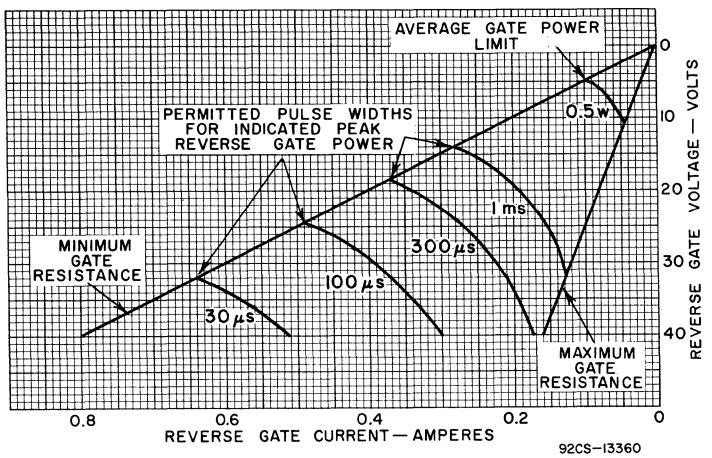
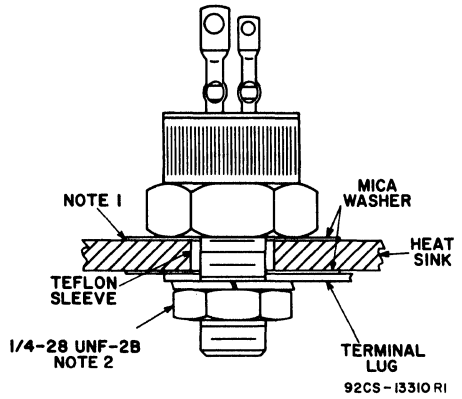


Fig.7

TRIGGERING CONSIDERATIONS

The construction of the gate-cathode junction used in these devices provides a large periphery center gate and employs shorted-emitter design which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown in Fig.6. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown in Fig.7 should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAV}) of 0.5 watt.

SUGGESTED MOUNTING ARRANGEMENT FOR INSULATING TYPES 2N3896-2N3899 FROM HEAT SINK. COMPONENTS SHOWN (EXCEPT HEAT SINK) ARE FURNISHED WITH EACH DEVICE



NOTE 1: DOW CORNING 340 SILICON HEAT SINK COMPOUND, OR EQUIVALENT.

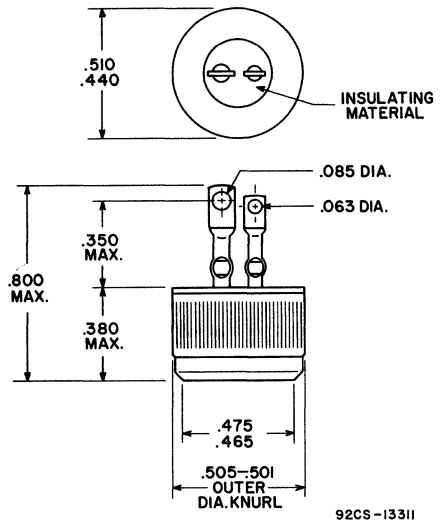
NOTE 2: THE RECOMMENDED TORQUE IS 26 TO 36 INCH-POUNDS APPLIED TO A 1/4-28 UNF-2B HEX NUT ASSEMBLED ON THREAD. THE APPLIED TORQUE DURING INSTALLATION SHOULD NOT EXCEED 50 INCH-POUNDS

CASE-TO-HEAT SINK THERMAL RESISTANCE FOR DIFFERENT MOUNTING ARRANGEMENTS

Device Types	Type of Mounting Employed	Thermal Resistance
2N3870 through 2N3873	Press-fitted into heat sink. (Minimum Required thickness of heat sink = 1/8 ").	0.5° C/W
	Soldered directly to heat sink. (60÷40 solder which has a melting point of 188° C should be used. Exposure time should be sufficient to cause solder to flow freely).	0.35° C/W
2N3896 through 2N3899	Directly mounted on heat sink with or without the use of heat sink compound.	0.6° C/W
	Mounted on heat sink with a 0.004" to 0.006" thick mica insulating washer used between unit and heat sink.	
	Without heat sink compound	2.5° C/W
	With heat sink compound	1.5° C/W

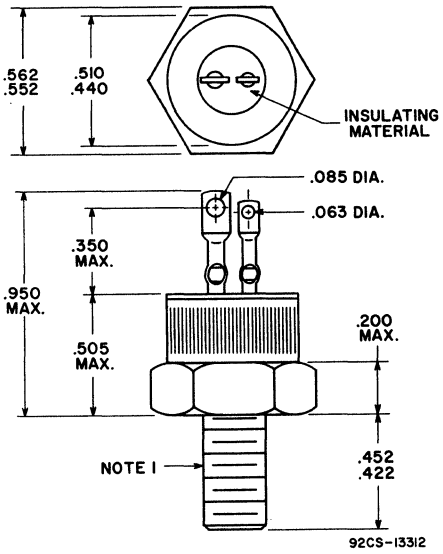
Table I

DIMENSIONAL OUTLINE
2N3870 - 2N3873



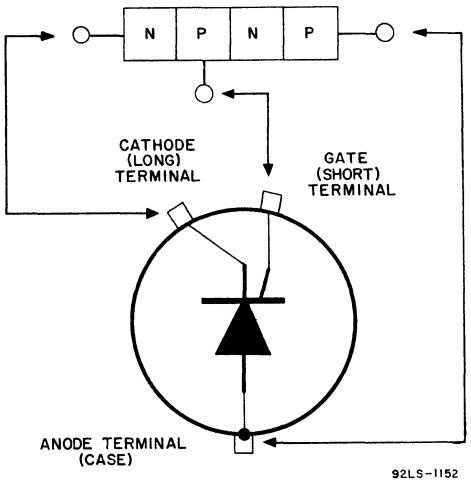
Dimensions in Inches

DIMENSIONAL OUTLINE
2N3896 - 2N3899



Dimensions in Inches

TERMINAL DIAGRAM



NOTE 1: 1/4-28 UNF-2A. Maximum pitch dia. of plated threads shall be basic pitch dia. 0.2268", minimum pitch dia. 0.2225". Ref. (Screw Thread Standards for Federal Services 1957) Handbook H28 1957 P1.

CONTROLLED-RECTIFIER TERMS, SYMBOLS, AND DEFINITIONS

a **Transient Peak Reverse Voltage (Non-repetitive)** - v_{RM} (non-rep) - The maximum value of negative (reverse-blocking) voltage which may be applied between the anode and cathode for not more than 5 milliseconds when the gate is open (gate voltage is zero or negative with respect to cathode).

b **Peak Reverse Voltage (Repetitive)** - v_{RM}(rep) - The maximum instantaneous value of negative (reverse-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

c **Peak Forward Blocking Voltage (Repetitive)** - v_{FBOM}(rep) - The maximum instantaneous value of positive (forward-blocking) voltage which may be applied repetitively between the anode and cathode when the gate is open.

d **Average Forward Current** - I_{FAV} - The average (dc) value of the current flowing from anode to cathode in the device.

e **RMS Forward Current** - I_{FRMS} - The RMS value of the current flowing from anode to cathode in the device.

f **Peak Surge Current** - i_{FM}(surge) - The maximum total instantaneous value of forward current which may be imposed during one forward half-cycle with the device operating within its specified maximum voltage, average-forward-current, gate-power, and temperature ratings in a single-phase circuit with 60-cps supply and resistive load. The peak surge current may be repeated after sufficient time has elapsed for the device to return to pre-surge thermal equilibrium conditions.

g **Rate of Change of Forward Current** - di/dt - The maximum rate of change of current which may be imposed on the device immediately after turn on by the gate from a forward blocking condition.

h **Peak Forward and Reverse Gate Power** - P_{GM} - The maximum instantaneous power dissipated between gate and cathode for a specified time duration.

i **Average Forward Gate Power** - P_{GAV} - The average power dissipated between gate and cathode.

k **Forward Breakover Voltage** - v_{BOO} - The value of positive anode voltage at which a controlled rectifier may switch into the conducting state when the gate is open.

m **Peak Forward Blocking Current** - I_{FBOM} - The maximum value of the forward blocking current of a controlled rectifier with gate open.

n **Forward and Reverse Blocking Voltage** - V_{FBO}, V_{RBO} - The value of voltage applied between anode and cathode with the gate open.

p **Peak Reverse Blocking Current** - I_{RBOM} - The maximum value of the reverse blocking current of a controlled rectifier with gate open.

q **Forward Voltage Drop** - v_F - The instantaneous voltage drop across a controlled rectifier at a given instantaneous forward current i_F and under steady-state conditions.

r **Initial Forward Voltage Drop** - v_F (initial) - The instantaneous forward voltage drop across a controlled rectifier at a given instantaneous forward current and at a specified time after turn on from a forward blocking condition.

s **Gate-Trigger Current** - I_{GT} - The gate current required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

t **Gate-Trigger Voltage** - V_{GT} - The gate-to-cathode voltage required to trigger a controlled rectifier operating at a specified temperature when the anode is at a potential of +6 volts with respect to the cathode.

u **Holding Current** - i_{HOO} - The instantaneous value of forward current i_F below which a controlled rectifier with its gate open returns to its forward blocking state.

v **Critical Rate of Applied Forward Voltage** - Critical dv/dt - The critical rate of applied forward voltage is the minimum value of the rate of applied forward voltage which will cause switching from the off-state to the on-state under stated conditions.

w **Turn-On Time** - t_{on} - Turn-on time is the time interval between the initiation of the gate signal and the time when the resulting forward current reaches 90 per cent of its maximum value during switching from the off-state to the on-state under stated conditions.

x **Turn-Off Time** - t_{off} - Turn-off time is the time interval between the time when the forward current decreases to zero and the time when the device anode voltage reaches zero and is rising to a stated value of forward blocking voltage at a stated rate of rise without turning on during switching in the external anode circuit from the on-state to the off-state under stated conditions.

Turn-on times for different gate currents are shown in Fig.8. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger pulse until the magnitude of the forward anode current has reached the latching current value. However, conservative design requires that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".

TURN-ON TIME CHARACTERISTICS

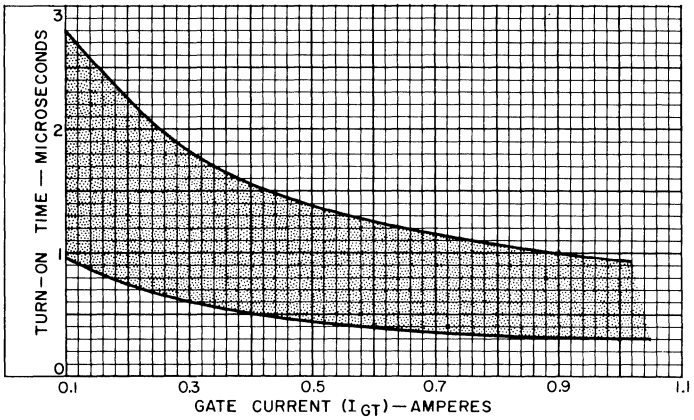


Fig.8

RATING CHART (CASE TEMPERATURE)

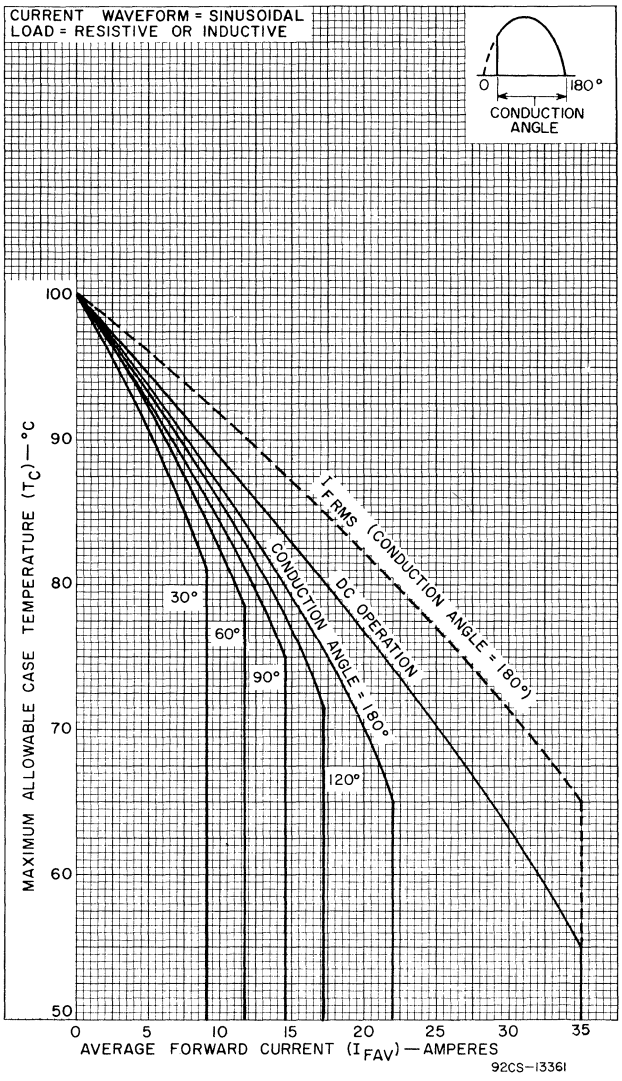


Fig.9

POWER DISSIPATION

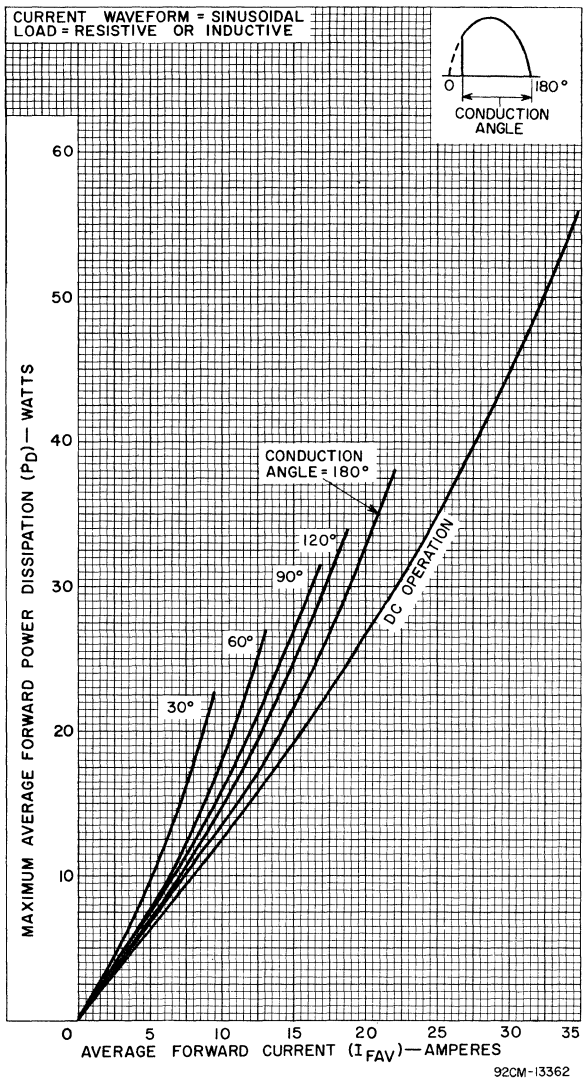


Fig.10

SURGE CURRENT RATING

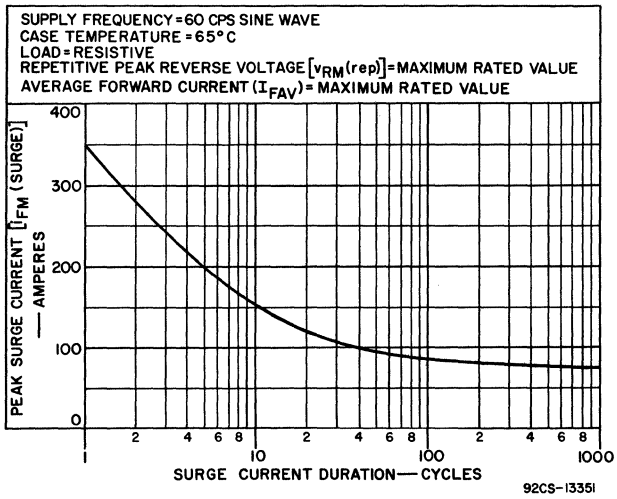


Fig. 11

FORWARD CHARACTERISTICS

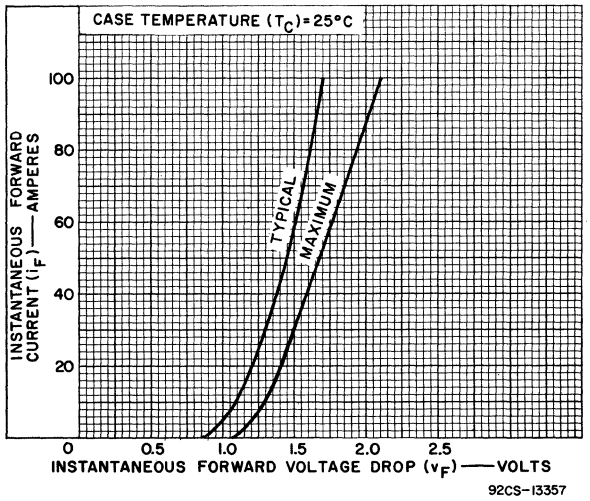


Fig. 12

COOLING CONSIDERATIONS

HEAT SINK GUIDANCE

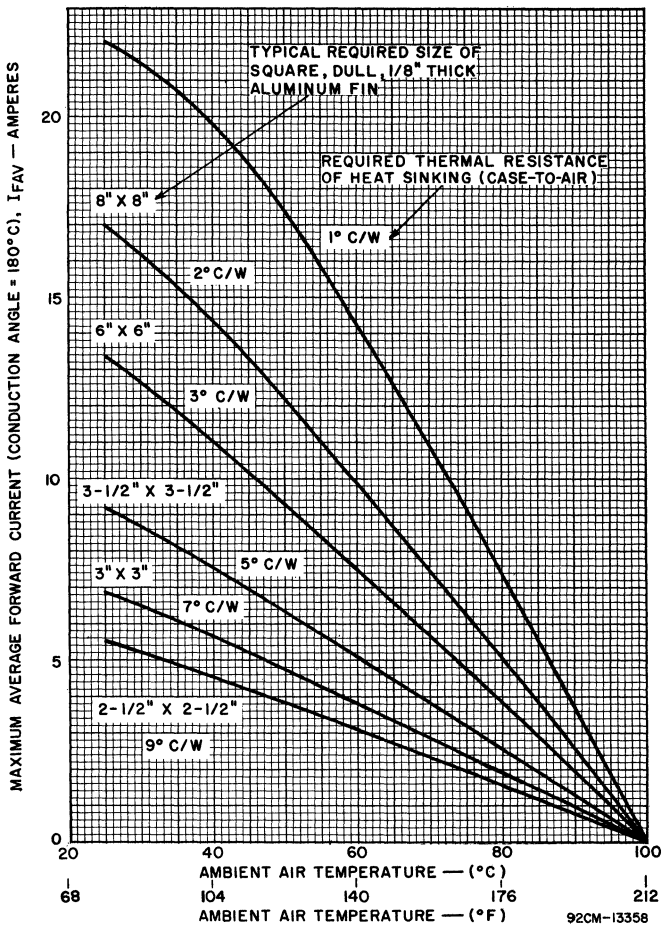


Fig. 13

The overall thermal resistance, case to air, needed to operate these devices at a given current and a specific ambient air temperature is shown in Fig. 13. For example: for a forward current of 10 amperes and an ambient air temperature of 45° C (113° F), the required thermal resistance, case to air, is 3° C/W. This required case-to-air thermal resistance includes both case-to-heat sink and heat sink-to-air thermal resistances.

Typical values of case-to-heat sink thermal resistances for different mounting arrangements are shown in Table I. Thermal resistance characteristics of commercial heat sinks are contained in various manufacturers' data sheets. For guidance purposes, the required sizes of typical, square, 1/8"-thick, aluminum fins having dull surfaces for different thermal resistance values are also shown in Fig. 13. These sizes apply for stud-mounted types mounted without insulating hardware.

SILICON N-P-N POWER TRANSISTORS

2N3878
2N3879
40375

File No. 110

RCA-2N3878,* 2N3879,* and 40375▲ are epitaxial silicon n-p-n high-current transistors. The 2N3878 and 40375 are amplifier types intended for audio-, ultrasonic-, and radio-frequency circuits. Type 2N3879 is a switching transistor intended for use in high-current, high-speed switching circuits.

Type 40375, with an attached heat radiator, is intended for those applications which require a power transistor for mounting on a printed-circuit board. Tabs are provided on the underside of the radiator for mounting purposes and for making electrical connection to the collector (which is connected internally to the mounting flange of the TO-66 Package).

Typical applications for these transistors include: low-distortion power amplifiers, oscillators, switching regulators, series regulators, converters and inverters.

A "radiator-type TO-66" version of type 2N3879 can be supplied on special order.

* Formerly Dev. Type Nos. TA2509 and TA2509A, respectively.

▲ The 40375 is a 2N3878 factory-attached on a heat radiator for free-air operation.

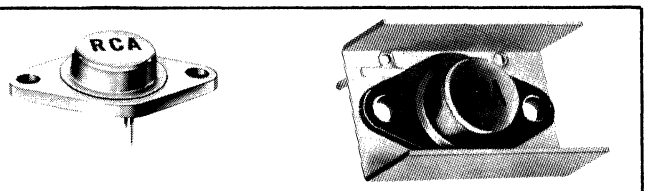
NEW!

Maximum area-of-operation curves for DC & pulse operation.

Derating curves for $I_{S/b}$ – limited and dissipation-limited operation.

Now possible to specify maximum operating conditions for operation without second breakdown.

For Amplifier and Switching Circuits in Industrial and Commercial Applications



2N3878,2N3879 (JEDEC TO-66)

40375 (JEDEC TO-66 WITH HEAT-RADIATOR)

- High collector-current ratings: 10 A (peak) 7 A (continuous)
- V_{CEO}(sus) = 75 V min. (2N3879)
  = 50 V min. (2N3878, 40375)
- V_{CER}(sus) = 90 V min. (2N3879)
  = 65 V min. (2N3878, 40375)
- V_{CBO} = 120 V min.
- Rated for safe operation without second breakdown in both forward- and reverse-bias conditions.
- Total saturated switching time typically less than 1 μs at 4 A (2N3879).
- Popular TO-66 ("small TO-3") package for mounting convenience (2N3878 & 2N3879).

40375

- Heat-radiator package with mounting tabs for printed-circuit board application.
- 5.8-W dissipation capability (at 25°C free-air temperature)

MAXIMUM RATINGS

Absolute-Maximum Values:		2N3878	2N3879	40375	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	120	120	V
COLLECTOR-TO-EMITTER VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V_{CER}(sus)	65	90	65	V
With base open	V_{CEO}(sus)	50	75	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	7	7	7	A
PEAK COLLECTOR CURRENT		10	10	10	A
CONTINUOUS BASE CURRENT	I_B	5	5	5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		35	35	—	W
At free-air temperatures up to 25°C		—	—	5.8	W
At temperatures above 25°C		See Figs. 4, 5, & 6	See Figs. 4, 7, & 8	Fig. 9	
TEMPERATURE RANGE:					
Storage & Operating (Junction)		← -65 to 200 →			°C
PIN TEMPERATURE (During soldering):					
At distance ≥1/32 in. from seating plane for 10 s max.		← 255 →			°C

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Printed in U.S.A.
2N3878,2N3879,40375 6/66
Reprinted from 2N3878,2N3879,40375 1/66

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) of 25° C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS				Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Types 2N3878 40375		Type 2N3879		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		40					0	–	5	–	5	mA
	I_{CEV}		100		-1.5				–	4	–	4	mA
At T_C = 150° C	I_{CEV}		100		- 1.5				–	4	–	4	mA
Emitter-Cutoff Current	I_{EBO}			4		0			–	4	–	2	mA
DC Forward-Current Transfer Ratio	h_{FE}		5 5 2			0.5 4 4			50 20 8	200 – –	40 20 12	– 80 –	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 10 & 11)* With base open	$V_{CEO}(sus)$					0.2		0	50●	–	75●	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$					0.2			65●	–	90●	–	V
Base-to-Emitter Voltage	V_{BE}		2			4			–	2.5	–	1.8	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					4 4		0.4 0.5	– –	– 2.0	– –	1.2 –	V
Small-Signal, Forward-Current Transfer Ratio (At 10 Mc/s)	h_{fe}		10			0.5			6.0	–	6.0	–	
Output Capacitance (At 1 Mc/s)	C_{ob}	10					0		–	175	–	175	pF
Second-Breakdown Collector Current With base forward biased	$I_{S/b}$*		40						750▲	–	500▲	–	mA
Second-Breakdown Energy With base reverse biased R_{BE} = 50 Ω, L = 125 μH	$E_{S/b}$ †				-4				1▲	–	1▲	–	mJ
Delay Time *(See Figs. 20, 21, & 22)*	t_d		30 (V_{CC})			4		0.4 (I_{B1})	–	–	–	40	ns
Rise Time *(See Figs. 20, 21, & 22)*	t_r		30 (V_{CC})			4		0.4 (I_{B1})	–	–	–	400	ns
Storage Time *(See Figs. 20, 21, & 23)*	t_s		30 (V_{CC})			4		-0.4* (I_{B2})				800	ns
Fall Time *(See Figs. 20, 21, & 24)*	t_f		30 (V_{CC})			4		-0.4* (I_{B2})				400	ns
Thermal Resistance: Junction-to-Case	$\theta_{J\text{-}C}$								5 (Max.) 2N3878	–		5	°C/W
Junction-to-Free Air	$\theta_{J\text{-}FA}$								30 (Max.) 40375	–		–	°C/W

★ I_{B1} = 0.4 A

● **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. *10*.

▲ Safe-operating region for second breakdown is explained under "SECOND BREAKDOWN" on page *3*.

* $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

† $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2\ LI^2$, where L is a series load or leakage inductance and I is the peak collector current from Figs. *1, 2, and 3.*.

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

Figures 5 and 7 show the DC current derating curves applicable to the 2N3878 and 2N3879, respectively, at different temperatures. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant at 35 watts). That portion where the slope is approximately -2.5 shows the region where the device is second breakdown limited, and applies for one-second pulse duration (essentially equal to DC operation). For shorter pulses, the transistor's second breakdown capability improves (See Figures 4, 6, and 8).

The 40375 is not limited by second breakdown. Figure 9 shows the collector current derating curves applicable for this type.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the on condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in Figure 1, 2, and 3 are recommended when designing circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals; also, Figures 1. 2, and 3 can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers). For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 40375

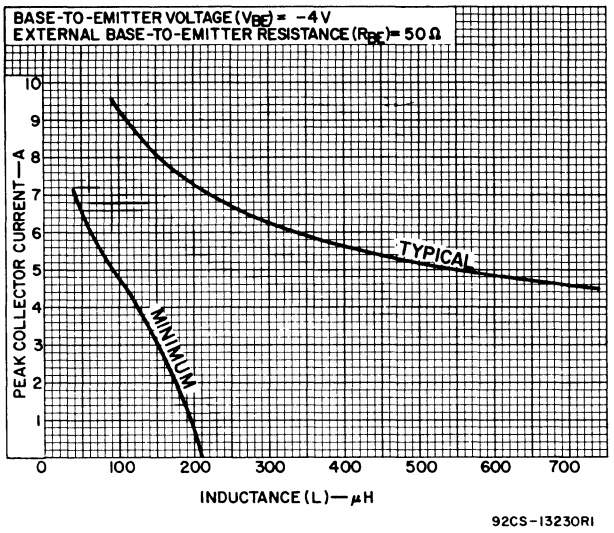


Fig. 1

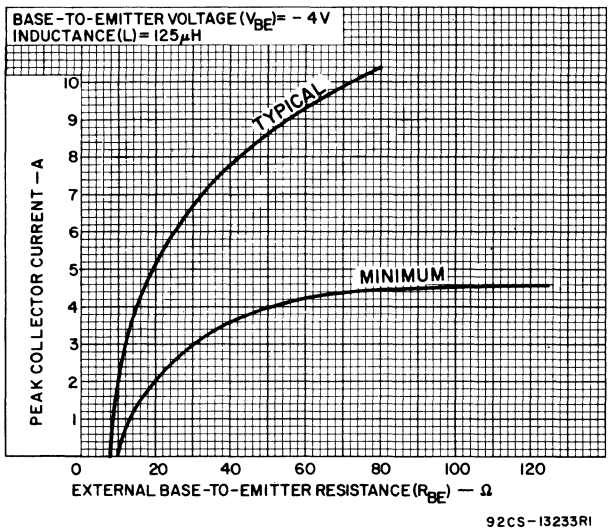


Fig. 2

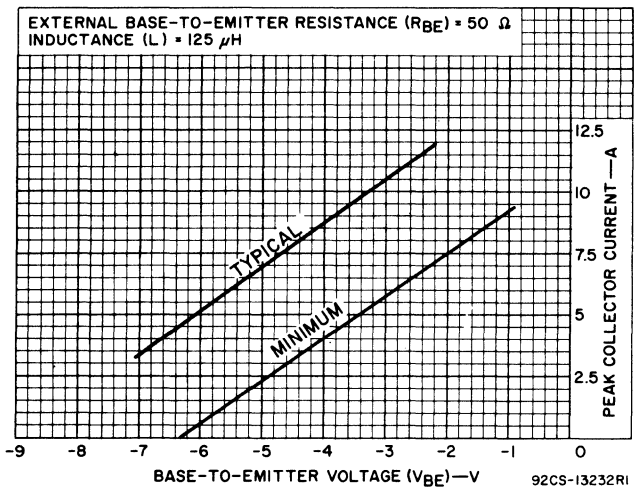


Fig. 3

MAXIMUM AREA-OF-OPERATION

Second breakdown is much less sensitive to temperature variations than normal power-dissipation limitations. Therefore, separate temperature derating curves are required for these two limiting factors as shown in Fig.4. Figs.5 & 7 may be used directly for DC operation. For pulse operation at a temperature greater than 25°C, Figs. 6 & 8 are used together with Fig. 4 to obtain the maximum allowable power. This is done as follows:

(1) For a specified pulse width and collector-to-emitter voltage, V_{CE}, determine (from either Fig. *6* or Fig. *8*) the maximum collector current at 25°C, using the curve marked "DISSIPATION LIMITED" (or its dashed-line extension);

(2) Refer to Fig. *4* and from the dissipation-limited curve determine the percentage current derating at the specified temperature. Apply this derating to the Value of I_C from step 1, to obtain the maximum current for dissipation-limited operation.

(3) If the specified value of V_{CE} required the use of a dashed-line extension of a dissipation-limited curve in step (1), then repeat step (1), using the curve marked "$I_{S/b}$ LIMITED";

(4) Repeat step 2 using the $I_{S/b}$-LIMITED curve in Fig. *4*;

(5) The maximum allowable current is the smaller of the two values obtained in steps (2) and (4).

For repetitive-pulse operation, the actual case temperature to be used in Fig. 4 is the sum of the maximum ambient temperature and the rise in case temperature resulting from the average transistor power dissipation. The temperature rise is the product of average power dissipation and the thermal resistance from case to ambient, which depends on the heat-sink properties.

DISSIPATION DERATING CURVE FOR
2N3878 & 2N3879

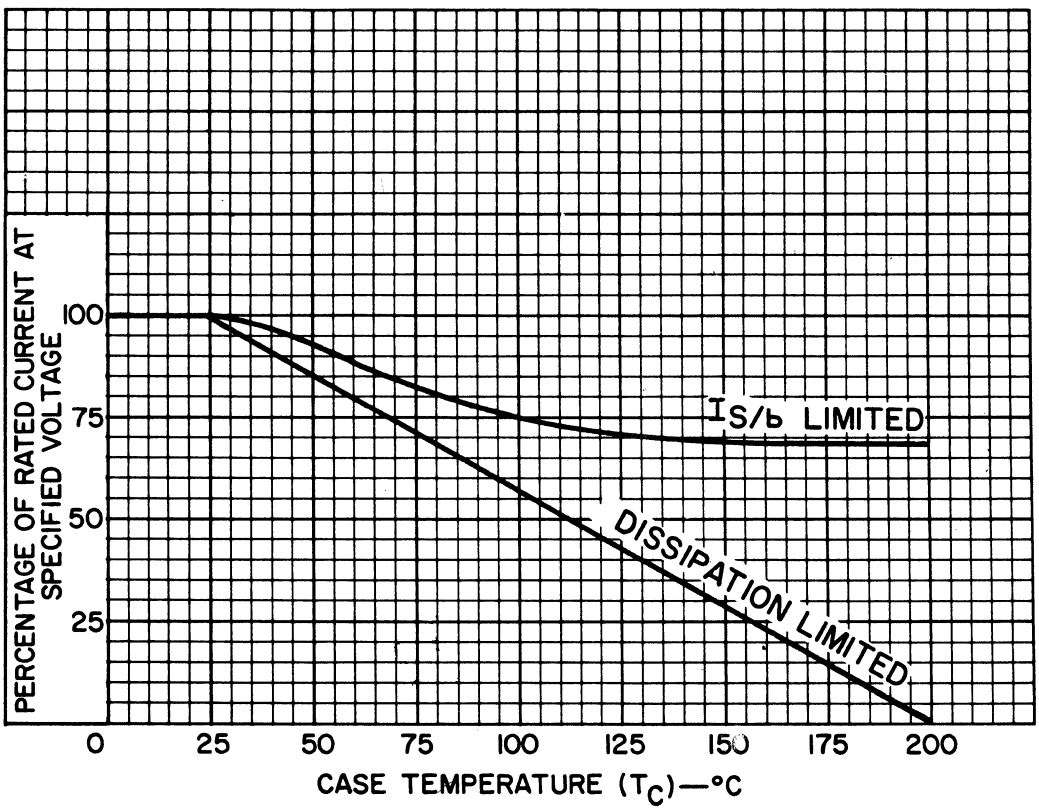


Fig. 4

92SS-2796C

MAXIMUM OPERATING AREAS FOR TYPE 2N3878, DC CONDITIONS

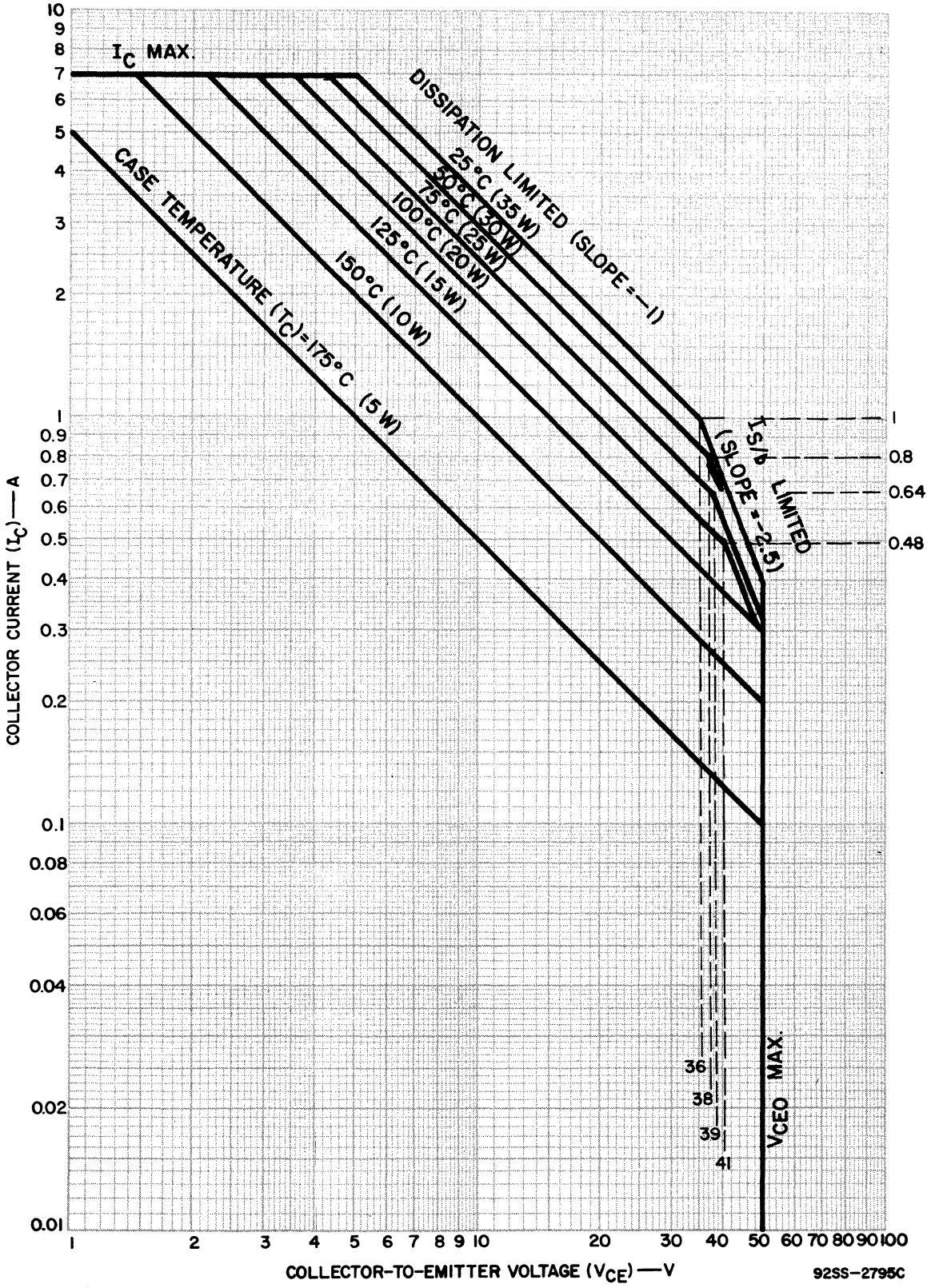


Fig. 5

MAXIMUM OPERATING AREAS FOR TYPE 2N3878, PULSE CONDITIONS

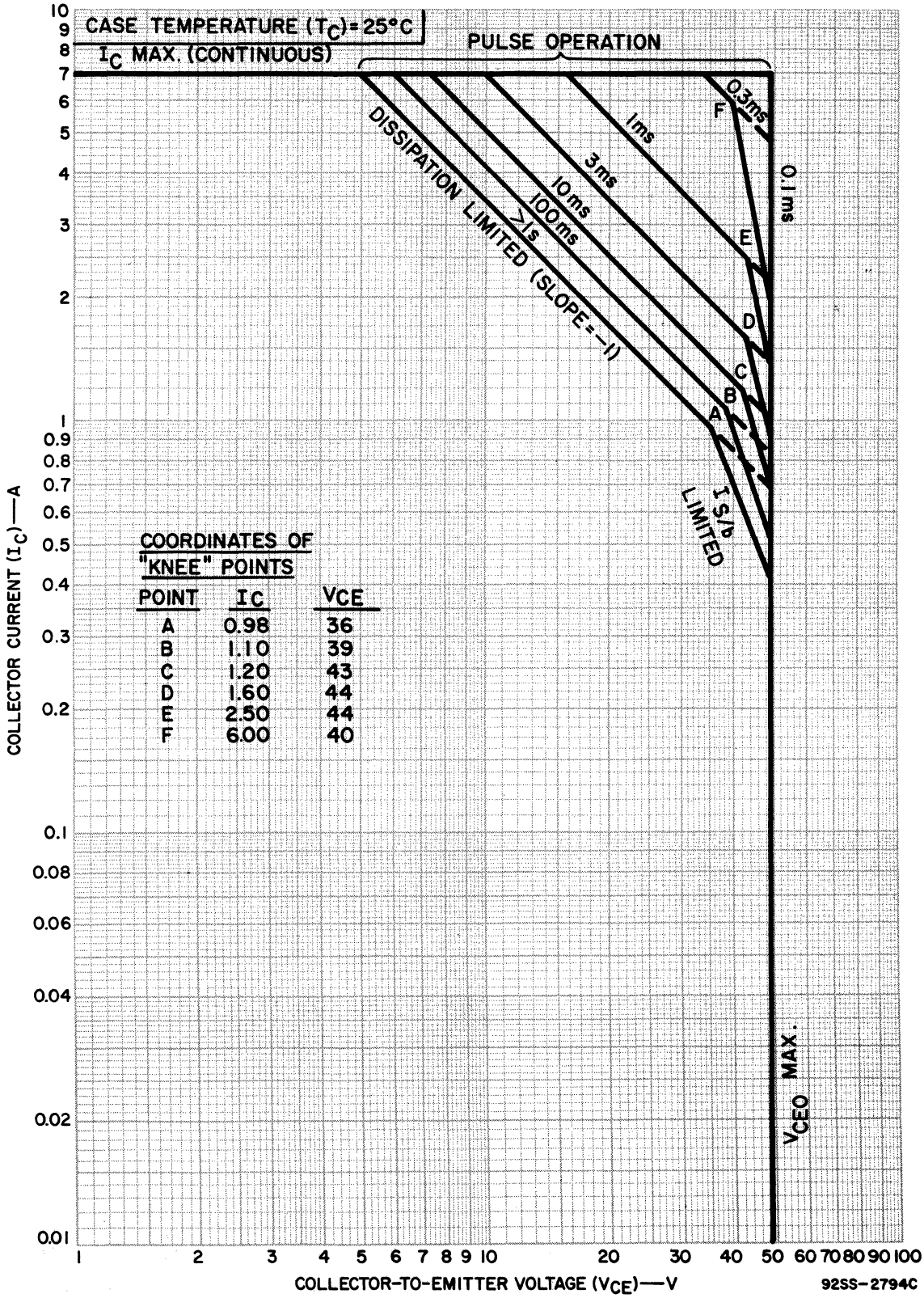


Fig. 6

MAXIMUM OPERATING AREAS FOR TYPE 2N3879, DC OPERATION

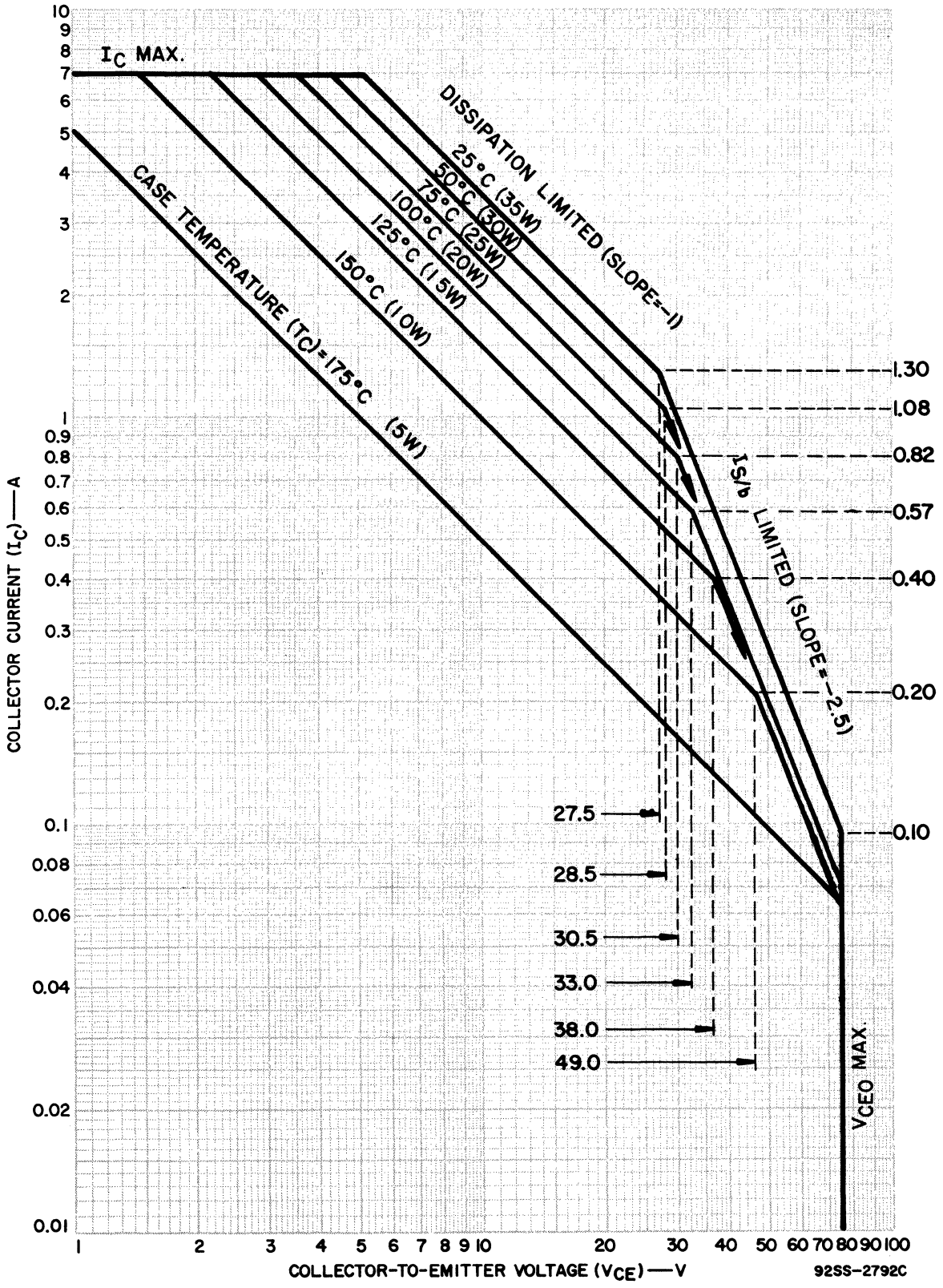


Fig. 7

MAXIMUM OPERATING AREAS FOR TYPE 2N3879, PULSE CONDITIONS

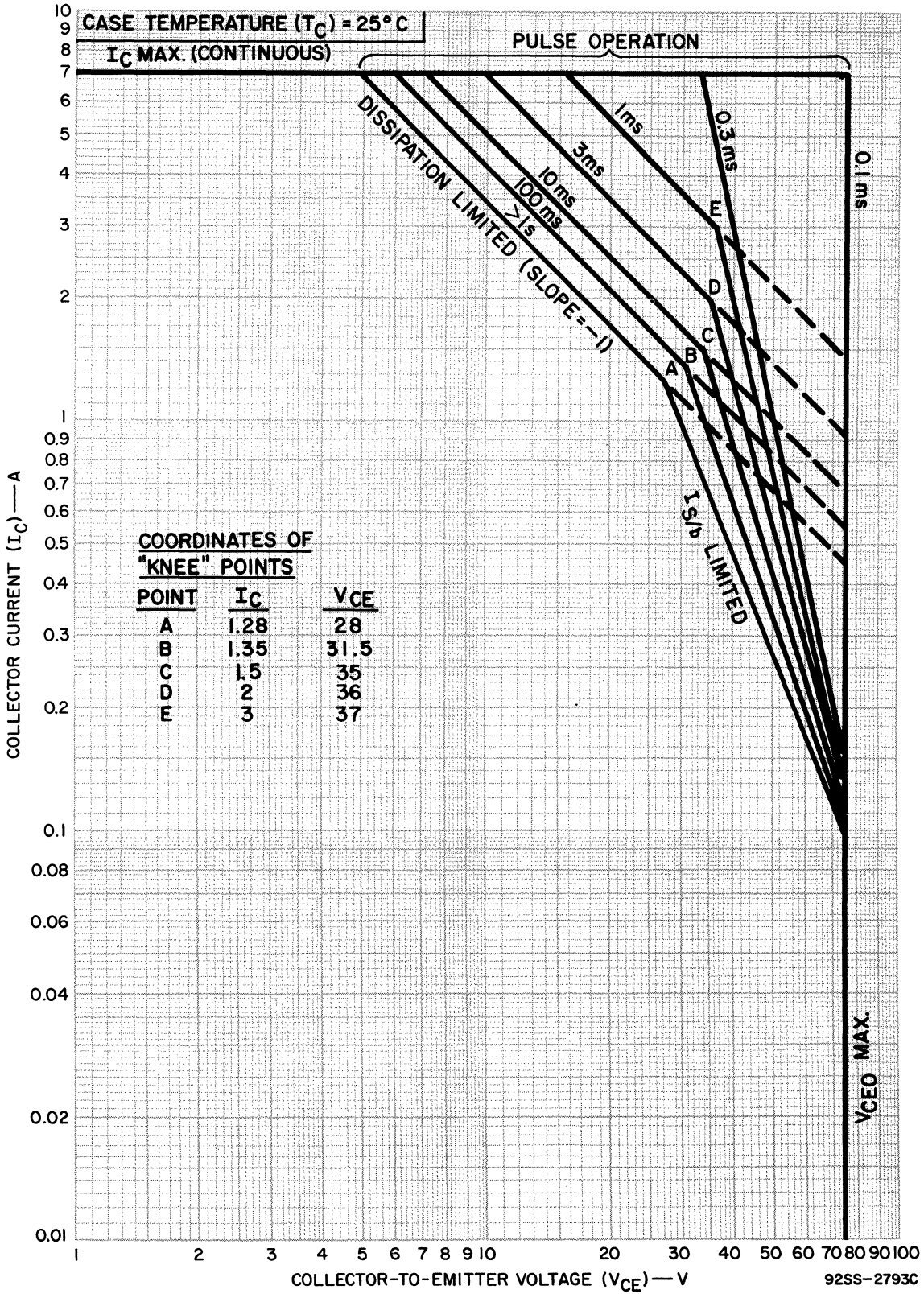


Fig. 8

MAXIMUM OPERATING AREAS FOR TYPE 40375

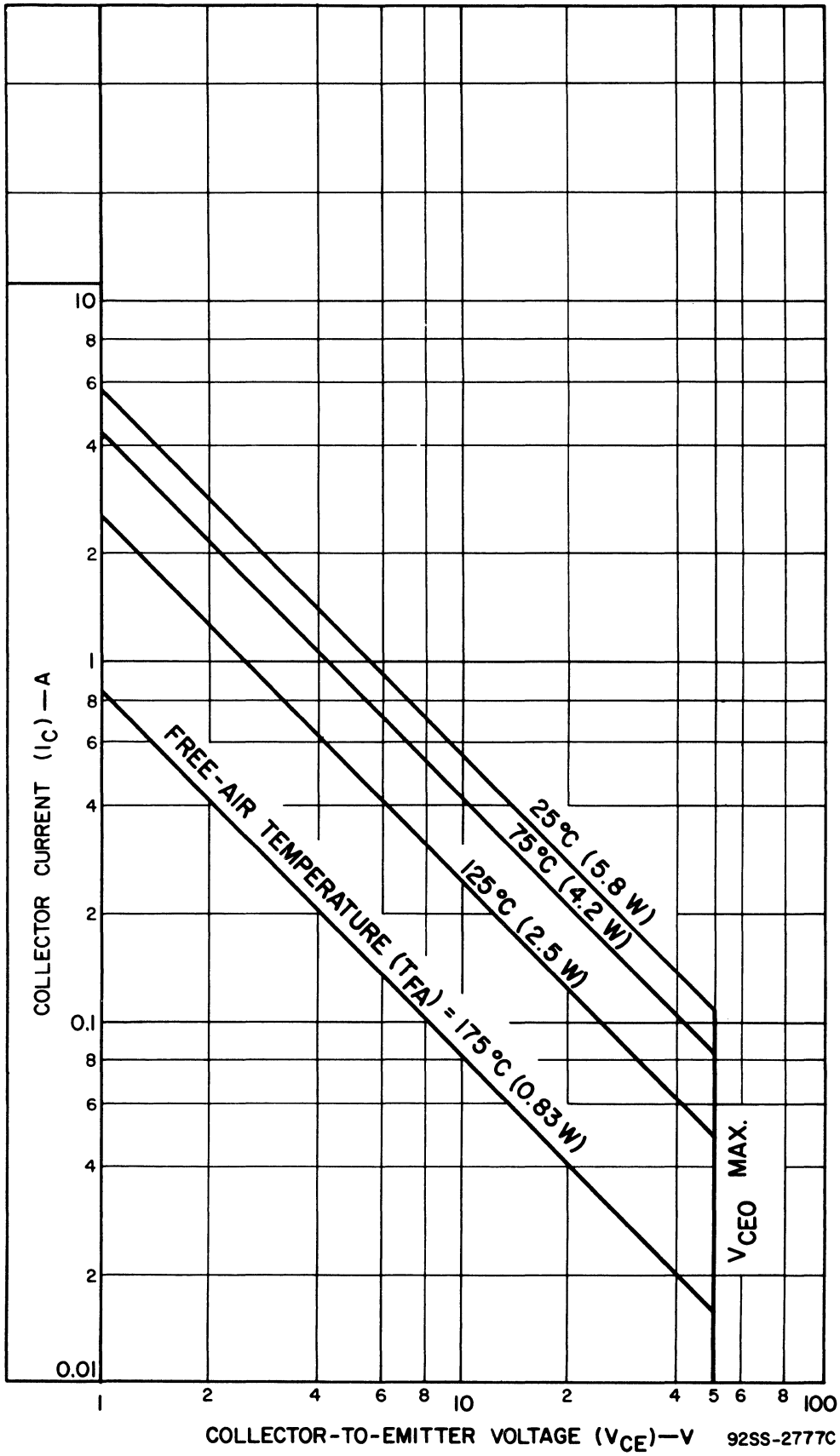


Fig. 9

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES $V_{CEO(sus)}$ & $V_{CER(sus)}$ FOR TYPES 2N3878, 2N3879, & 40375

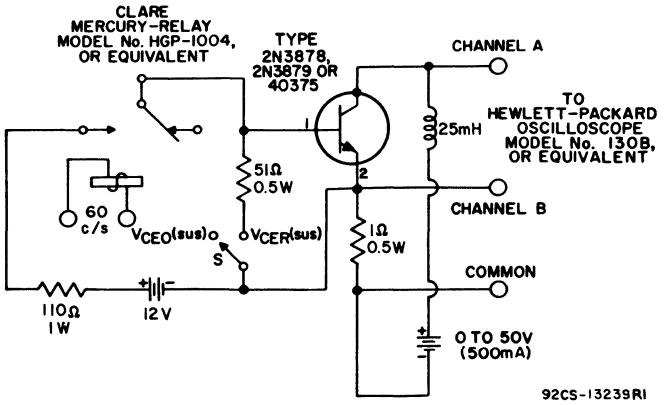
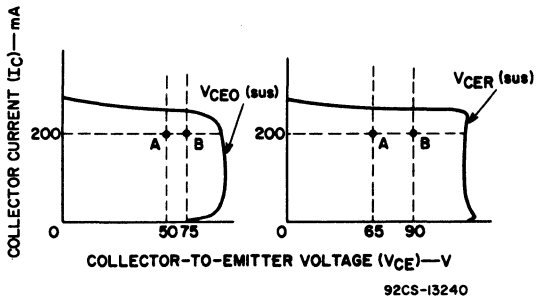


Fig. 10

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN IN FIG. 10)



NOTE: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ are acceptable when the traces fall to the right and above points "A" and "B" for types 2N3878, 2N3879, and 40375, respectively.

Fig. 11

TYPICAL DC-BETA CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 40375

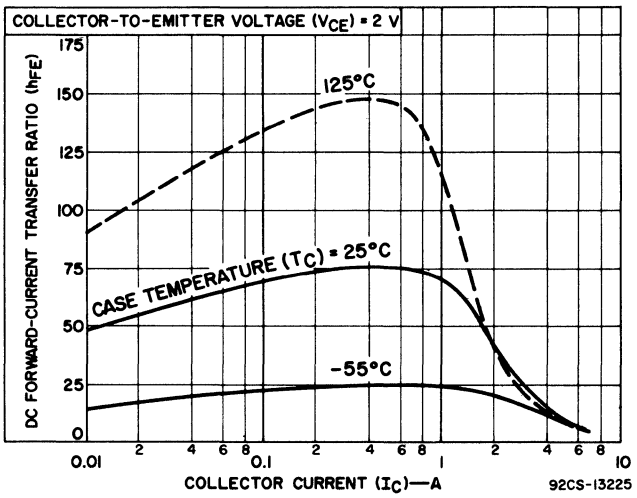


Fig. 12

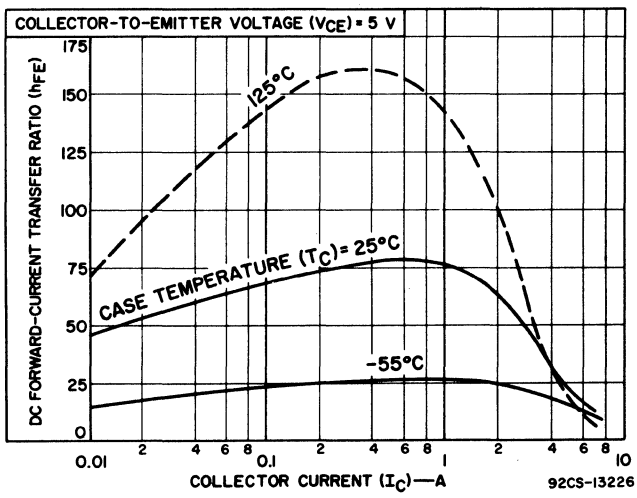


Fig. 13

TYPICAL GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT FOR TYPES 2N3878, 2N3879, & 40375

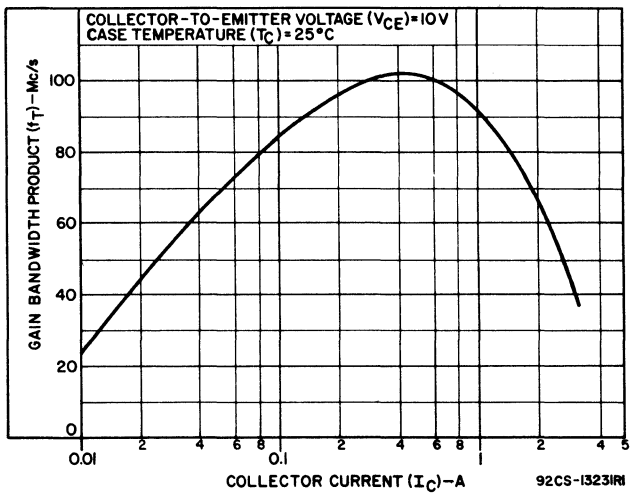


Fig. 14

TYPICAL COLLECTOR CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 40375

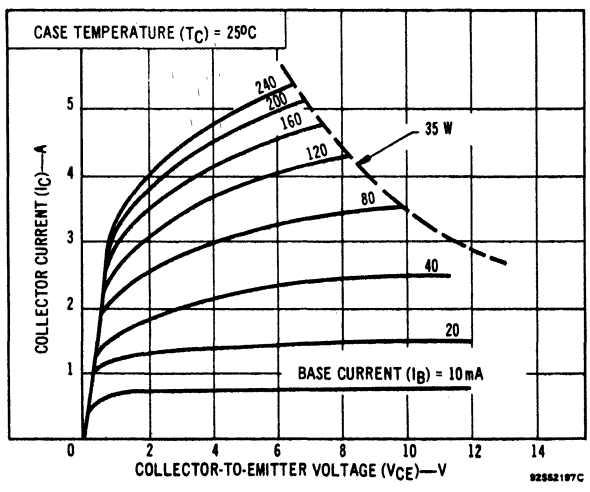


Fig. 15

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPES 2N3878, 2N3879, & 40375

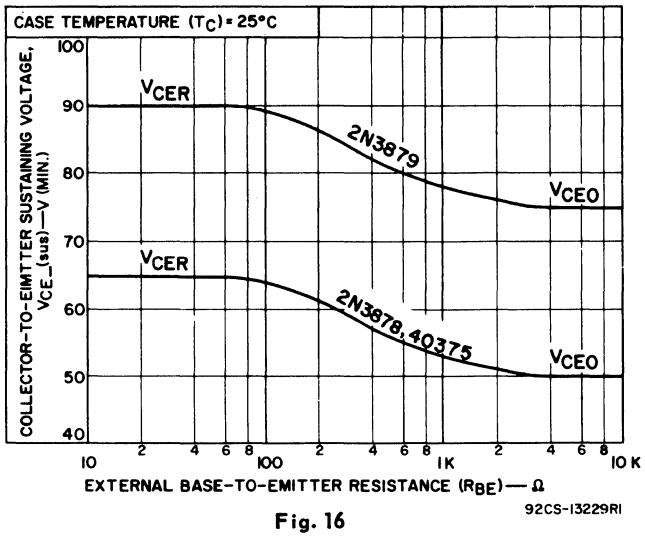


Fig. 16

TYPICAL INPUT CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 40375

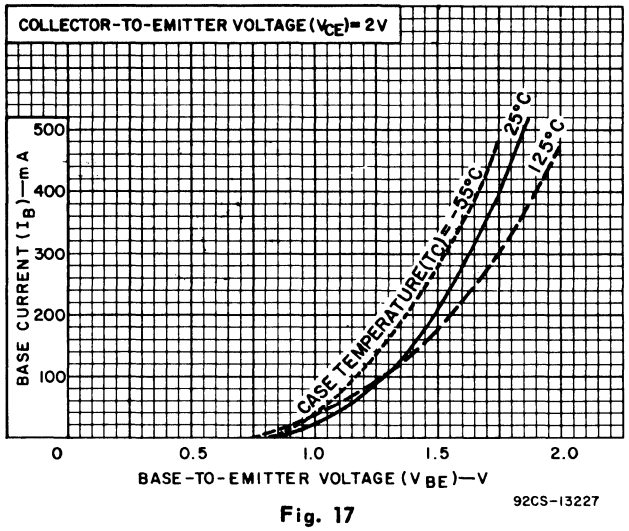


Fig. 17

TYPICAL TRANSFER CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 40375

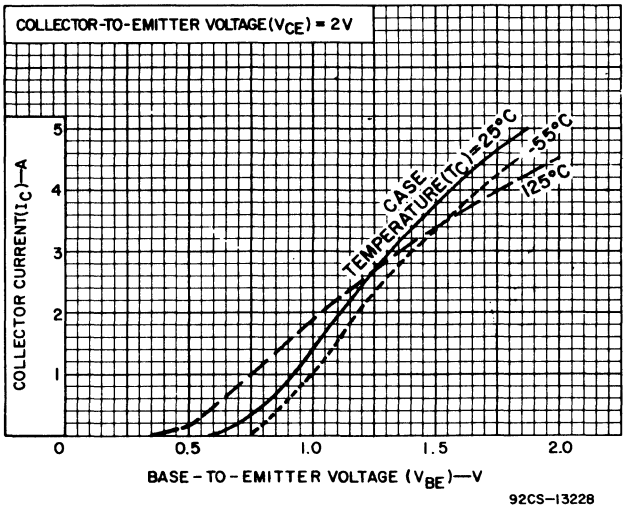


Fig. 18

COLLECTOR-TO-EMITTER SATURATION VOLTAGE vs. COLLECTOR CURRENT FOR TYPE 2N3879

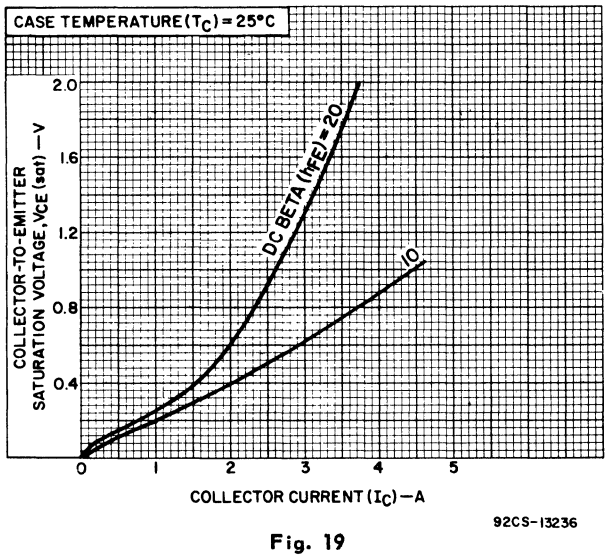
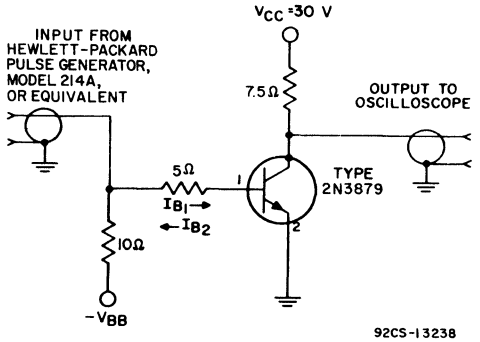


Fig. 19

CIRCUIT USED TO MEASURE SWITCHING TIMES FOR TYPE 2N3879



INPUT PULSE:
Pulse rep. rate = 1,000 pulses/s
Pulse width = 20 μs

Fig. 20

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES (TEST CIRCUIT SHOWN IN FIG. 20)

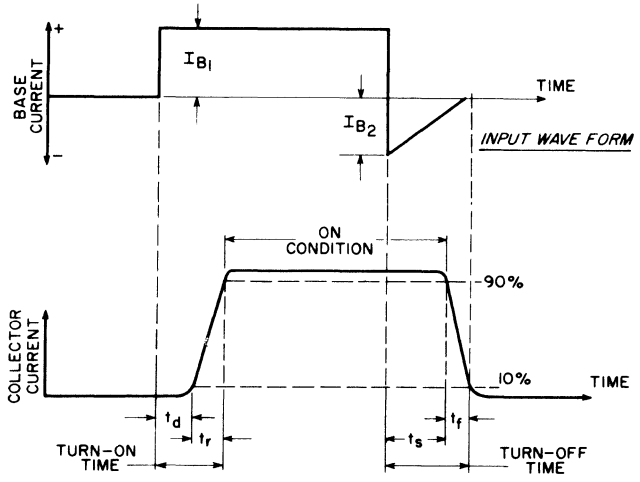


Fig. 21 *OUTPUT WAVE FORM*

TURN-ON TIME vs. COLLECTOR CURRENT FOR TYPE 2N3879

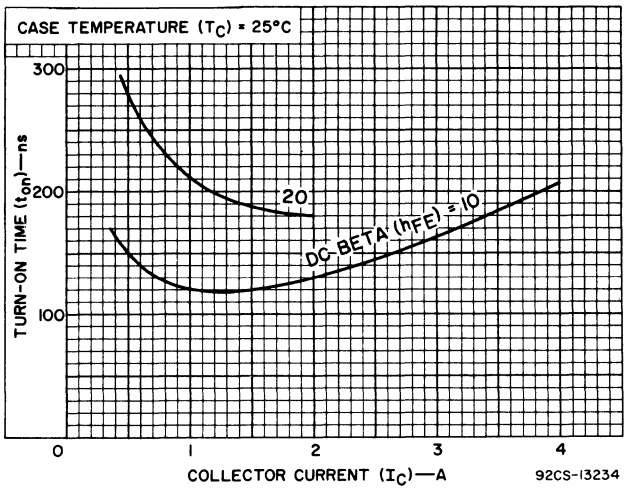


Fig. 22

STORAGE TIME vs. COLLECTOR CURRENT FOR TYPE 2N3879

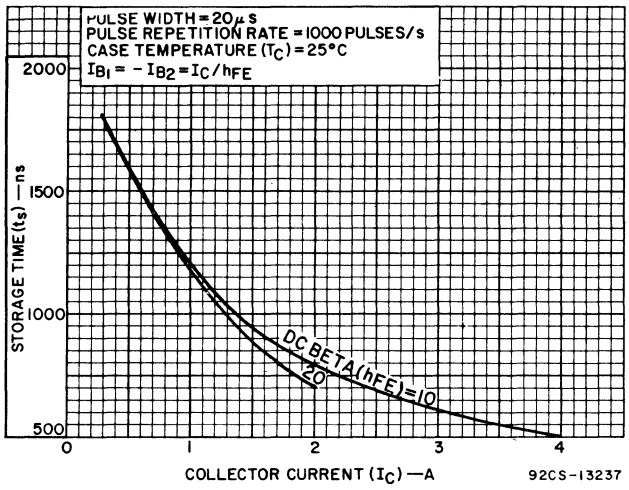


Fig. 23

FALL TIME vs. COLLECTOR CURRENT FOR TYPE 2N3879

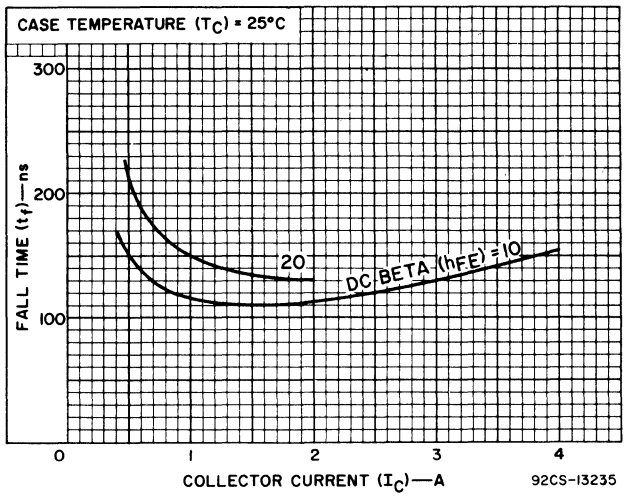
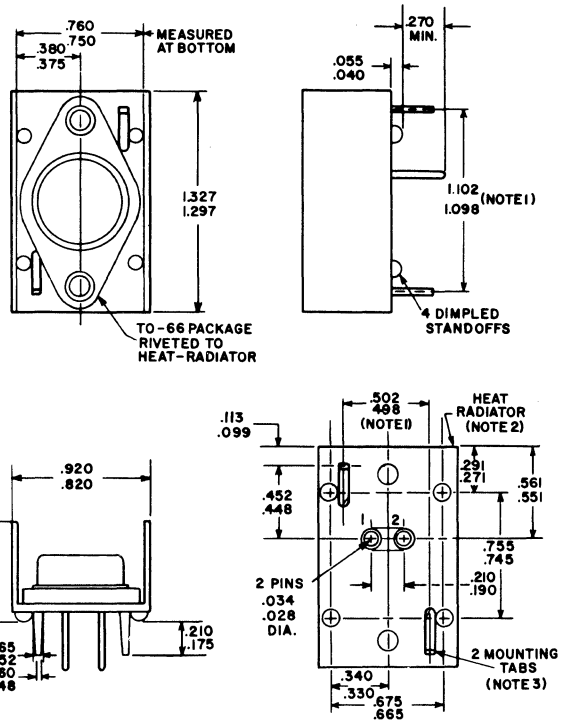


Fig. 24

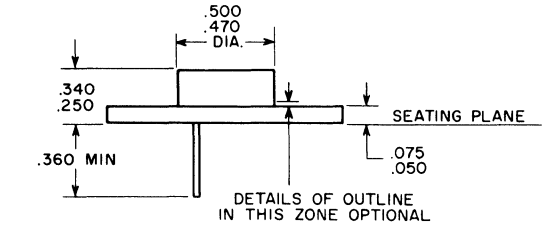
DIMENSIONAL OUTLINE FOR TYPE 40375 JEDEC TO-66 WITH HEAT-RADIATOR

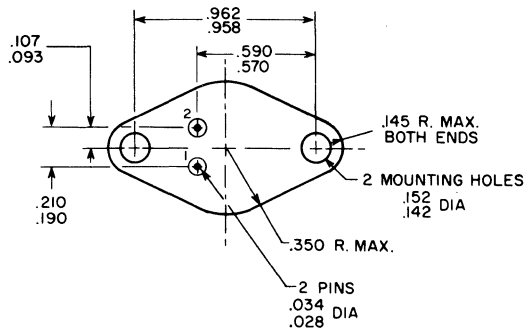


Dimensions in Inches

92CS-13383R1

DIMENSIONAL OUTLINE FOR TYPES 2N3878 & 2N3879 JEDEC NO. TO-66





Dimensions in Inches

92CS-12865

NOTE 1: Measured at bottom of heat-radiator.
NOTE 2: 0.035" C.R.S., tin plated.
NOTE 3: Recommended hole size for printed-circuit board is 0.070" dia.

TERMINAL CONNECTIONS FOR TYPES 2N3878, 2N3879, & 40375

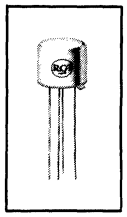
Pin 1-Base
Pin 2-Emitter

Flange, Case-Collector (For 2N3878 & 2N3879)
Heat Radiator-Collector (For 40375)

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2N3932
2N3933

SILICON NPN EPITAXIAL PLANAR TYPES



For VHF and UHF Applications in Industrial and Military Equipment

RCA-2N3932 and 2N3933 are epitaxial planar transistors of the silicon npn type, with characteristics which make them extremely useful as general-purpose rf amplifiers at frequencies up to 450 MHz.

These characteristics include low noise figures at 60, 200, and 450 MHz low feedback capacitance, high gain-bandwidth product, and high power gains in unneutralized amplifier circuits.

The 2N3932 and 2N3933 utilize a compact, hermetically sealed four-lead metal package, in which the active elements of the transistor are insulated from the case. The construction of these devices contributes to highly reliable performance at very- and ultra-high-frequencies, and permits grounding of the case to minimize feedback capacitances and undesired coupling –a feature not available in devices using conventional epoxy-type enclosures.

FEATURES

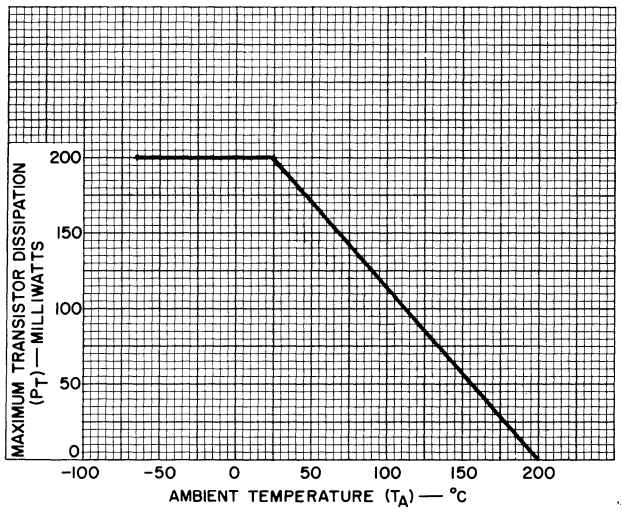
- **low noise figures (NF):**

2N3932	2N3933	
2.5 dB typ.	3 dB max.	@ 60 MHz
4.5 dB max.	4 dB max.	@ 200 MHz
5 dB typ.	5 dB typ.	@ 450 MHz

- **high gain-bandwidth product (f_T):**
  750 MHz min. for both types
- **low collector-to-base time constant ($r_b' C_c$):**
  2N3932 = 8 ps max.
  2N3933 = 6 ps max.
- **high unneutralized power gain (G_{pe}):**
  2N3932 = 11.5 dB min. at 200 MHz
  2N3933 = 14 dB min. at 200 MHz
- **low output capacitance (C_{cb}):**
  C_{cb} = 0.55 pF max. for both types
- **hermetically sealed metal 4-lead package**

Maximum Ratings, *Absolute-Maximum Values:*

	2N3932	2N3933	
Collector-to-Base Voltage, V_{CBO}	30	40 max.	V
Collector-to-Emitter Voltage, V_{CEO}	20	30 max.	V
Emitter-to-Base Voltage, V_{EBO}	2.5	2.5 max.	V
Collector Current, I_C	limited by dissipation		
Transistor Dissipation, P_T:			
at ambient temperatures: up to 25° C	200	200 max.	mW
at ambient temperatures: above 25° C	See *Fig. 1*		
Temperature Range:			
Storage and Operating (Junction)	−65 to 200° C		
Lead Temperature (During Soldering): At distances not less than 1/16" from seating surface for 10 seconds	265	265 max.	°C



92CS-13273RI

Fig. 1 - Rating chart for RCA-2N3932 and 2N3933

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N3932, 2N3933 10-66
Supersedes issue dated 8-65

ELECTRICAL CHARACTERISTICS

At a Ambient Temperature (T_A) of 25°C:

Characteristics	Symbol & Unit	LIMITS						TEST CONDITIONS				
		Type 2N3932			Type 2N3933			Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C
		Min.	Typ.	Max.	Min.	Typ.	Max.	MHz	V	V	mA	mA
Collector-Cutoff Current	I_{CBO} μA	–	–	0.01	–	–	0.01	–	15	–	0	–
Collector-to-Base Breakdown Voltage	BV_{CBO} V	30	–	–	40	–	–	–	–	–	0	0.001
Collector-to-Emitter Breakdown Voltage	BV_{CEO} V	20	–	–	30	–	–	–	–	–	–	1
Emitter-to-Base Breakdown Voltage	BV_{EBO} V	2.5	–	–	2.5	–	–	–	–	–	0.001	0
Static Forward Current-Transfer Ratio	h_{FE}	40	–	150	60	–	200	–	–	8	–	2
Magnitude of Small-Signal Forward Current Transfer Ratio	$\lvert h_{fe} \rvert$ [a]	7.5	–	16	7.5	–	16	100	–	8	–	2
Collector-to-Base Feedback Capacitance	C_{cb} [b] pF	–	–	0.55	–	–	0.55	0.1 to 1	8	–	0	–
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See *Fig. 3*)	G_{pe} [a] dB	11.5	–	17	14	–	18	200	8	–	–	2
Collector-to-Base Time Constant	$r_b' C_c$ ps	1	–	8	1	–	6	31.9	8	–	2	–
Noise Figure	NF dB	–	2.5	–	–	–	3	60	R_S [c] = 400Ω	6	–	1
		–	–	4.5	–	–	4	200 See *Figs 3 and 4*	R_S [c] = 200Ω	8	–	2
		–	5	–	–	5	–	450	R_S [c] = 100Ω	6	–	1.5

[a] Lead No. 4 (case) grounded.

[b] Three-terminal measurement: Lead No. 1 (emitter) and lead No. 4 (case) connected to guard terminal.

[c] R_S (Source Resistance) is the resistance looking back from the base terminal (2) toward the generator input.

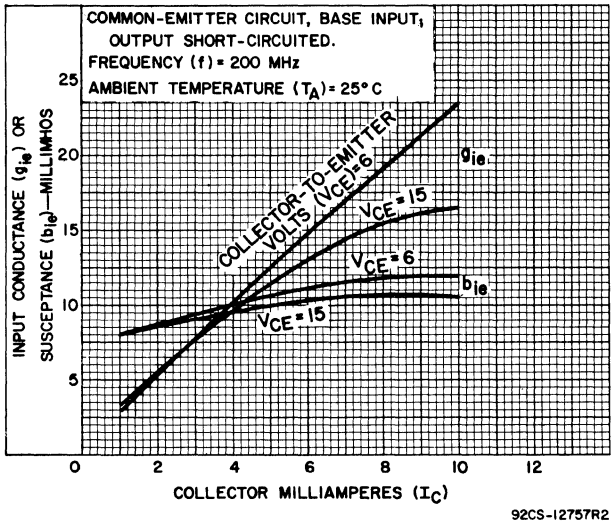


Fig. 5 - Input admittance (y_{ie}). Typical two-port admittance (y) parameters as functions of collector current for RCA-2N3932 and 2N3933

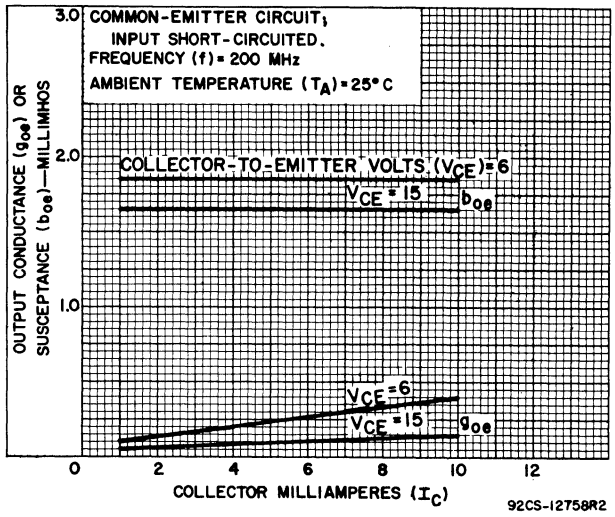


Fig. 6 - Output admittance (y_{oe}). Typical two-port admittance (y) parameters as functions of collector current for RCA-2N3932 and 2N3933

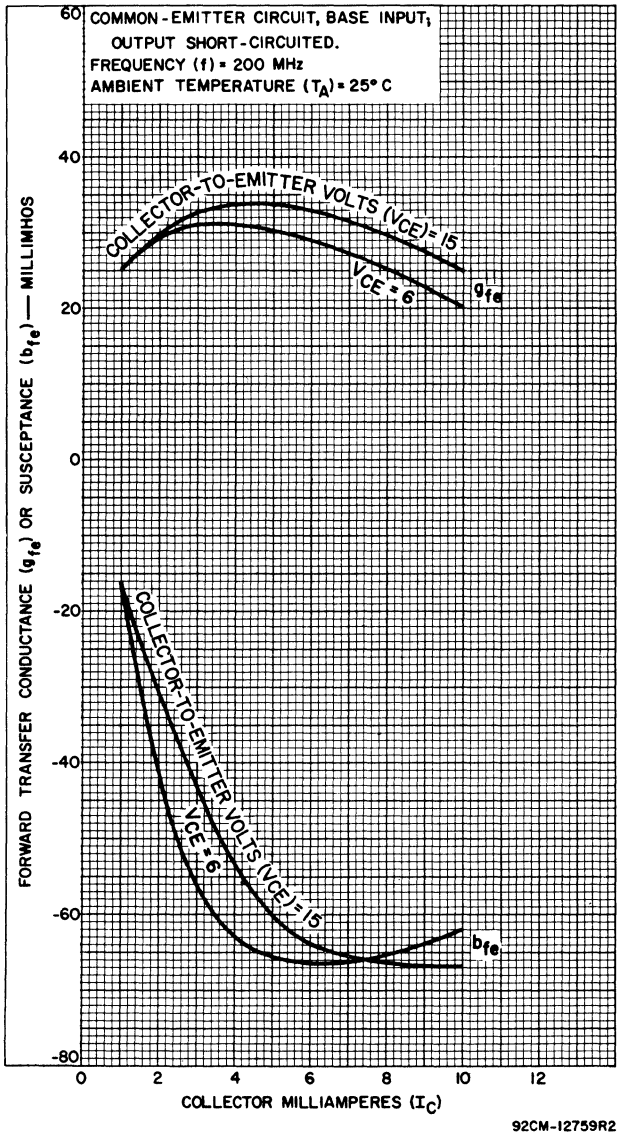


Fig. 7 - Forward transadmittance (y_{fe}). Typical two-port admittance (y) parameters as functions of collector current for RCA-2N3932 and 2N3933

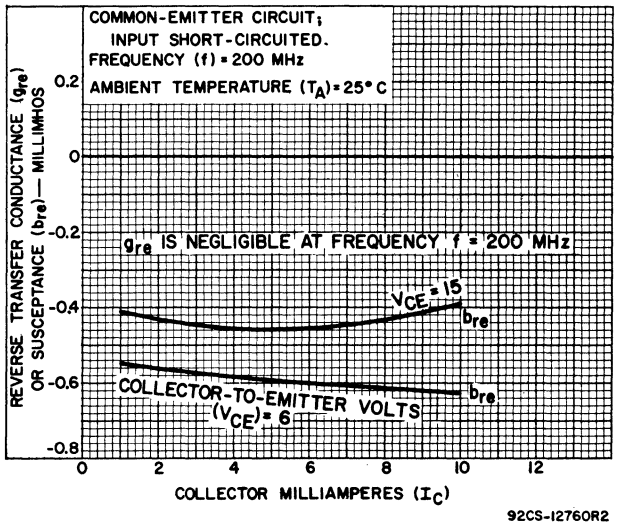


Fig. 8 - Reverse transadmittance (y_{re}). Typical two-port admittance (y) parameters as functions of collector current for RCA-2N3932 and 2N3933

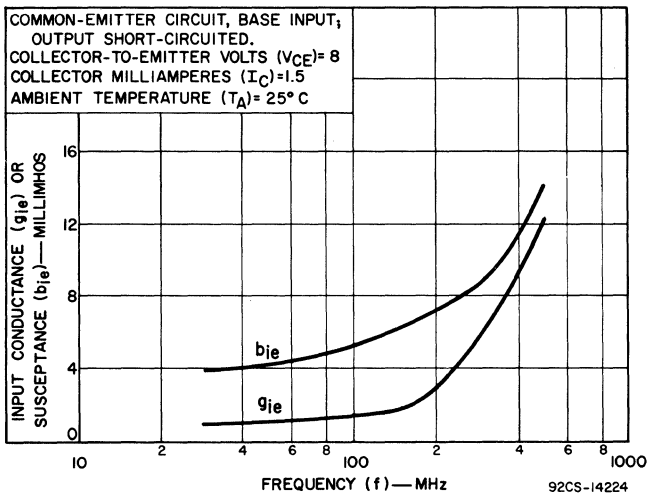


Fig. 9 - Input admittance (y_{ie}). Typical two-port admittance (y) parameters as functions of frequency for RCA-2N3932 and 2N3933

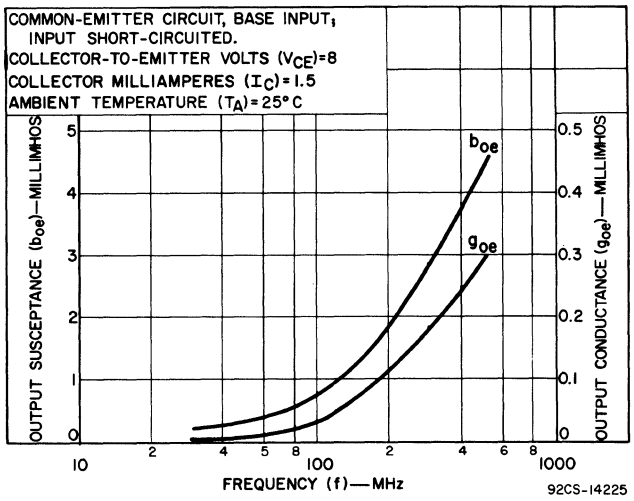


Fig. 10 - Output admittance (y_{oe}). Typical two-port admittance (y) parameters as functions of frequency for RCA-2N3932 and 2N3933

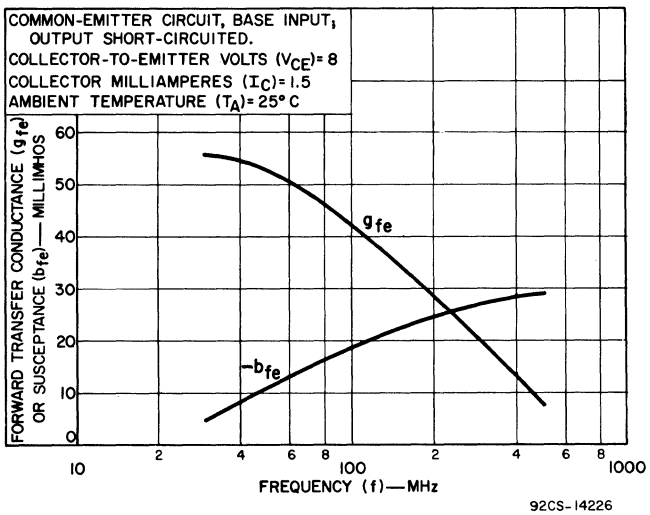


Fig. 11 - Forward transadmittance (y_{fe}). Typical two-port admittance (y) parameters as functions of frequency for RCA-2N3932 and 2N3933

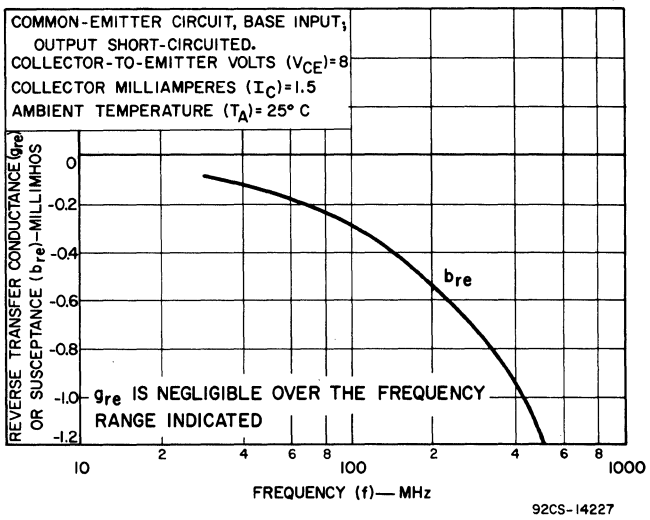
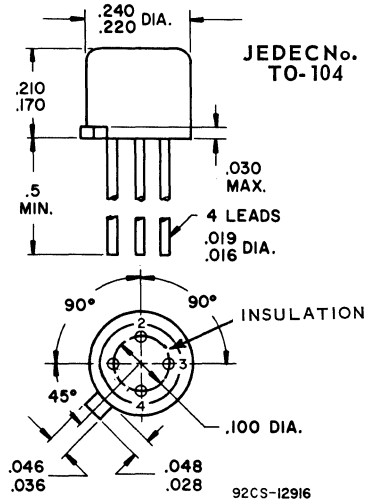


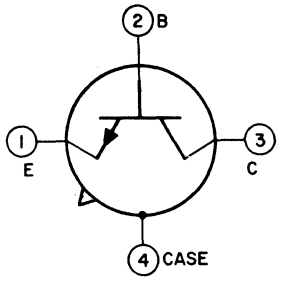
Fig. 12 - Reverse transadmittance (y_{re}). Typical two-port admittance (y) parameters as functions of frequency for RCA-2N3932 and 2N3933

DIMENSIONAL OUTLINE



Dimensions in Inches

TERMINAL DIAGRAM



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector
Lead 4 - Connected to Case

Bottom View

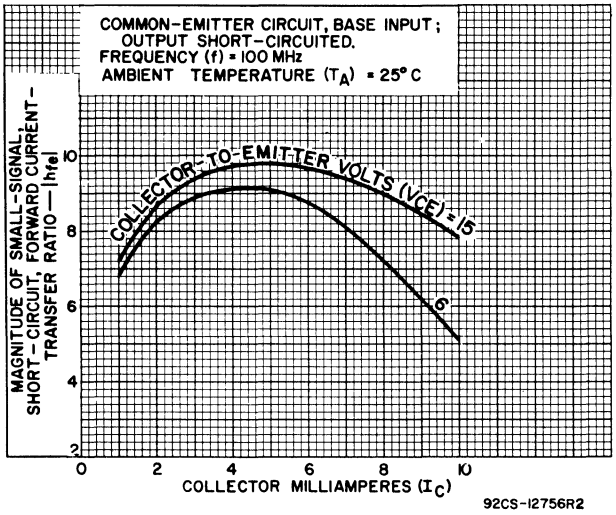
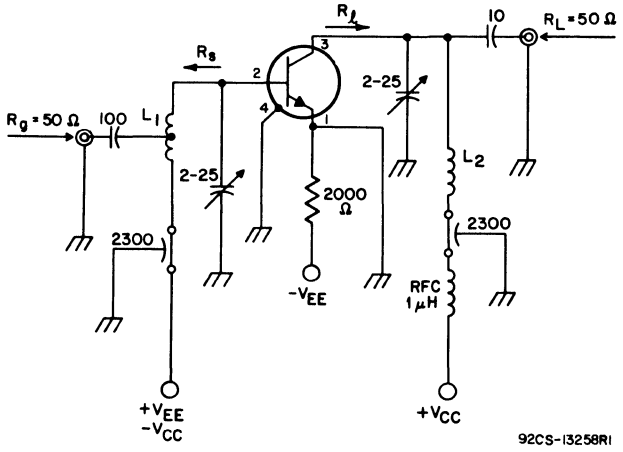


Fig. 2 - Typical small-signal beta characteristics for RCA-2N3932 and 2N3933



All Capacitance Values in Picofarads

L_1 = 1/2 turn No. 14 FORMVAR* wire; center-tapped; total wire length = 2 inches.

L_2 = 1/2 turn No. 14 FORMVAR wire; total wire length = 1-1/2 inches.

Q = Type 2N3932, 2N3933

⏚ = Chassis Ground

Transistor Terminating Resistances (R_s and R_l) = 200 ohms

R_s is the resistance looking back from the base terminal (2) toward the generator input.

R_l = Resistance looking from transistor collector terminal (3) towards the load.

*Registered Trade Mark of Shawindian Products Corp.

Fig. 3 - 200-MHz power gain and noise figure test circuit for RCA-2N3932 and 2N3933

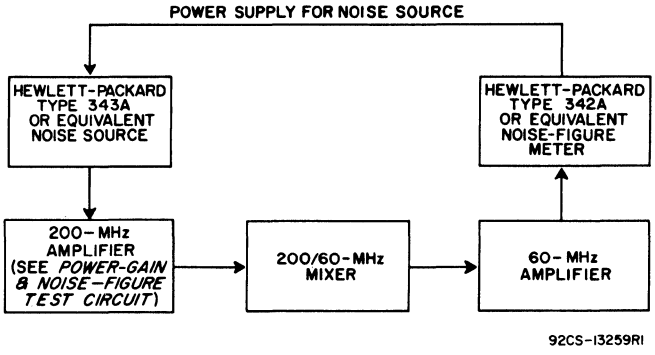


Fig. 4 - Block diagram of noise-figure test circuit for RCA-2N3932 and 2N3933


RCA

SILICON N-P-N "overlay" TRANSISTOR

2N4012

File No. 90

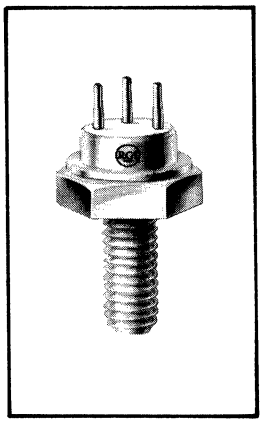
RCA-2N4012 is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is especially designed to provide high power as a frequency multiplier into the UHF, or L-band, frequency range for military and industrial communications equipment.

Frequency multiplication – with power amplification – is possible with the overlay structure because the variable collector-to-base capacitance becomes the nonlinear element of a harmonic generator. The collector-to-base capacitance acts like a variable-capacitance diode, or varactor, in parallel with the amplifier section of the transistor.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a single base and collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, and frequency capability.

The 2N4012 pellet is mounted in a JEDEC TO-60 package electrically isolating all three electrodes from the case for design flexibility and features low lead inductance and thermal resistance. The heavy copper mounting stud provides effective contact with a heat sink.

High-Power Frequency Multiplier UHF or L-Band



JEDEC TO-60

- 2.5 Watts Output with 4 dB Conversion Gain (min.) as Tripler to 1 Gc/s
- 3.0 Watts Output with 4.8 dB Conversion Gain (typ.) as Doubler to 800 Mc/s
- High Voltage Ratings
- Freedom from Second Breakdown

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	40	volts
With V_{BE} = -1.5 volts	V_{CEV}	65	volts
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	volts
COLLECTOR CURRENT	I_C	1.5	amperes
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		11.6	watts
At case temperatures above 25° C		See Fig.12	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

POWER OUTPUT vs. OUTPUT FREQUENCY

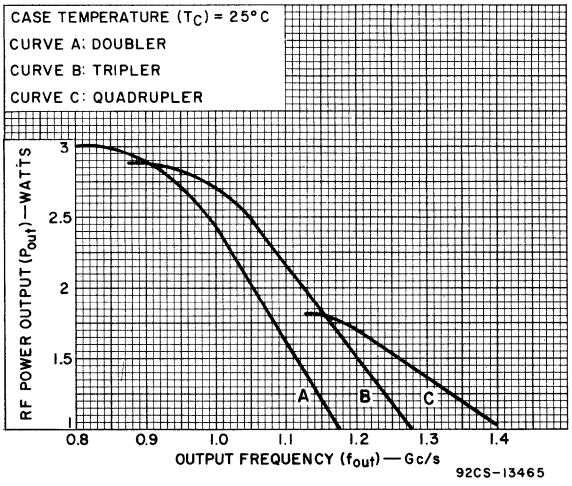


Fig. 1

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Trademark(s) ® Registered
Marca(s) Registrada(s)

Printed in U.S.A.
2N4012 5/66
Reprinted from 2N4012 10/65

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	0.1	mA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	65	–	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	0 to 200[a]	40[b]	–	volts
	BV_{CEV}			-1.5			0 to 200[a]	65[b]	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					100	500	–	1	volt
Collector-to-Base Capacitance (See Fig.4)	C_{ob}	30			0			–	10	pF
RF Power Output Tripler At 1002 Mc/s (See Fig.2) Doubler At 800 Mc/s (See Fig.3)	P_{OUT}		28 28					2.5[c] 3.0[d] (typ.)		watts
Gain-Bandwidth Product	f_T		28				150	500 (typ.)		Mc/s
Collector-to-Base Cutoff Frequency[e]	f_c		28				0	25 (typ.)		Gc/s

a Pulsed through an inductor (25 mH); duty factor = 50%.

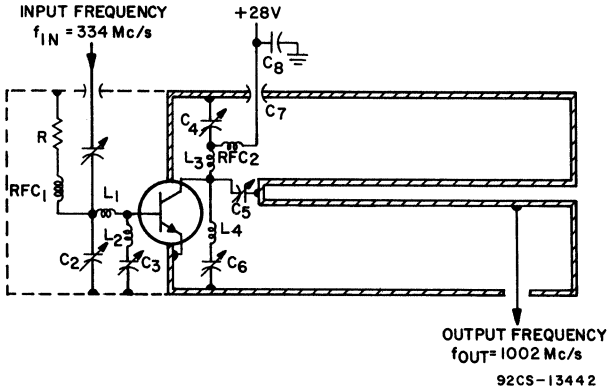
b Measured at a current where the breakdown voltage is a minimum.

c For P_{IN} = 1.0 W; at 334 Mc/s; minimum collector efficiency = 25%.

d For P_{IN} = 1.0 W; at 400 Mc/s; typical collector efficiency = 35%.

e Cutoff frequency is determined from Q measurement at 210 Mc/s. The cutoff frequency of the collector-to-base junction of the transistor, f_c = Q x 210 Mc/s.

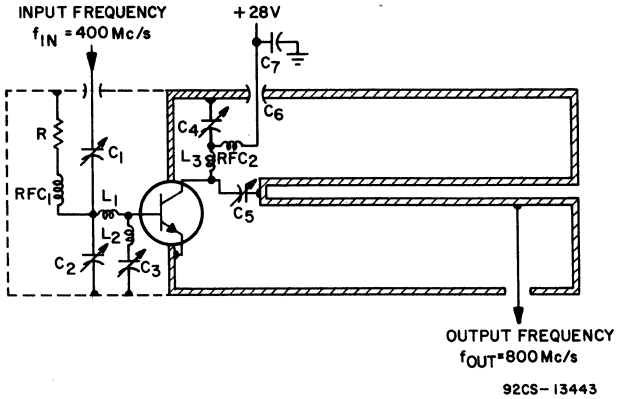
TRIPLER CIRCUIT FOR POWER OUTPUT TEST



C_1 = 0.9 - 7 pF
C_2 = 1 - 10 pF
C_3,C_4,C_5,C_6 = 0.8 - 10 pF
C_7 = 1000 pF
C_8 = 0.2 μF
RFC_1 = 0.22 μH
RFC_2 = 0.33 ohms, W.W. Resistor
L_1 = 2 turns, 3/8" diameter, No.16 wire
L_2 = 1/16" width copper strip, 3/8" long
L_3 = 2 turns, 3/8" diameter, No.18 wire
L_4 = 1-1/2 turns, 3/8" diameter, 1/16 copper strip
R = 2.7 ohms
Output Cavity = 1-1/4" x 1-1/4" x 2-1/4"
Center Conductor = 1/4" OD tube
Output direct couple = 1/2" from shorted end

Fig.2

DOUBLER CIRCUIT FOR POWER OUTPUT TEST



C_1 = 0.9 - 7 pF
C_2 = 1 - 10 pF
C_3,C_4,C_5 = 0.8 - 10 pF
C_6 = 1000 pF
C_7 = 0.2 μF
RFC_1 = 0.22 μH
RFC_2 = 0.33 ohms, W.W. Resistor
R = 2.7 ohms
L_1 = 1 turn, 3/8" diameter, No.16 wire
L_2 = 1/16" width copper strip, 3/8" long
L_3 = 2 turns, 3/8" diameter, No.18 wire
Output Cavity = 1-1/4" x 1-1/4" x 2-1/4"
Center Conductor = 1/4" OD tube
Output direct couple = 1/2" from shorted end

Fig.3

COLLECTOR-TO-BASE CAPACITANCE vs. COLLECTOR-TO-BASE VOLTAGE

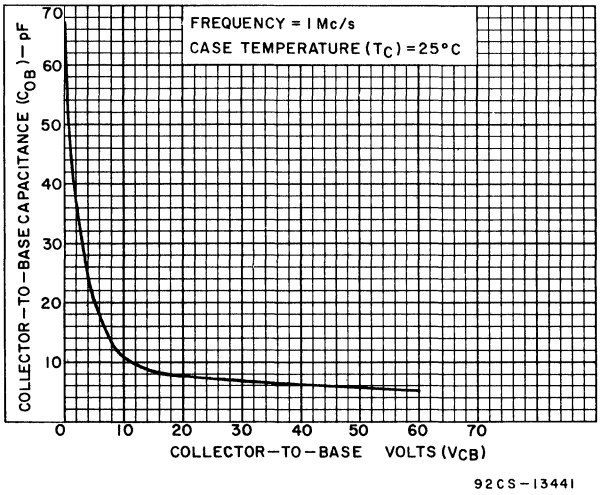


Fig.4

POWER OUTPUT vs. POWER INPUT

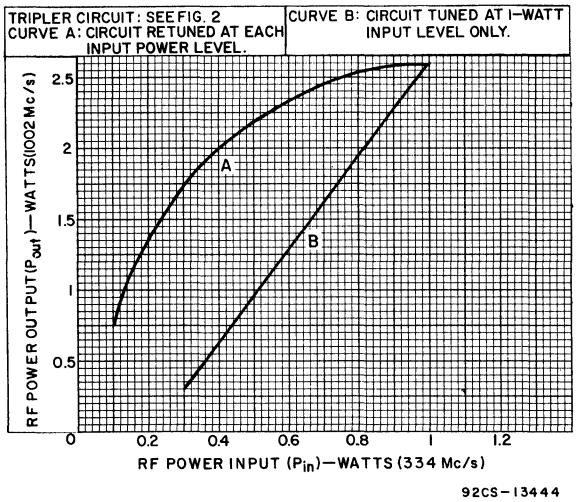


Fig.5

POWER OUTPUT vs. COLLECTOR SUPPLY VOLTAGE

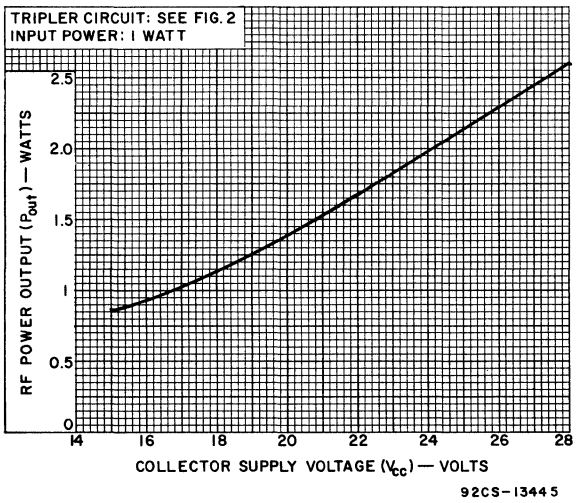


Fig.6

GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

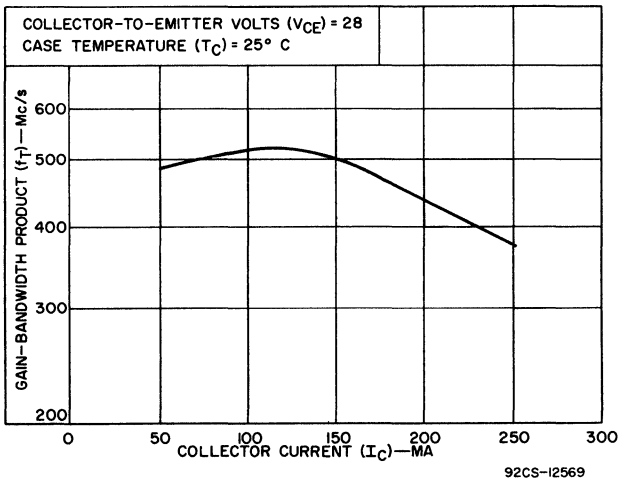


Fig.7

SERIES INPUT RESISTANCE vs. FREQUENCY

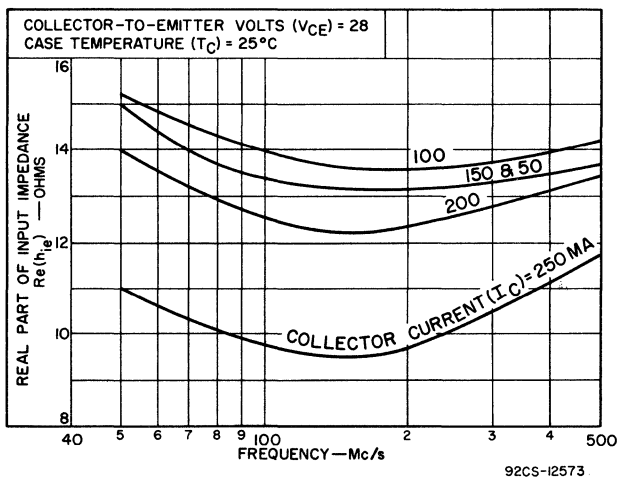


Fig.8

SERIES INPUT REACTANCE vs. FREQUENCY

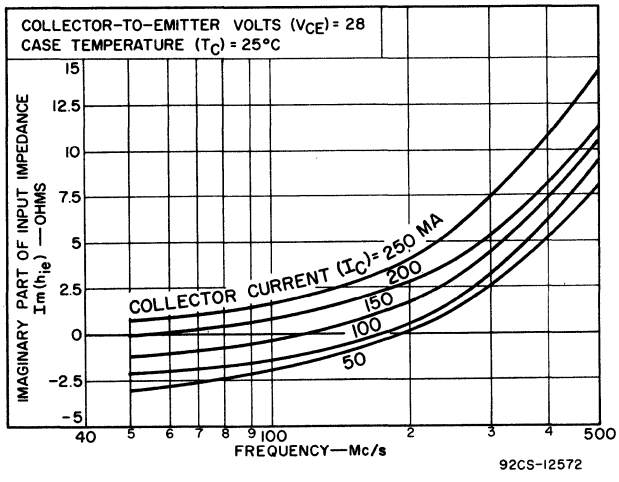


Fig.9

PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

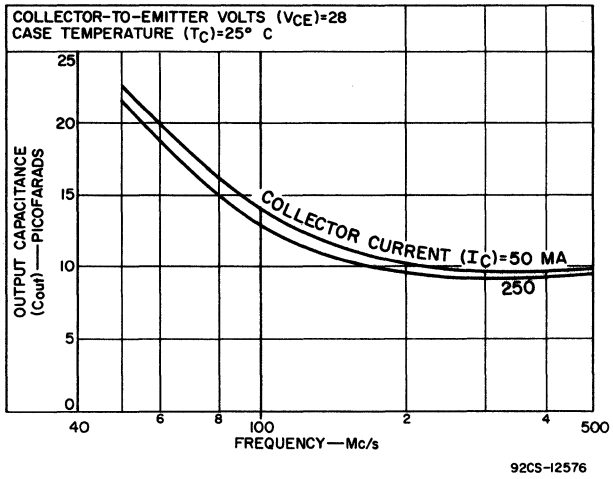


Fig. 10

PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

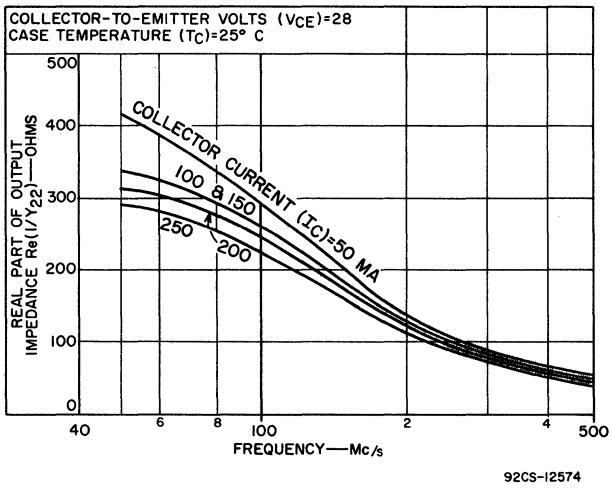


Fig. 11

DISSIPATION DERATING CURVE

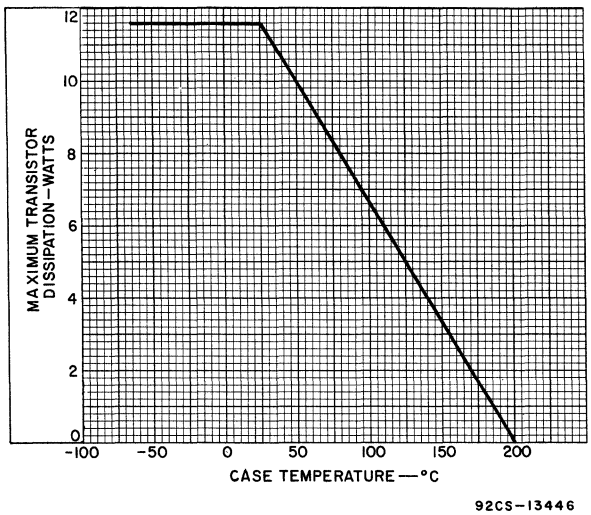
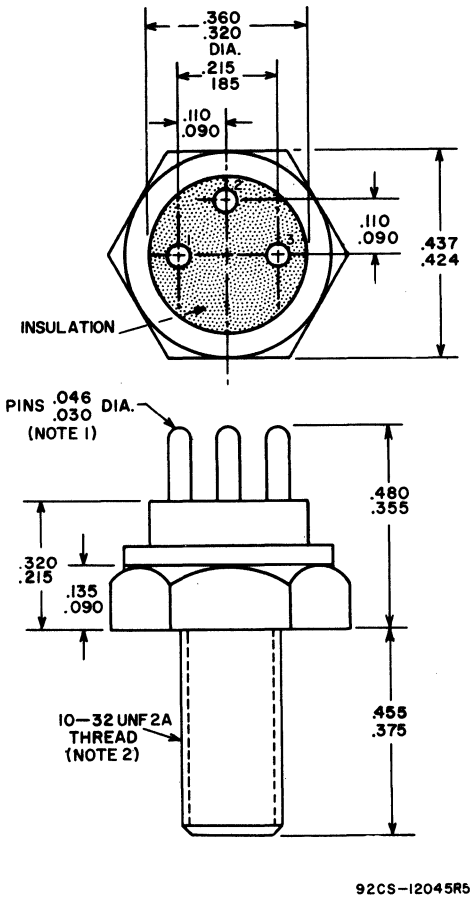


Fig. 12

DIMENSIONAL OUTLINE



Dimensions in Inches

NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200" AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.030" MIN., 0.046" MAX.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

NOTE 3: THIS DEVICE MAY BE OPERATED IN ANY POSITION.

TERMINAL CONNECTIONS

Pin No.1 - Emitter
Pin No.2 - Base
Pin No.3 - Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.
   Part I - *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.
   Part II - *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.
2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

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RCA POWER TRANSISTORS

2N4036, 2N4037
2N4314
Including
40391 & 40394

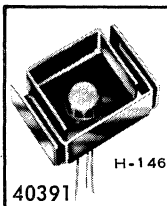
File No. 216

RCA-2N4036, 2N4037, and 2N4314* are double-diffused, epitaxial-planar, silicon p-n-p transistors. These devices employ the popular JEDEC TO-5 package; they differ in breakdown-voltage ratings, leakage-current, and saturation characteristics.

These transistors are intended for a wide variety of small-signal, medium-power applications. With a minimum gain-bandwidth product (f_T) of 60 MHz, these types will provide useful gain at frequencies in the HF region. In addition, the 2N4036 is useful in high-speed saturated switching applications.

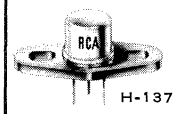
*Formerly Dev. Type Nos. TA2651, TA2670, and TA2670A, respectively.

ALSO AVAILABLE. . .



40391

Type 40391 is a 2N4037 with a factory-attached heat radiator intended for printed circuit-board applications.



40394

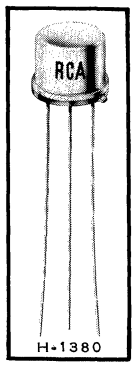
Type 40394 is a 2N4037 with a factory-attached diamond-shaped mounting flange.

SILICON P-N-P TYPES

General-Purpose Transistors for Industrial and Commercial Applications

2N4036 2N4037	P-N-P Complements of	2N2102** 2N3053

**2N2102 is a linear-beta type; the 2N3053 is a general-purpose type. For technical bulletins for these devices, write Commercial Engineering, RCA, Harrison, N.J.



2N4036, 2N4037
2N4314
JEDEC TO-5

- Maximum area-of-operation curves for DC and pulse operation
- Planar construction provides low-noise and low-leakage characteristics
- Gain-bandwidth product (f_T) = 60 MHz min.
- High-breakdown voltages:
  BV_{CBO} = −90 V min. (2N4036, 2N4314)
  −60 V min. (2N4037)
  BV_{EBO} = − 7 V min. (2N4036, 2N4037, 2N4314)
- Low saturation Voltages:
- $V_{CE}(sat)$ = −9.65 V max. (2N4036)
  −1.4 V max. (2N4037, 2N4314)
- High pulse beta at high collector current:
  h_{FE} = 20 min. at I_C = 500 mA (2N4036)
- High saturated switching speed:
  t_{on} = 110 ns max.
  t_{off} = 700 ns max.
  } (2N4036)

MAXIMUM RATINGS		2N4036	2N4037 40391 40394	2N4314	
Absolute-Maximum Values:					
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−90	−60	−90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With 1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	−85	−60	−85	V
With external base-to-emitter resistance (R_{BE}) ≤ 200 Ω	$V_{CER}(sus)$	−85	−60	−85	V
With base open	$V_{CEO}(sus)$	−65	−40	−65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−7	−7	−7	V
COLLECTOR CURRENT	I_C	−1.0	−1.0	−1.0	A
BASE CURRENT	I_B	−0.5	−0.5	−0.5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		7	7(2N4037)	7	W
		−	7(40394)	−	W
At free-air temperatures up to 25°C		1	3.5(40391)	1	W
		−	1(40394)	−	W
At temperatures above 25°C		← See Fig. 5. →			
For pulse operation		← See Fig. 7. →			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		← −65 to 200 →			°C
LEAD TEMPERATURE (During soldering):		← 230 →			
At distance ≥1/32 in. from seating plane for 10 s max.		← 230 →			°C

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N4036, 2N4037, 2N4314
40391 & 40394 8/66
Supersedes issue dated 2/66

ELECTRICAL CHARACTERISTICS

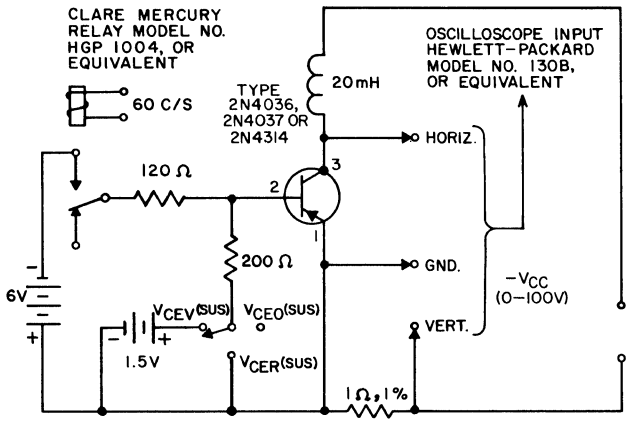
Case Temperature (T_C) = 25°C

Characteristic	Symbol	TEST CONDITIONS							LIMITS						Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current milliamperes			Type 2N4036		Types 2N4037 40391 40394		Type 2N4314		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO} I_{CEO}	-60	 -30				0	 0	— —	-0.02 -0.5	— —	-0.25 -5	— —	-0.25 -5	μA μA
Emitter-Cutoff Current	I_{EBO}			-5		0			—	-0.02	—	-1	—	-1	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}					-0.1	0		-90	—	-60	—	-90	—	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0	-0.1		-7	—	-7	—	-7	—	V
Collector-to-Emitter Sustaining Voltage: *(See Figs. 1 & 2.)* With base-emitter junction reverse biased	$V_{CEV}(sus)$				1.5	-100			-85[a]	—	-60[a]	—	-85[a]	—	V
With external base-to-emitter resistance (R_{BE}) ≤ 200 Ω	$V_{CER}(sus)$					-100			-85[a]	—	-60[a]	—	-85[a]	—	V
With base open	$V_{CEO}(sus)$					-100			-65[a]	—	-40[a]	—	-65[a]	—	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					-150		15	—	-0.65	—	-1.4	—	-1.4	V
Base-to-Emitter Voltage	V_{BE}		-10			-150			—	-1.1	—	-1.5	—	-1.5	V
DC Forward-Current Transfer Ratio	h_{FE}		-10 -10 -10 -10			-0.1 -1.0 -150[b] -500[b]			20 — 40 20	— — 140 —	— 15 50 —	— — 250 —	— 15 50 —	— — 250 —	
Small-Signal, Forward-Current Transfer Ratio (at f = 20MHz)	h_{fe}		-10			-50			3.0	—	3.0	—	3.0	—	
Output Capacitance	C_{ob}	-10							—	30	—	30	—	30	pF
Input Capacitance	C_{ib}			-0.5					—	90	—	90	—	90	pF
Sat. Switching Time: *(See Figs. 10 & 11.)*															
Turn-on Time	t_{on}		-30			-150		-15	—	110	—	—	—	—	ns
Turn-off Time	t_{off}		-30			-150		-15	—	700	—	—	—	—	ns
Thermal Resistance: Junction-to-Case	θ_{J-C}								— —	25 —	25 (max.) 2N4037 & 40394		— —	25 —	°C/W
Junction-to-Free Air	θ_{J-FA}								— —	165 —	165 (max.) 2N4037 & 40394 50 (max.) 40391		— —	165 —	°C/W °C/W

[a]CAUTION: The sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 1.

[b]Pulsed; pulse duration = 300 μs, duty factor < 2 %.

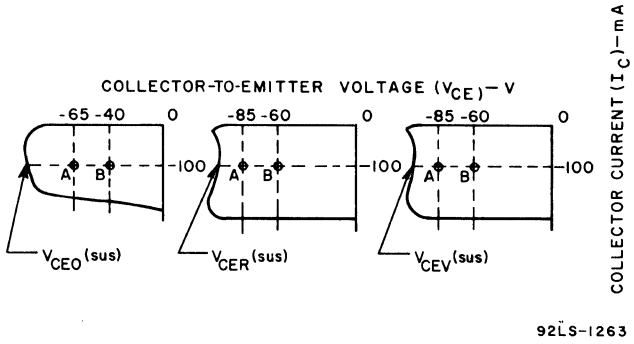
CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES
V_{CEO} (sus), V_{CER} (sus), & V_{CEV} (sus)
FOR TYPES 2N4036, 2N4037, & 2N4314



92LS-1255RI

Fig. 1

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES
(TEST CIRCUIT SHOWN IN FIG. 1)

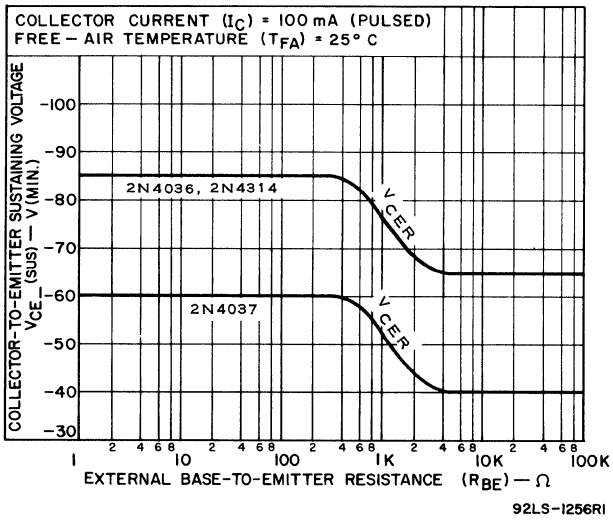


92LS-1263

NOTE: The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) are acceptable when the traces fall to the left and below point "A" for type 2N4036 and 2N4314, and point "B" for type 2N4037.

Fig. 2

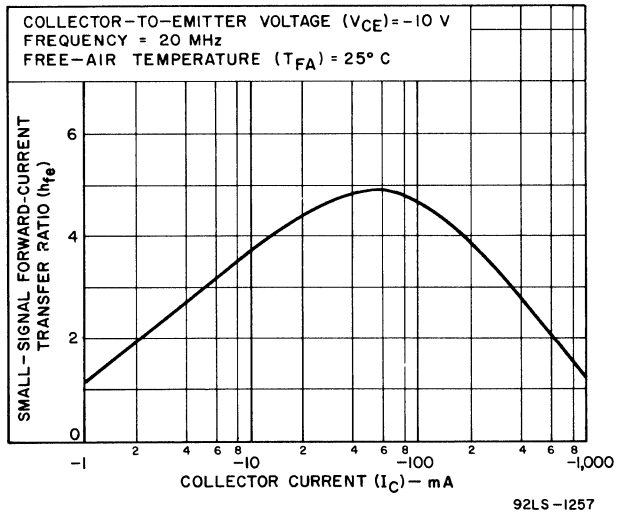
SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPES 2N4036, 2N4037, & 2N4314



92LS-1256RI

Fig. 3

TYPICAL SMALL-SIGNAL-BETA CHARACTERISTIC
FOR TYPES 2N4036, 2N4037, & 2N4314



92LS-1257

Fig. 4

MAXIMUM AREA-OF-OPERATION

The maximum-operating-area curves shown on a log-log plot in Fig. 7 have a slope equal to -1 indicating that a thermal (dissipation) limitation exists over the entire operating region for these types. (The ratings shown are based upon a case temperature of 25°C.) All boundary lines must be derated linearly to zero at a case temperature of 200°C; see Fig. 6.

DISSIPATION DERATING CURVE FOR TYPES 2N4036, 2N4037, 2N4314, 40391, & 40394

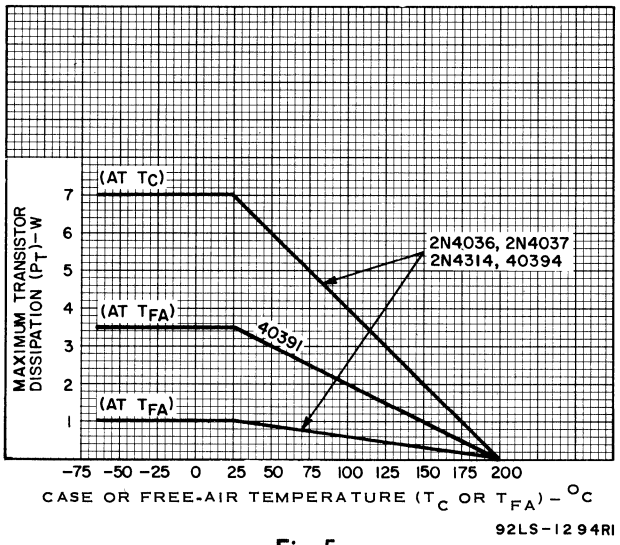


Fig. 5

DISSIPATION DERATING CURVE FOR TYPES 2N4036, 2N4037, & 2N4314

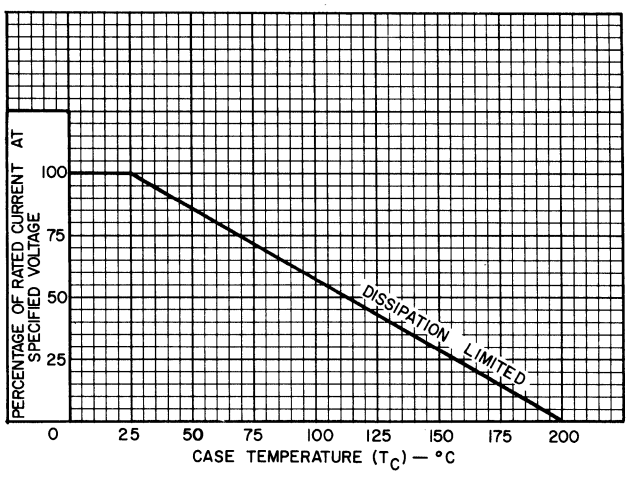


Fig. 6

MAXIMUM OPERATING AREAS FOR TYPES
2N4036, 2N4037, & 2N4314

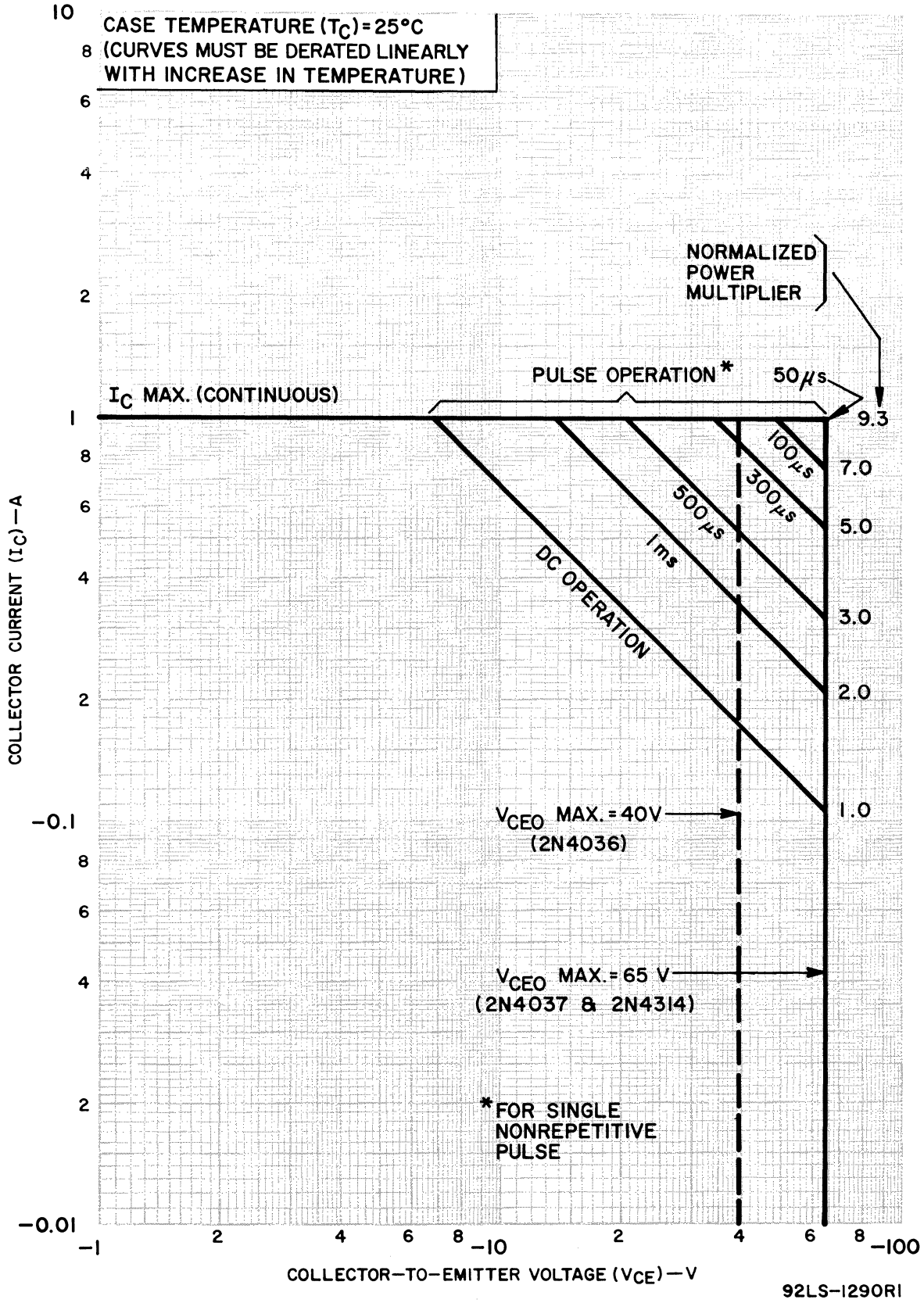


Fig. 7

TYPICAL COLLECTOR-CUTOFF CURRENT vs.
JUNCTION TEMPERATURE FOR TYPE 2N4036

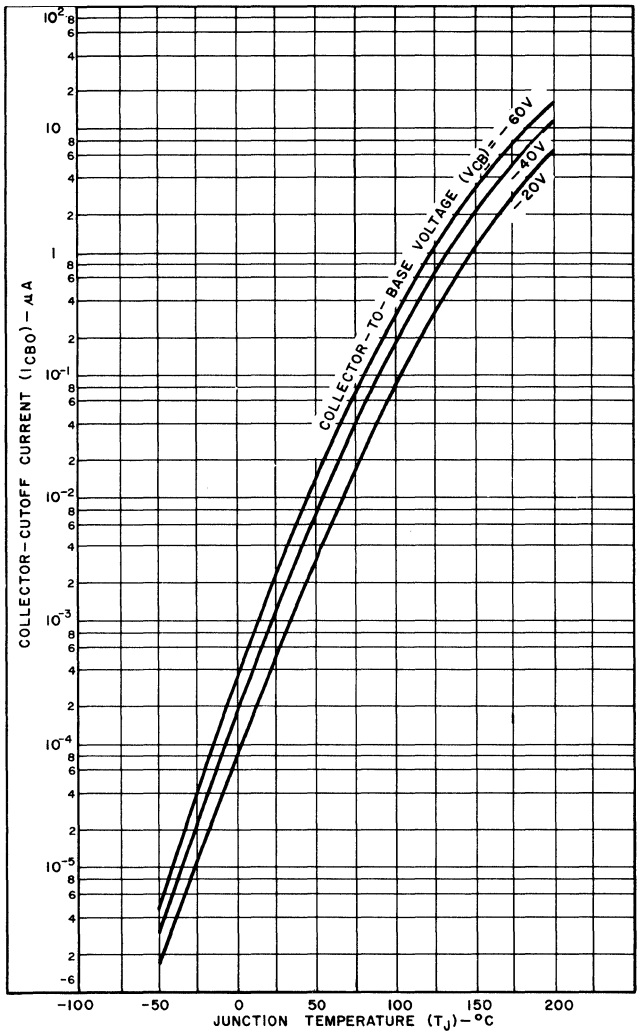


Fig. 8

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS
FOR TYPE 2N4036

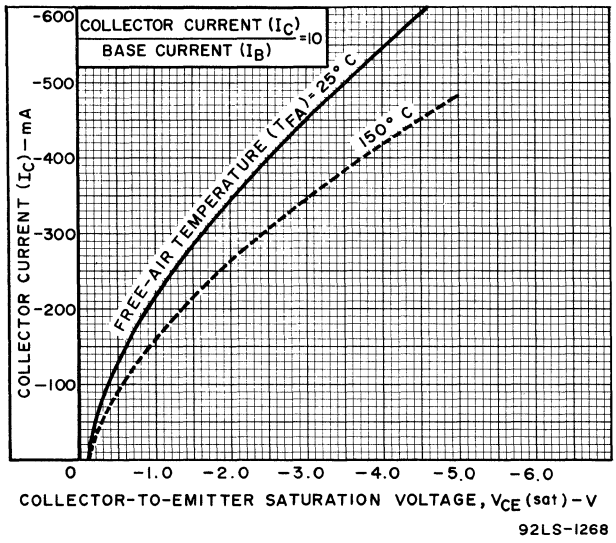


Fig. 9

CIRCUIT USED TO MEASURE SWITCHING TIMES
FOR TYPE 2N4036

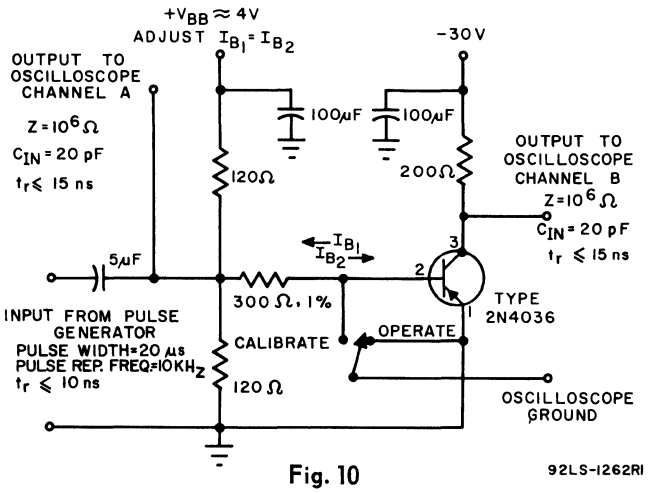
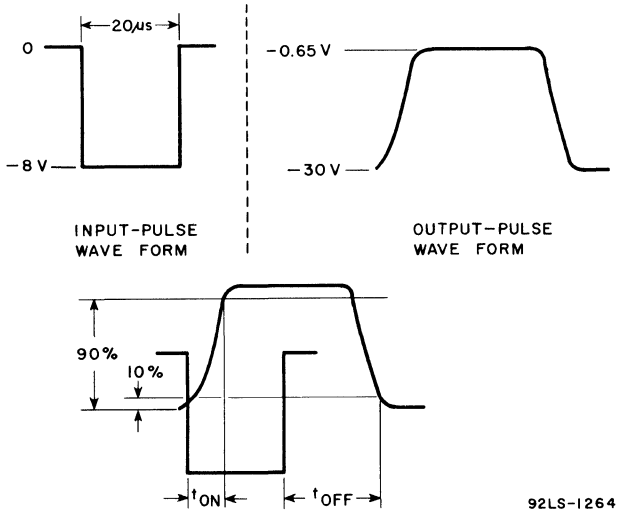


Fig. 10

92LS-1262RI

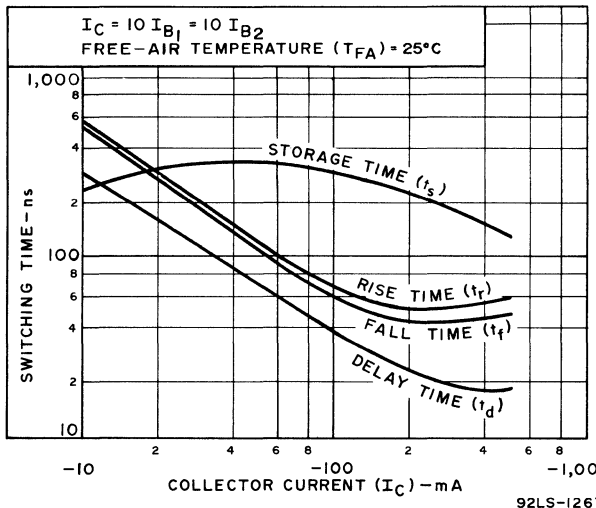
OSCILLOSCOPE DISPLAY FOR MEASUREMENT
OF SWITCHING TIMES
(TEST CIRCUIT SHOWN IN FIG. 10)



92LS-1264

Fig. 11

TYPICAL SATURATED SWITCHING TIMES
FOR TYPE 2N4036



92LS-1267

Fig. 12

TYPICAL DC-BETA CHARACTERISTICS
FOR TYPES 2N4036, 2N4037, & 2N4314

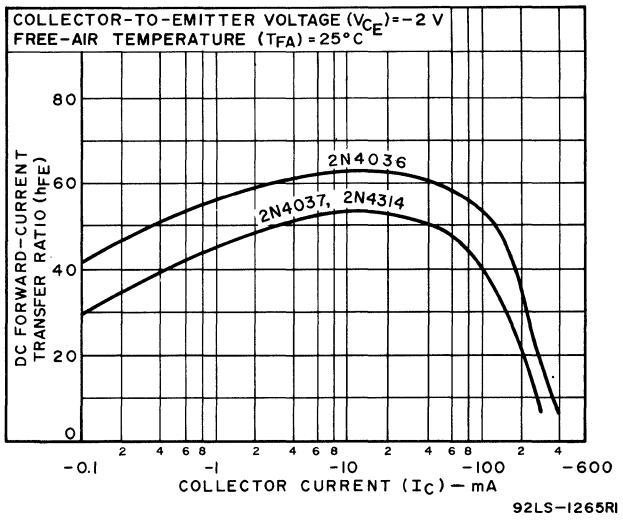


Fig. 13

TYPICAL DC-BETA CHARACTERISTICS
FOR TYPES 2N4037 & 2N4314

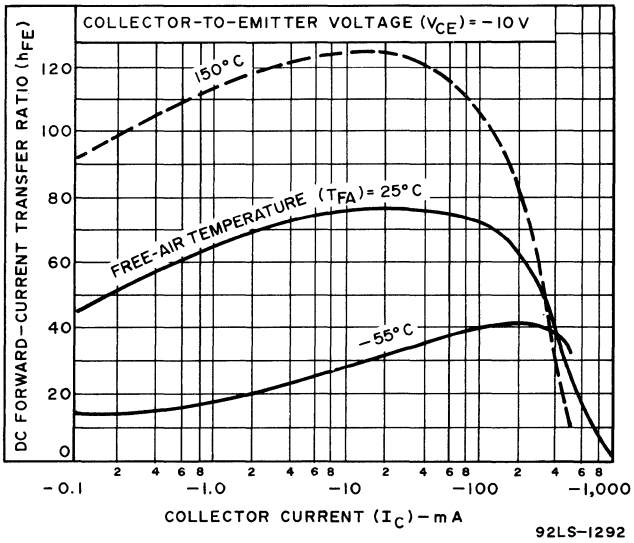


Fig. 14

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPES 2N4037 & 2N4314

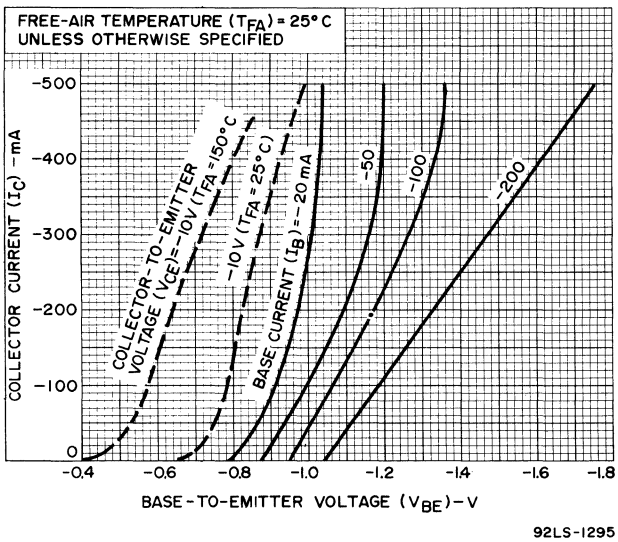


Fig. 15

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N4037

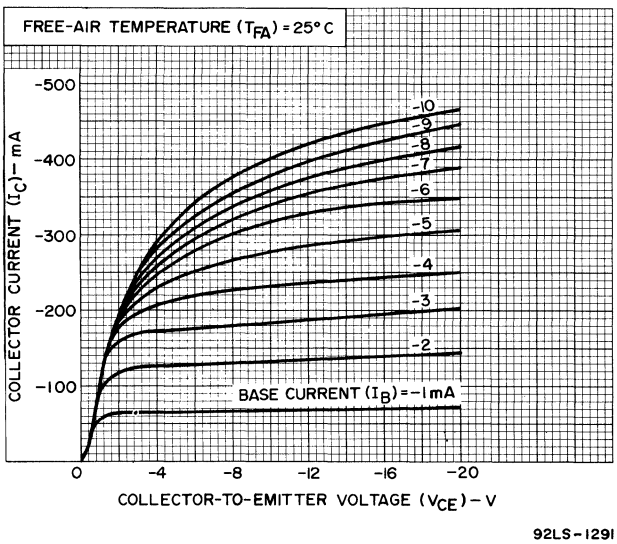


Fig. 16

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPES 2N4037 & 2N4314

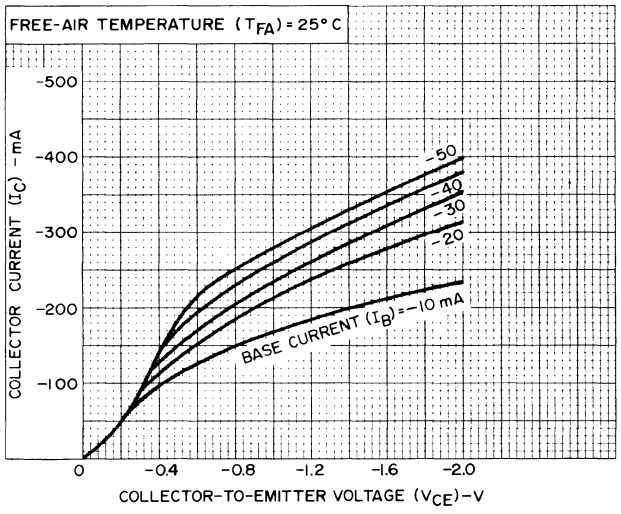


Fig. 17

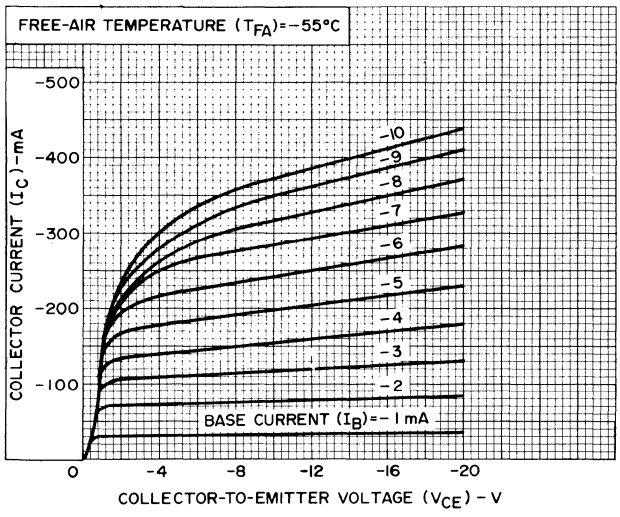


Fig. 18

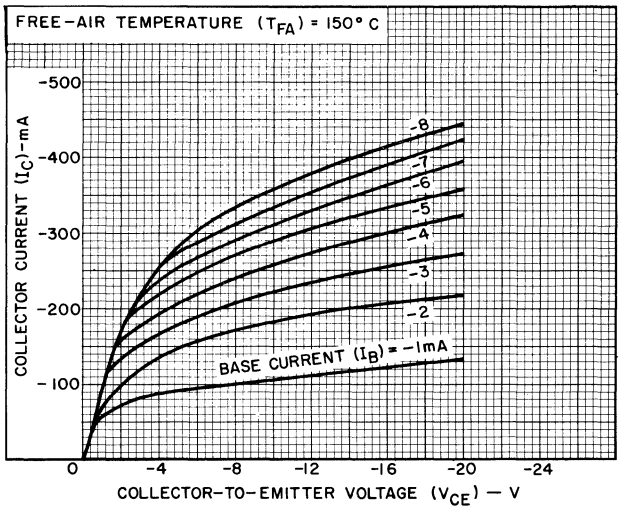
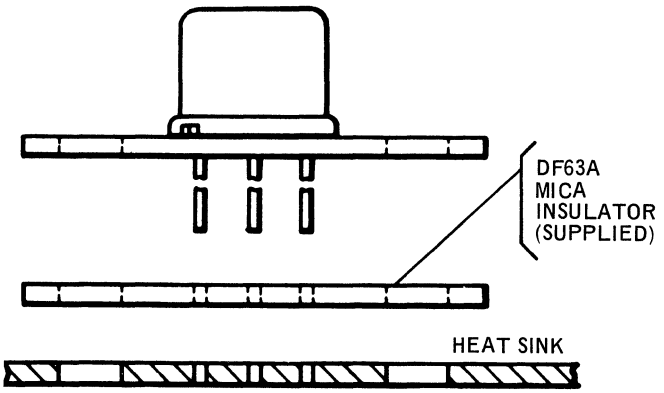


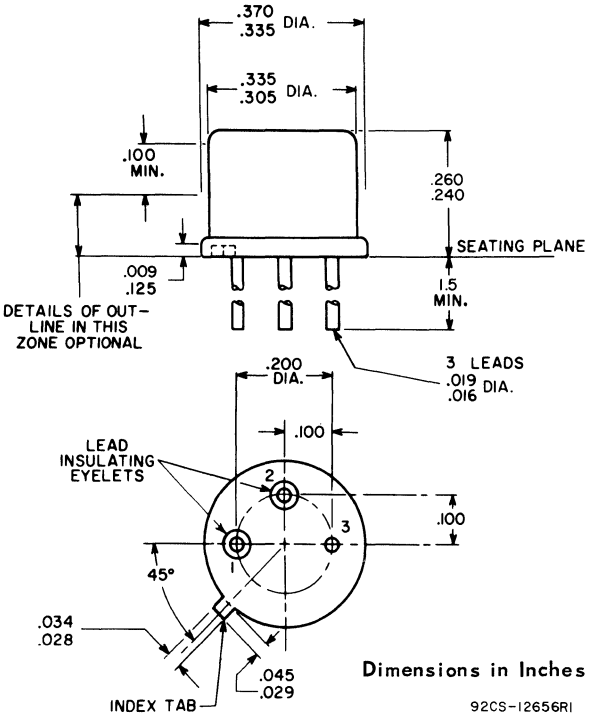
Fig. 19

SUGGESTED HARDWARE FOR TYPE 40394



92SS-3375

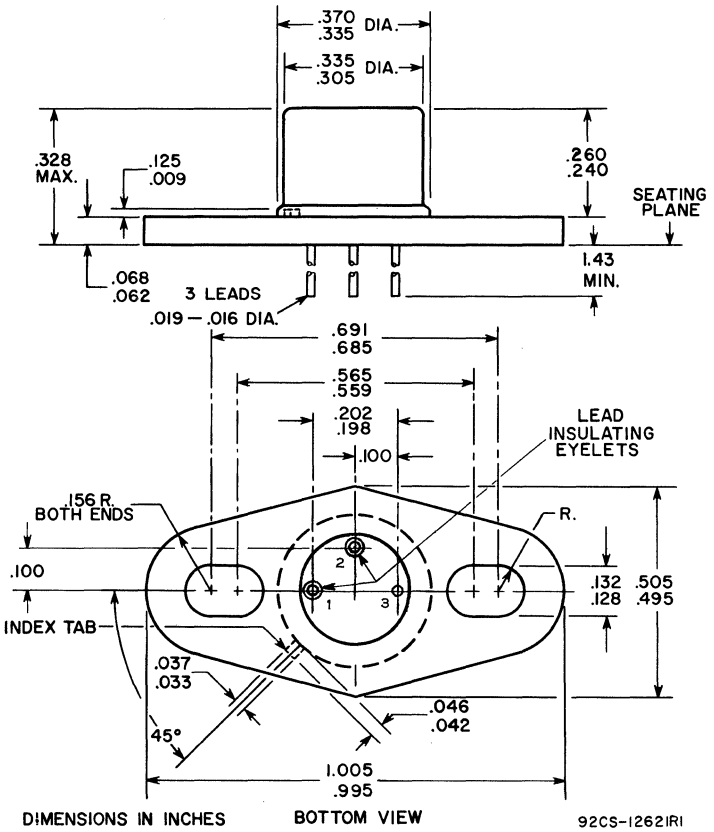
DIMENSIONAL OUTLINE FOR TYPES 2N4036, 2N4037, & 2N4314 JEDEC No. TO-5



Dimensions in Inches

92CS-12656RI

DIMENSIONAL OUTLINE FOR TYPE 40394 JEDEC TO-5 WITH FLANGE



DIMENSIONS IN INCHES BOTTOM VIEW

92CS-12621RI

NOTE:

SOME DEVICESMAY HAVE A FLANGE WITH A TRIANGULAR CUT-OUT FOR LEADS.

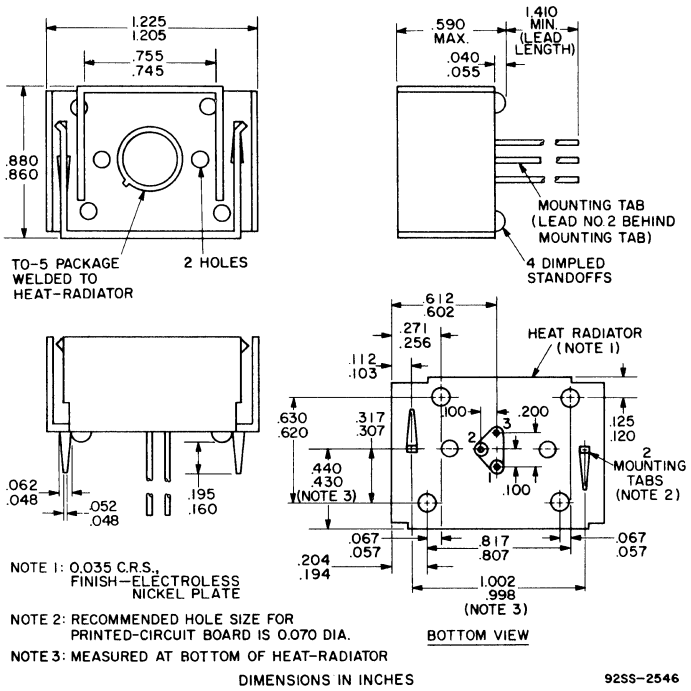
TERMINAL CONNECTIONS FOR TYPES 2N4036, 2N4037, & 2N4314

Lead 1 - Emitter
Lead 2 - Base
Case, Lead 3 - Collector

TERMINAL CONNECTIONS FOR TYPE 40394

Lead 1 - Emitter
Lead 2 - Base
Flange, Lead 3 - Collector

DIMENSIONAL OUTLINE FOR TYPE 40391
JEDEC TO-5 WITH HEAT RADIATOR



TERMINAL CONNECTIONS
FOR TYPE 40391

Lead 1 - Emitter

Lead 2 - Base

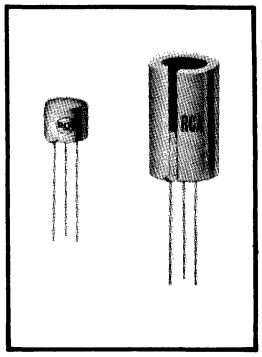
Heat Radiator, Lead 3 - Collector

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RCA

SILICON NPN TRANSISTORS

High-Voltage Types For Wide-Band-Amplifier And Relay-Driver Applications In Critical Industrial Equipment



JEDEC TO-1

RCA-2N4068 and 2N4069* are transistors of the silicon npn type, for use in wide-band-amplifier and relay-driver service in critical industrial applications. These transistors, which differ only in package configuration and dissipation capability, are designed for operation at frequencies up to 100 Mc/s, and feature high breakdown-voltage capabilities, exceptionally low collector-to-base feedback capacitance (2.8 pF typ.), low leakage currents, and low saturation voltages. They also feature an exceptionally linear transfer characteristic, and a high operating-temperature capability.

Both the 2N4068 and 2N4069 utilize a compact, hermetically sealed metal package and have the collector electrode internally connected to the case. The case of the 2N4069 is provided with an integral heat sink of 16-gauge aluminum which gives this transistor twice the dissipation capability of the 2N4068.

* Formerly Dev. Nos. TA-2786 and TA-2787, respectively.

Registered Trade Mark: Burroughs Corporation.

AMPLIFIER SERVICE

Absolute-Maximum Ratings:

	RCA 2N4068	RCA 2N4069	
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	150	150 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	5 max.	volts
COLLECTOR CURRENT, I_C	200	200 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures up to 25°C	0.5	1 max.	watt
At ambient temperatures above 25°C	See Fig.1		
TEMPERATURE RANGE:			
Storage and operating (Junction).	-65 to +175		°C
LEAD TEMPERATURE (During soldering):			
At distances not closer than 1/32" to seating surface for 10 seconds max.	255	255 max.	°C

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APPLICATIONS:

- Distributed amplifiers
- Video amplifiers in TV cameras, camera chains, monitors, oscilloscopes
- Neon-indicator driver circuits
- NIXIE# driver circuits

FEATURES:

- high collector-to-emitter breakdown voltage capability:
  BV_{CEO} = 150 V min., 180 V typ.
- low collector-to-base feedback capacitance:
  C_{cb} = 2.8 pF typ., 3.5 pF max.
- low saturation voltages:
  $V_{CE}(sat)$ = 1 V typ. } I_C = 30 mA,
  $V_{BE}(sat)$ = 0.68 V typ. } I_B = 1 mA
- hermetically sealed 3-lead metal packages – collector internally connected to case
- RCA-2N4069 has integral heat sink for increased dissipation capability

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Trademark(s) ® Registered
Marca(s) Registrada(s)

Printed in U.S.A.
2N4068, 2N4069 7-66
Supersedes issue dated 2-60

ELECTRICAL CHARACTERISTICS, *at an Ambient Temperature (T_A) of 25° C*

CHARACTERISTICS	SYMBOLS AND UNITS	LIMITS			TEST CONDITIONS			
		RCA 2N4068 2N4069			DC Collector-Voltage V_{CB} or V_{CE}	DC Base Current I_B	DC Collector Current I_C	DC Emitter Current I_E
		Min.	Typ.	Max.	volts	mA	mA	μA
Collector-Cutoff Current	I_{CBO} nA	-	5	50	V_{CB} = 120			0
Collector-to-Emitter Breakdown Voltage	BV_{CEO} volts	150	180	-		0	1	
Emitter-to-Base Breakdown Voltage	BV_{EBO} volts	5	7	-			0	-10
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$ volts	-	1	3		1	30	
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$ volts	-	0.68	-		1	30	
Static Forward Current-Transfer Ratio	h_{FE}	30	70	-	V_{CE} = 10		30	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	-	80	-	V_{CE} = 10		30	f = 1 kc/s
Gain-Bandwidth Product	f_T Mc/s	50 50	100 100	- -	V_{CE} = 10 V_{CE} = 140		30 2	f = 100 Mc/s
Output Capacitance	C_{cb}△ pF	-	2.8	3.5	V_{CE} = 10		0	f = 1 Mc/s
Thermal Resistance, Junction-to-Case	θ_{J-C} °C/Watt	-	45	60	-	-	-	-
Thermal Resistance, Junction-to-Air	θ_{J-A} °C/Watt	2N4068 = 300 max. 2N4069 = 150 max.			-	-	-	-

△ Three terminal measurement: Lead No. 1 (emitter) and Lead No. 3 (case) connected to guard terminal.

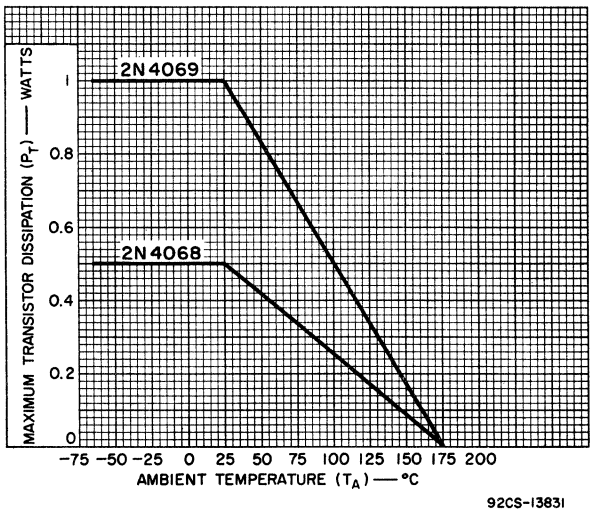


Fig. 1 - Rating Chart for RCA - 2N4068 and 2N4069

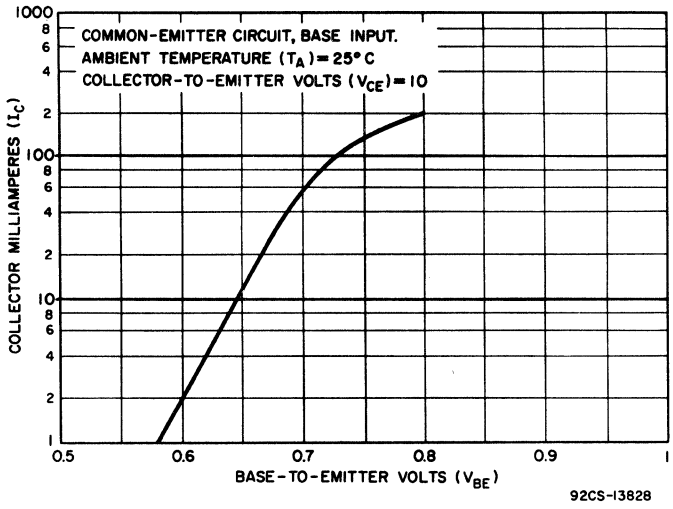


Fig. 2 - Typical Transfer Characteristic for RCA - 2N4068 and 2N4069

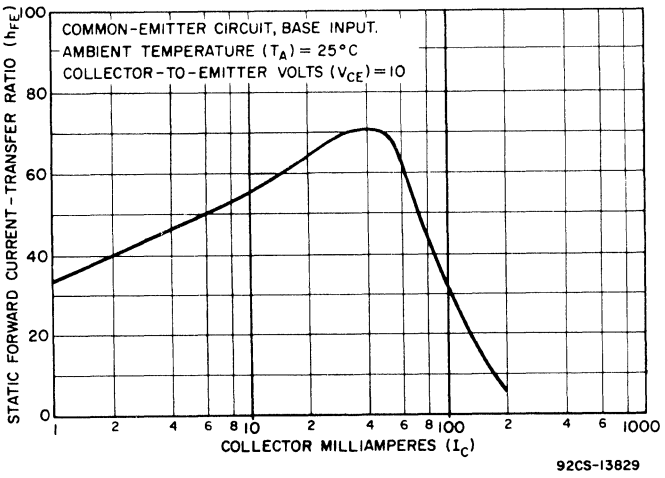


Fig. 3 - Typical Static Forward Current-Transfer Ratio (h_{FE}) Characteristic for RCA-2N4068 and 2N4069

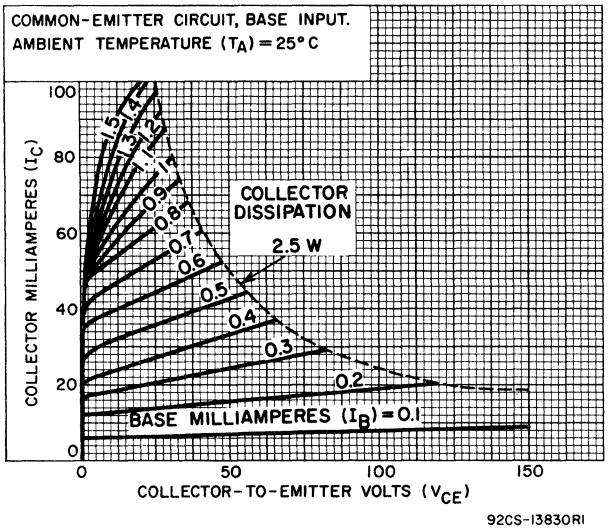


Fig. 4 - Typical Collector Characteristics for RCA-2N4068 and 2N4069

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

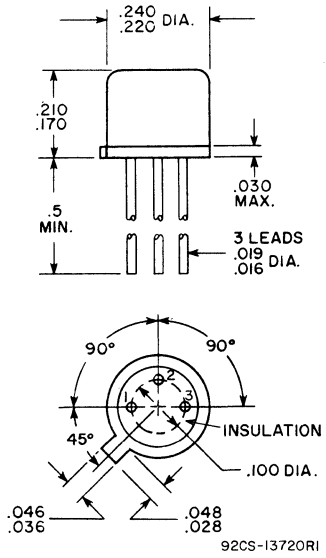
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

RCA-2N4068 and 2N4069 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

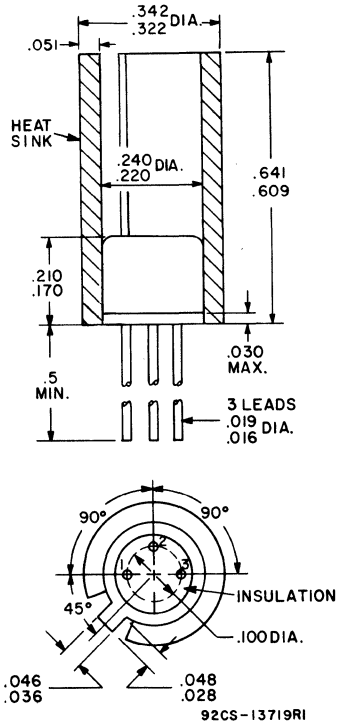
These transistors can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

DIMENSIONAL OUTLINE FOR RCA-2N4068



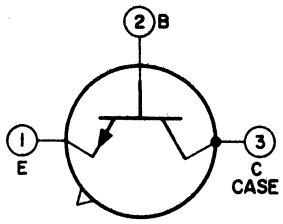
Dimensions in Inches

DIMENSIONAL OUTLINE FOR RCA-2N4069



Dimensions in Inches

TERMINAL DIAGRAM FOR RCA-2N4068 and 2N4069



Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector, Case

RCA RF TRANSISTORS
Low-Noise VHF/UHF "Forward-AGC" Type

2N4081

File No. 271

RCA 2N4081* is an epitaxial planar transistor of the silicon n-p-n type, with characteristics which make it very useful as a low-noise rf amplifier at frequencies up to 500 MHz. The 2N4081 is particularly useful for applications employing "forward-bias" AGC.

The RCA 2N4081 employs a New Terminal Arrangement in which the emitter and base connections are interchanged to provide maximum isolation between the output (collector) and the input (base) terminals. Although this new basing configuration does not appreciably change the measured device feedback capacitance, it permits the use of external inter-terminal shields to reduce the feedback due to external capacitances, particularly on printed circuit boards. This feature makes it possible to achieve greater circuit stability or higher useable gain per stage in critical circuit designs.

RCA 2N4081 features very low feedback capacitance, low noise, and high useful power gain. The high-temperature capability of this silicon device permits operation up to 200° C junction temperature.

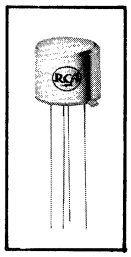
RCA 2N4081 utilizes a hermetically sealed JEDEC TO-104 metal case which is electrically isolated from the transistor electrodes. The case is provided with a separate lead which may be grounded to minimize collector-to-base interlead capacitance and coupling to other circuit components.

* Formerly Developmental No. TA-2860

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40 max	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	40 max	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max	V
COLLECTOR CURRENT, I_C	limited by dissipation	
TRANSISTOR DISSIPATION, P_T:		
At ambient temperatures: Up to 25° C	200 max	mW
Above 25° C	derate linearly at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage	-65 to +200	°C
Operating (junction)	-65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/16 inch from seating surface for 10 seconds max	265	°C

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

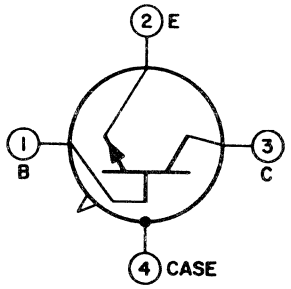


JEDEC TO-104

For Low-Noise VHF/UHF Applications in Industrial and Military Equipment Requiring "Forward-Bias" AGC

FEATURES

- New Terminal Arrangement — for superior high-frequency performance



Bottom View

1 - Base
2 - Emitter
3 - Collector
4 - Case

- controlled forward AGC characteristics — gain reduction (ΔG_{pe}) = 30 dB min for change in I_C from 2 mA to 11 mA
- low noise figure — NF = 3.5 dB max. at 200 MHz
- very low collector-to-base feedback capacitance — C_{cb} = 0.25 pF max.
- high unneutralized power gain — G_{pe} = 19 dB min. at 200 MHz
- hermetically sealed JEDEC TO-104 metal package

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N4081 5-67

ELECTRICAL CHARACTERISTICS, *At a Ambient Temperature (T_A) of 25°C*

Characteristics	Symbol	TEST CONDITIONS					LIMITS			Units
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N4081			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-	10	-	0	-	-	-	0.02	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	-	-	-	0	0.001	40	-	-	V
Collector-to-Emitter Breakdown Voltage $I_B = 0$	$V_{(BR)CEO}$	-	-	-	-	1	40	-	-	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CES}$	Emitter-Base Termination Shorted				0.001	40	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	-	-	-	-0.01	0	3	-	-	V
Static Forward Current-Transfer Ratio	h_{FE}	-	-	10	-	2	40	-	180	-
Magnitude of Small-Signal Forward Current Transfer Ratio	$\lvert h_{fe} \rvert$ [a]	1 kHz	-	10	-	2	40	-	200	-
		100	-	10	-	2	6	-	11	-
Collector-to-Base Feedback Capacitance	C_{cb} [b]	0.1 to 1	10	-	0	-	-	-	0.25	pF
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See *Fig.1*)	G_{pe} [a,d]	200	-	10	-	2	19	-	24	dB
Reduction in Small-Signal Power Gain with AGC (See *Fig.1*)	$\triangle G_{pe}$ [a]	For change in I_C from 2 mA to 11 mA					30	-	-	dB
Noise Figure [a,e] (See *Figs. 1 & 2*)	NF	200	R_S [c] = 200Ω	10	-	2	-	-	3.5	dB

[a] Lead No.4 (case) grounded.

[b] Three-terminal measurement: Lead No.2 (emitter) and lead No.4 (case) connected to guard terminal.

[c] R_s (Source Resistance) is the resistance looking back from the base terminal (1) toward the generator input.

[d] Power Gain (G_{pe}) value given was obtained by adjusting circuit tuning for maximum power output.

[e] Value of Noise Figure (NF) given was obtained by tuning the input circuit of Fig.1 for minimum NF. This tuning results in a value of Power Gain (G_{pe}) which is typically 1.5 dB lower than that obtained by tuning as in (d) above.

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TYPICAL Y-PARAMETER CHARACTERISTICS AS FUNCTIONS OF COLLECTOR CURRENT FOR 2N4081

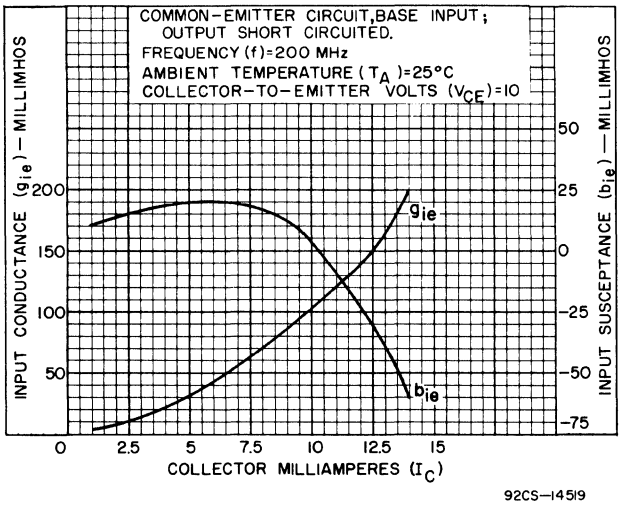


Fig.4 - Y_{ie} vs I_C

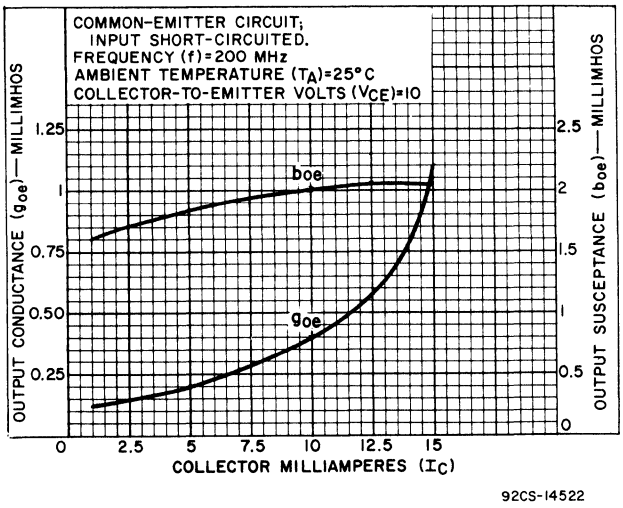


Fig.5 - Y_{oe} vs I_C

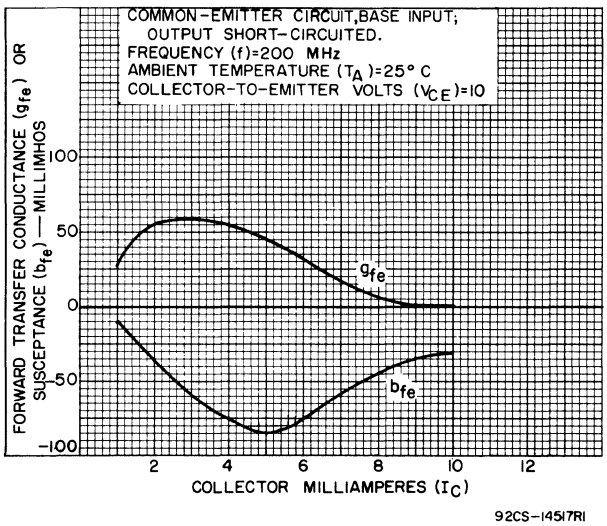


Fig.6 - Y_{fe} vs I_C

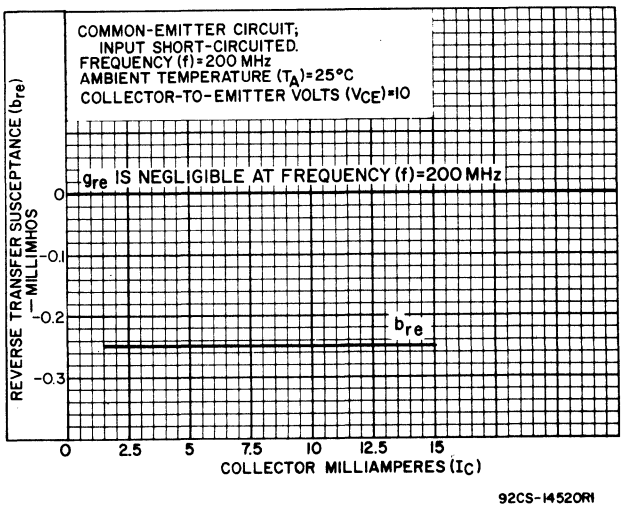


Fig.7 - Y_{re} vs I_C

TYPICAL Y-PARAMETER CHARACTERISTICS AS FUNCTIONS OF FREQUENCY FOR 2N4081

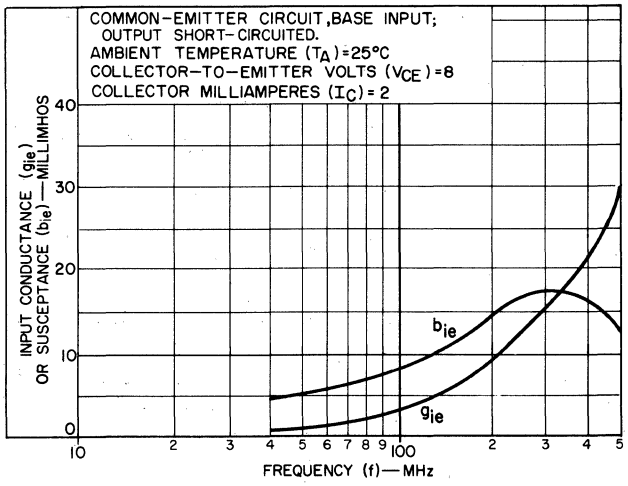


Fig.8 - Y_{ie} vs f

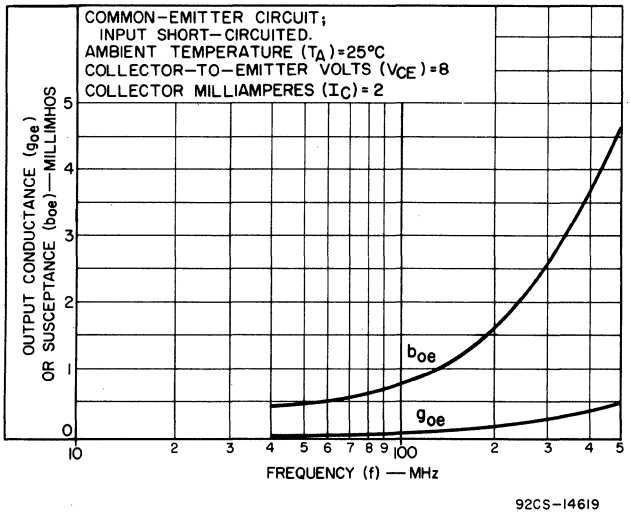


Fig.9 - Y_{oe} vs f

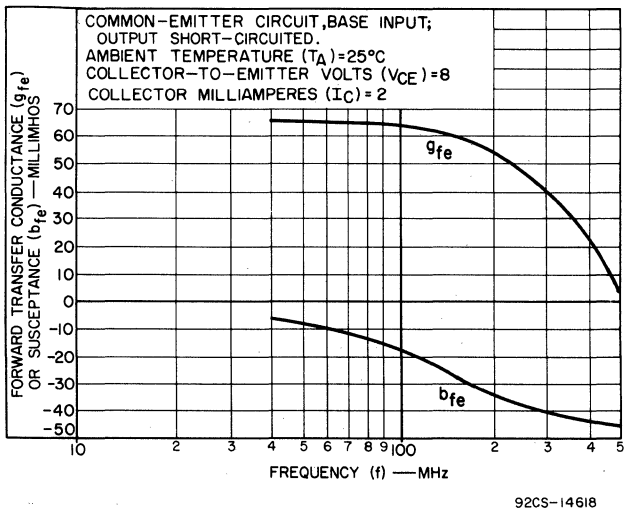


Fig.10 - Y_{fe} vs f

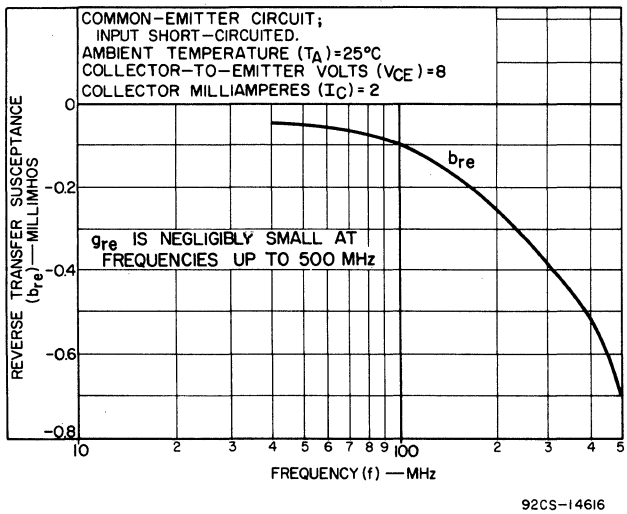
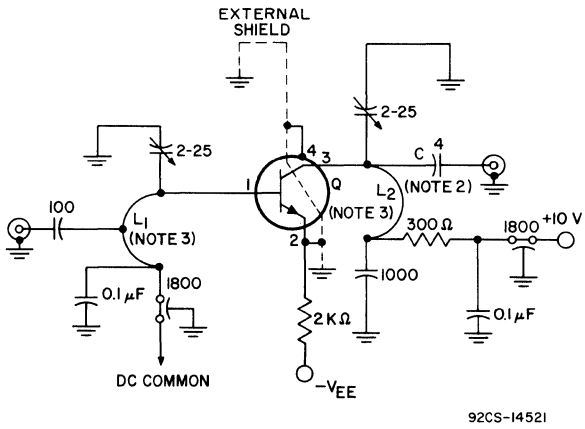


Fig.11 - Y_{re} vs f



Note 1: All capacitances in pF except where noted.

Note 2: Effective value of C from the collector terminal to the output connector is 4 pF. The actual capacitor is a ceramic button type with 7/8" lead length and labeled capacity of 3.3 pF.

Note 3: L_1 - 1/2 turn #14 AWG: Center-Tapped; total length = 2 inches.

L_2 - 1/2 turn #14 AWG: total length = 1-1/2 inches.

Q = 2N4081

Fig. 1 - 200-MHz Power Gain and Noise Figure test circuit for 2N4081.

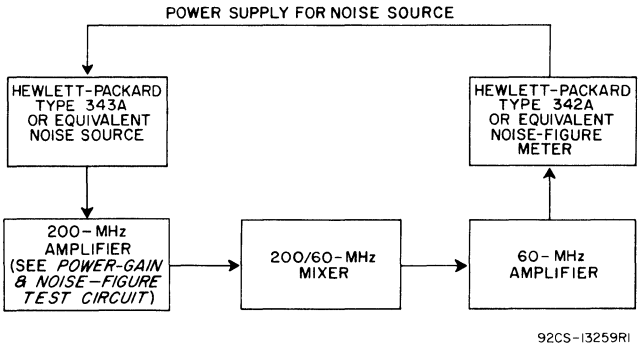


Fig. 2 - Block diagram of Noise-Figure test circuit for 2N4081.

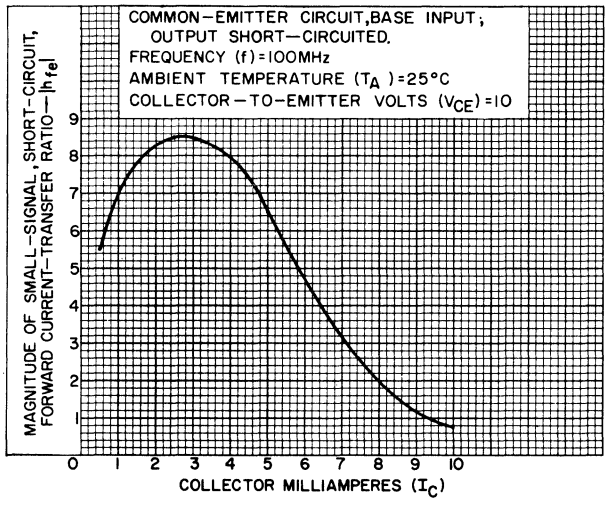
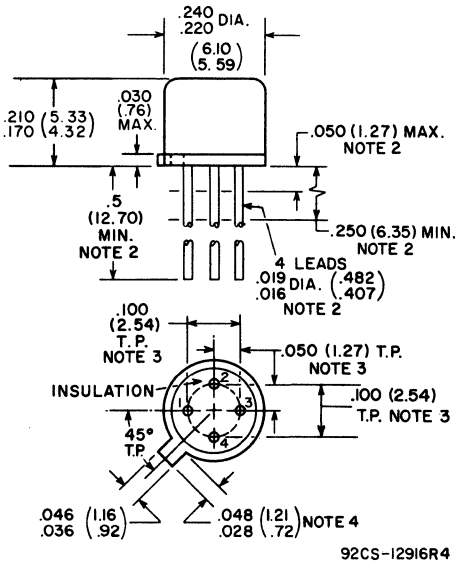


Fig. 3 - Typical Magnitude of Small-Signal Beta characteristic for 2N4081.

DIMENSIONAL OUTLINE
TO-104



Dimensions in Inches and Millimeters

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

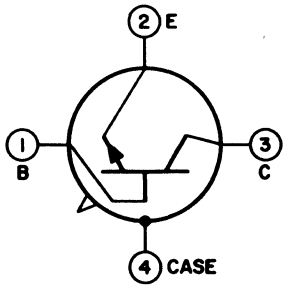
Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) +0.001" (0.025 mm) -0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

ATTENTION!
NEW TERMINAL ARRANGEMENT

Bottom View



1 - Base 3 - Collector

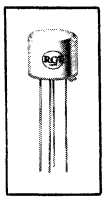
2 - Emitter 4 - Case

OPERATING CONSIDERATIONS

The flexible leads of the 2N4081 are usually soldered to the circuit elements. As in the case of any high-frequency semiconductor device, the tips of soldering irons should be grounded, and appropriate precautions should be taken to protect the device against high electric fields.

This device should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the device.

RF TRANSISTOR



Silicon NPN Epitaxial Planar Type For VHF and UHF Applications In Industrial and Military Equipment

RCA 2N4259* is an epitaxial planar transistor of the silicon n-p-n type, with characteristics which make it extremely useful as a general-purpose rf amplifier at frequencies up to 500 MHz.

These characteristics include low noise figure and high neutralized power gain at 450 MHz, low output capacitance, and high gain-bandwidth product.

The 2N4259 utilizes a compact, hermetically sealed four-lead metal package, in which the active elements of the transistor are insulated from the case. The construction of this device contributes to highly reliable performance at very-high and ultra-high frequencies, and permits grounding of the case to minimize feedback capacitance and undesired coupling—a feature not available in devices using epoxy-type enclosures.

Features:

- 100% tested for NOISE FIGURE (NF) and POWER GAIN (G_{pe}) at 450 MHz:
  - low noise figure – 5 dB max.
  - high power gain – 11.5 dB min.
- high gain-bandwidth product (f_T) – 1000 MHz typ.
- low feedback capacitance (C_{cb}) – 0.55 pF max.
- low collector-to-base time constant ($r_b'C_c$) – 8 ps max.
- hermetically sealed 4-lead metal package

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO}	40 max.	V
Collector-to-Emitter Voltage, V_{CEO}	30 max.	V
Emitter-to-Base Voltage, V_{EBO}	2.5 max.	V
Collector Current, I_C	Limited by Dissipation	
Transistor Dissipation, P_T:		
At ambient temperatures: up to 25°C	175 max.	mW
At ambient temperatures: above 25°C	See Fig.1	
Temperature Range:		
Storage and Operating (Junction)	-65 to +175	°C
Lead Temperature (During soldering):		
At distances not less than 1/16" from seating surface for 10 seconds	265 max.	°C

* Formerly Dev. No. TA2737

RATING CHART FOR RCA-2N4259

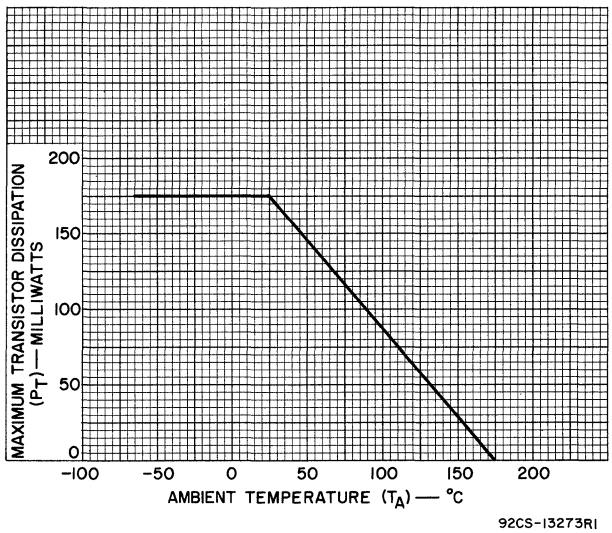


Fig. 1

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ELECTRICAL CHARACTERISTICS AT T_A = 25°C

CHARACTERISTICS	SYMBOLS	FREQUENCY f	DC COLLECTOR-TO-BASE VOLTAGE V_{CB}	DC COLLECTOR-TO-EMITTER VOLTAGE V_{CE}	DC EMITTER CURRENT I_E	DC COLLECTOR CURRENT I_C	TYPE 2N4259			UNITS
		MHz	V	V	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		15		0		-	-	0.01	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.001	40	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					1	30	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.001	0	2.5	-	-	V
Static Forward Current-Transfer Ratio	h_{FE}			8		2	60	-	250	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	0.001 100▲		8 8		2 2	70 7.5	- -	280 16	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1-1◈	8		0	-	-	0.35	0.55	pF
Collector-to-Base Time Constant	$r_b'C_c$	31.9▲	8		2		1	-	8	ps
Small-Signal, Common-Emitter Power Gain (See Fig.2)	G_{pe}	450▲		8		1.5	11.5	-	16.5	dB
Measured UHF Noise Figure* (See Figs.2 & 3)	NF	450▲		8		1.5	-	-	5	dB

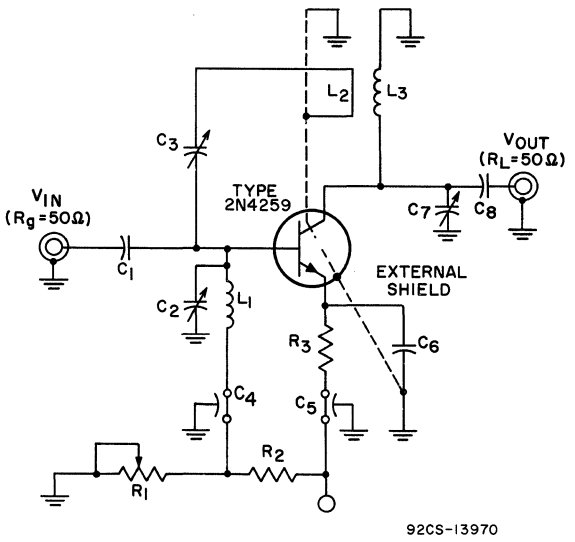
▲ Lead No.4 (Case) grounded.

◈ Three-terminal capacitance measurement with lead No.1 (Emitter) and lead No.4 (Case) connected to guard terminal.

† Neutralization adjusted and fixed for a transistor having a typical value of C_{cb} (0.35 pF).

* Source resistance as seen by transistor = 100 Ω. Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test amplifier and the contribution of the following stages in the test setup.

NEUTRALIZED AMPLIFIER CIRCUIT USED TO MEASURE 450-MHz GAIN AND NOISE FIGURE FOR RCA-2N4259



C_1 - 7.5 pF (effective value from socket terminal to input connector) CERAMIC TUBULAR

C_2, C_7 - 1.5-9.6 pF VARIABLE AIR CAPACITOR HAMMARLUND TYPE MAC-10 OR EQUIVALENT

C_3 - PLASTIC TUBULAR TRIMMER CAPACITOR [Adjusted and fixed for a transistor having a typical value of C_{cb} (0.35 pF)]

C_4 - 200 pF BUTTON-TYPE FEEDTHROUGH CAPACITOR

C_5 - 1000 pF FEEDTHROUGH CAPACITOR

C_6 - 470 pF LEADLESS CERAMIC DISK CAPACITOR

C_8 - 2.5 pF (effective value from socket terminal to output connector) CERAMIC TUBULAR

L_1, L_3 - 1" LENGTH OF 1/4"-DIAMETER COPPER BAR STOCK

L_2 - 1/2 LOOP No.14 AWG ENAMELED WIRE PARALLEL TO AND APPROXIMATELY 1/4" FROM L_3

R_1 - 5 kΩ POTENTIOMETER

R_2 - 1.2 kΩ

R_3 - 2 kΩ

Fig.2

BLOCK DIAGRAM OF NOISE-FIGURE TEST CIRCUIT FOR RCA-2N4259

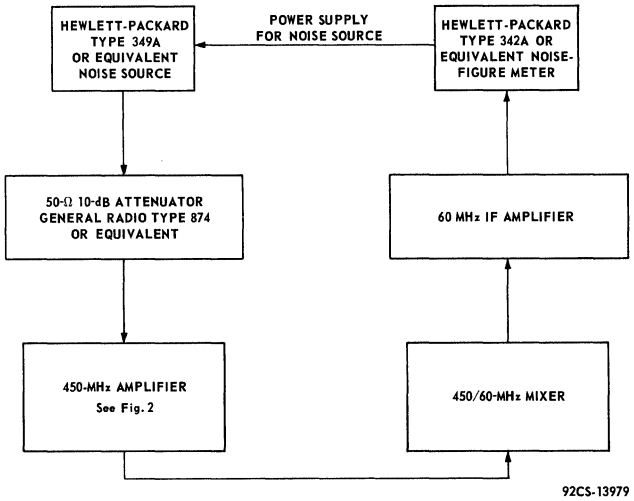


Fig.3

TYPICAL SMALL-SIGNAL BETA (100 MHz h_{fe}) CHARACTERISTICS vs. COLLECTOR CURRENT FOR RCA-2N4259

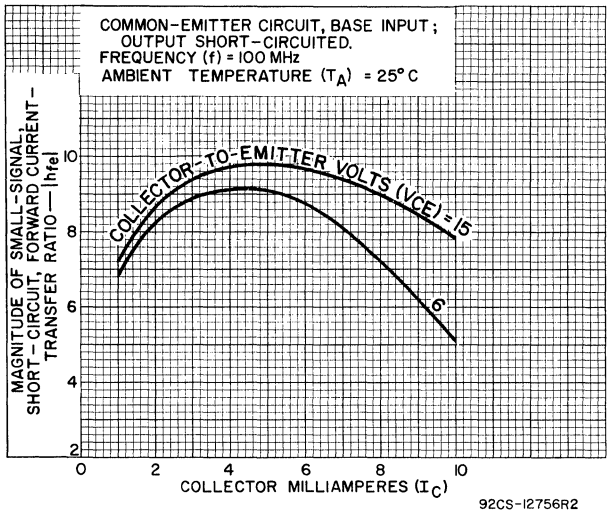


Fig.4

TYPICAL TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF FREQUENCY (f) FOR RCA-2N4259

INPUT-ADMITTANCE (y_{ie})

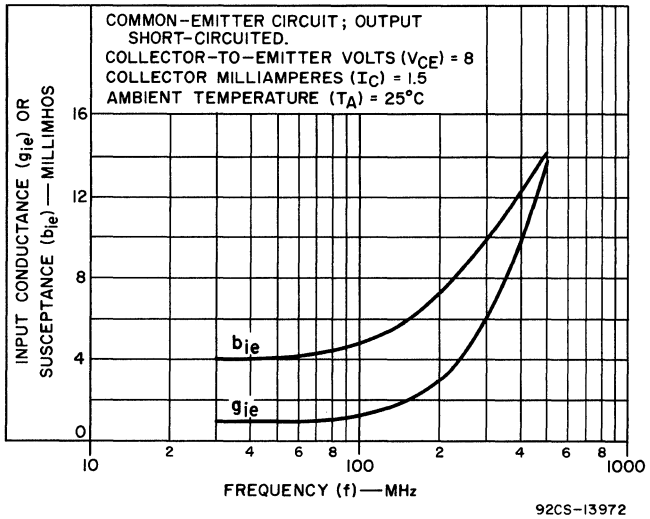


Fig.5

FORWARD-TRANSADMITTANCE (y_{fe})

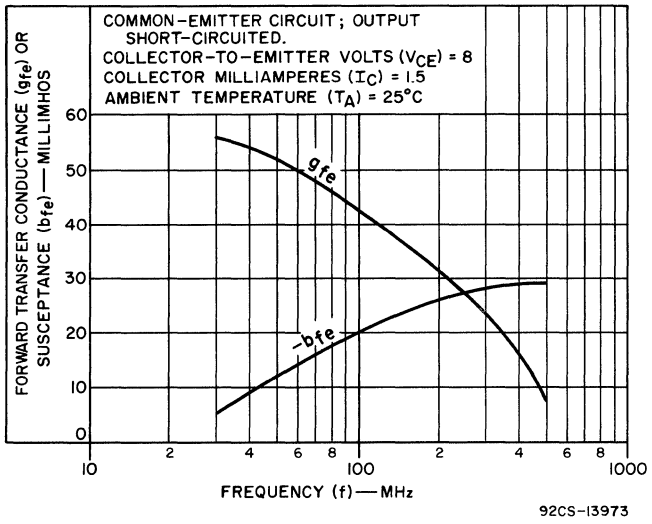


Fig.6

OUTPUT-ADMITTANCE (y_{oe})

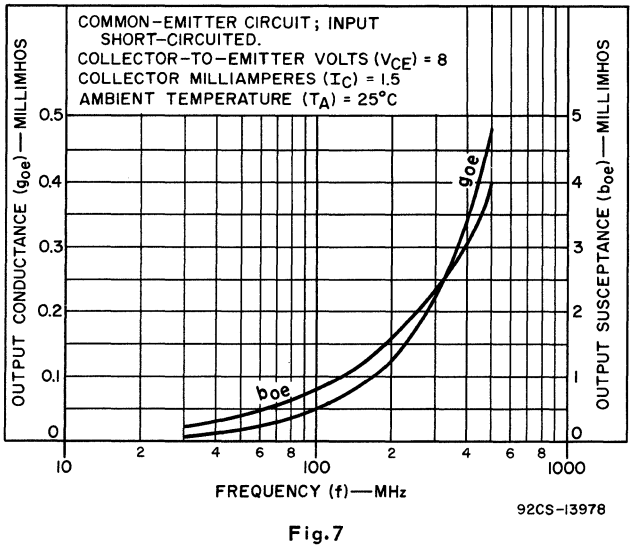


Fig.7

REVERSE-TRANSADMITTANCE (y_{re})

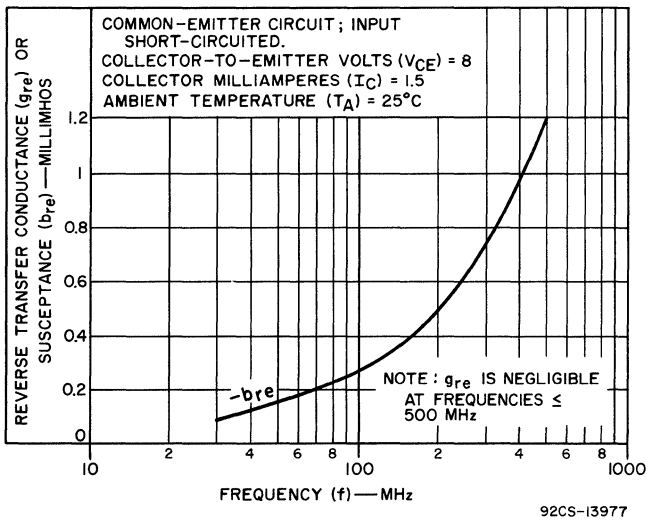


Fig.8

TYPICAL TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF COLLECTOR CURRENT (I_C) FOR RCA-2N4259

INPUT-ADMITTANCE (y_{ie})

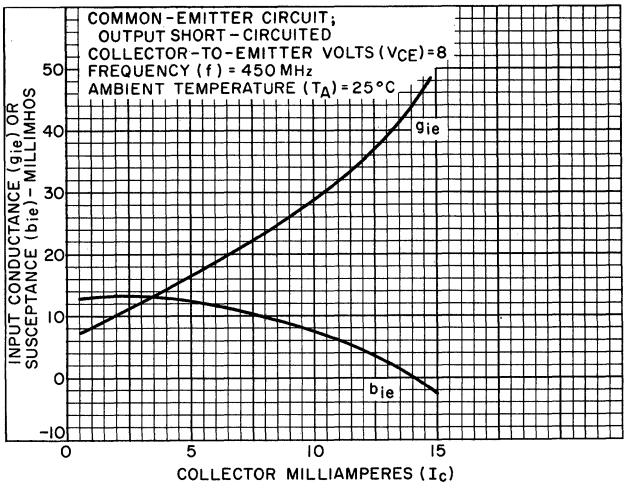


Fig.9

FORWARD-TRANSADMITTANCE (y_{fe})

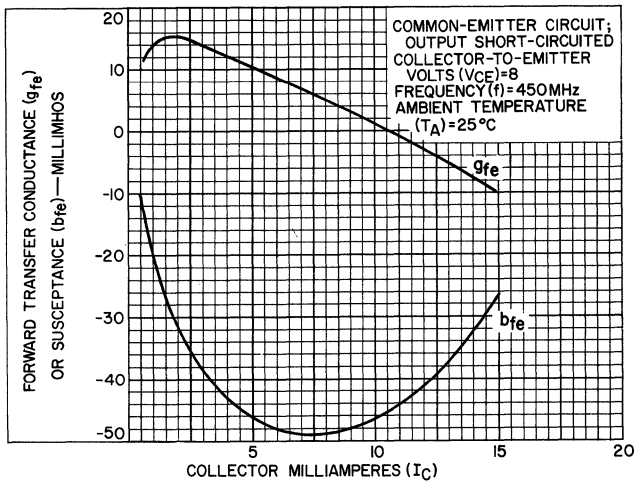


Fig.10

OUTPUT-ADMITTANCE (y_{oe})

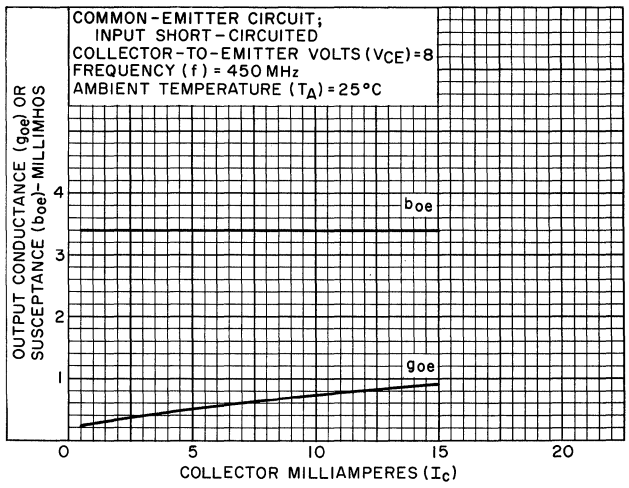


Fig.11

REVERSE-TRANSADMITTANCE (y_{re})

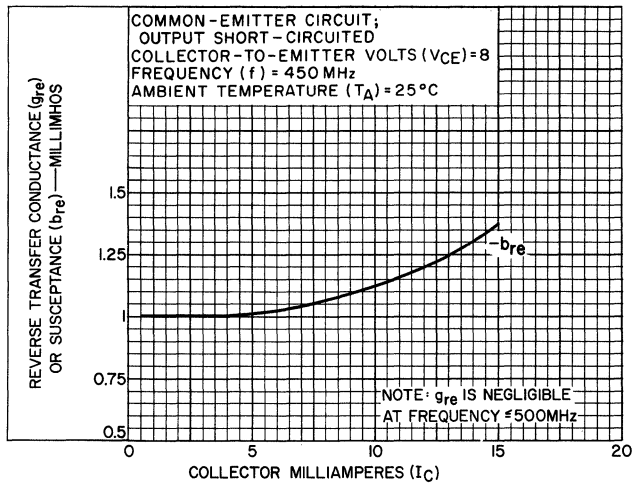
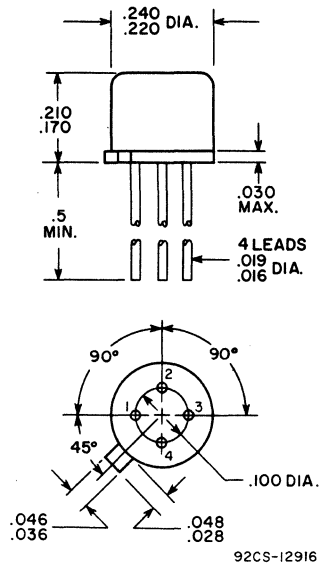


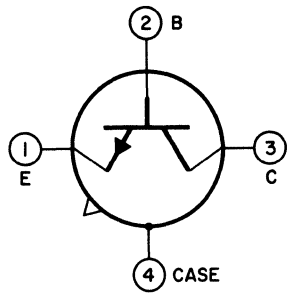
Fig.12

DIMENSIONAL OUTLINE
RCA-2N4259



Dimensions in Inches

TERMINAL DIAGRAM



Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector
Lead 4 - Connected to Case

Bottom View

RCA POWER TRANSISTORS

2N4296 2N4297
2N4298 2N4299

File No. 201

RCA-2N4296, 2N4297, 2N4298, and 2N4299* are high-voltage power transistors of the triple-diffused silicon npn type, suitable for a wide variety of applications in military, industrial, and commercial equipment.

Their ability to dissipate up to 20 watts of power and to sustain collector voltages up to 350 volts make them highly desirable for power amplifier service in line-operated equipment. In this type of service, their low feedback capacitance and high gain-bandwidth product can provide low distortion and excellent frequency-response characteristics.

The unique combination of low saturation voltages, short switching times and high voltage ratings make the 2N4296, 2N4297, 2N4298, and 2N4299 excellent devices for use in switching circuits, static inverters, and dc regulators.

These transistors are hermetically sealed devices, utilizing the JEDEC TO-66 flanged metal package, and can be operated over the temperature range from -65 to +175°C. A mica insulator and two insulating shoulder washers (see Fig.16) are supplied with each transistor.

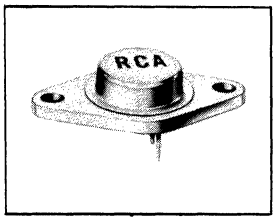
*Formerly Developmental Types TA2863, TA2863A, TA2864, and TA2864A, respectively.

Maximum Ratings, *Absolute-Maximum Values:*

	2N4296 2N4297	2N4298 2N4299		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	350	500	max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	250	350	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4	max.	V
COLLECTOR CURRENT, I_C	1	1	max.	A
BASE CURRENT, I_B	0.25	0.25	max.	A
TRANSISTOR DISSIPATION, P_T:				
At mounting-flange temperatures[a] up to 25°C	20	20	max.	W
above 25°C		See Fig.1		
At ambient temperatures up to 55°C	2	2	max.	W
above 55°C		See Fig.1		
TEMPERATURE RANGE:				
Storage and operating (junction)		-65 to +175		°C
LEAD TEMPERATURE (During soldering):				
At distances not closer than 1/16 inch to seating surface for 10 seconds maximum	265	265	max.	°C

[a]Measured at center of seating surface.

SILICON NPN HIGH-VOLTAGE POWER TRANSISTORS



For Critical Amplifier & Switching Applications In Military, Industrial & Commercial Equipment

APPLICATIONS:

- low-distortion, wide-band amplifiers in line-operated equipment
- series dc voltage regulators
- video amplifiers and color-difference amplifiers in TV camera chains and monitors
- relay drivers
- high-speed, high-level switches in static power converters and inverters: low-voltage dc to high-voltage dc or ac; high-voltage dc-to-dc converters

FEATURES:

- high voltage, current, and dissipation ratings:
  - V_{CBO} = 500 V max for 2N4298 and 2N4299; 350 V max for 2N4296 and 2N4297
  - I_C = 1 A max for all types
  - P_T = 20 W max for all types
- high sustaining voltages:
  - $V_{CEO(sus)}$ = 350 V min for 2N4298 and 2N4299; 250 V min for 2N4296 and 2N4297
- low saturation voltages:
  - $V_{CE(sat)}$ = 0.75 V max for 2N4297 and 2N4299; 0.9 V max for 2N4296 and 2N4298
  - $V_{BE(sat)}$ = 1.5 V max for all types
- low feedback capacitance:
  - C_{cb} = 3.8 pF typ, 6 pF max for all types
- high f_T = 20 MHz min for all types
- high switching speed:
  - t_{on} = 5 μs typ, 7 μs max
  - t_{off} = 7 μs typ, 10 μs max
  - for all types
- large area mounting flange for low thermal resistance:
  - θ_{J-C} = 7.5 °C/W max
- hardware for insulated mounting with each device

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A. 5-66
2N4296 — 2N4299

ELECTRICAL CHARACTERISTICS, at a Mounting Flange Temperature (T_{MF}) of 25°C unless otherwise specified.

Characteristics	Symbols	TEST CONDITIONS				LIMITS												Units
		DC Base-To-Emitter Voltage V_{BE}	DC Collector-To-Emitter Voltage V_{CE}	DC Base Current I_B	DC Collector Current I_C	TYPE 2N4296			TYPE 2N4297			TYPE 2N4298			TYPE 2N4299			
		V	V	mA	mA	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Collector-Cutoff Current	I_{CBO}		V_{CB} = 350 500			- -	- -	100 -	- -	- -	100 -	- -	- -	- 100	- -	- -	- 100	μA μA
Collector-Cutoff Current (T_{MF} = 135°C)	I_{CEV}	-1.5	150			-	-	600	-	-	600	-	-	600	-	-	600	μA
Emitter-Cutoff Current	I_{EBO}	-4			0	-	-	100	-	-	100	-	-	100	-	-	100	μA
Base-to-Emitter Voltage	V_{BE}		10		100	-	-	0.9	-	-	0.9	-	-	0.9	-	-	0.9	V
Collector-to-Emitter Sustaining Voltage (See Fig.2)	$V_{CEO(sus)}$			0	50	250	-	-	250	-	-	350	-	-	350	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			5	50	-	-	0.9	-	-	0.75	-	-	0.9	-	-	0.75	V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$			5	50	-	-	1.5	-	-	1.5	-	-	1.5	-	-	1.5	V
"Second-Breakdown" Collector Current*	$I_{C(s/b)}$		200			75	-	-	75	-	-	75	-	-	75	-	-	mA
Static Forward Current-Transfer Ratio	h_{FE}		10		5	35	-	-	50	-	-	20	-	-	35	-	-	
			10		50	50	80	150	75	100	300	25	30	75	50	80	150	
			10		100	35	-	-	50	-	-	20	-	-	35	-	-	
Small-Signal Forward Current-Transfer Ratio (f = 5 mHz)	h_{fe}		10		20	4	6	-	4	6	-	4	6	-	4	6	-	
Collector-to-Base Feedback Capacitance** (Emitter Open) (f = 0.1 to 1 MHz)	C_{cb}		V_{CB} = 100		0	-	3.8	6	-	3.8	6	-	3.8	6	-	3.8	6	pF
Turn-On Time (See Fig.3 for Test Circuit)	t_{on} ($t_d + t_r$)	V_{BB} = 10	V_{CC} = 100	I_{B1} = 10 I_{B2} = -10		-	5	7	-	5	7	-	5	7	-	5	7	μs
Turn-Off Time (See Fig.3 for Test Circuit)	t_{off} ($t_s + t_c$)	V_{BB} = 10	V_{CC} = 100	I_{B1} = 10 I_{B2} = -10	100	-	7	10	-	7	10	-	7	10	-	7	10	μs
Extrinsic Base-Lead Resistance	$r_{bb'}$		50		20	-	15	25	-	15	25	-	15	25	-	15	25	Ω
Thermal Resistance: Junction-to-Case	θ_{J-C}					-	-	7.5	-	-	7.5	-	-	7.5	-	-	7.5	°C/W
Thermal Resistance: Junction-to-Ambient	θ_{J-A}					-	-	60	-	-	60	-	-	60	-	-	60	°C/W

*See "SECOND BREAKDOWN" on Page 6.

**C_{cb} is a three terminal measurement of the collector-to-base capacitance with lead 1 (emitter) connected to the guard terminal.

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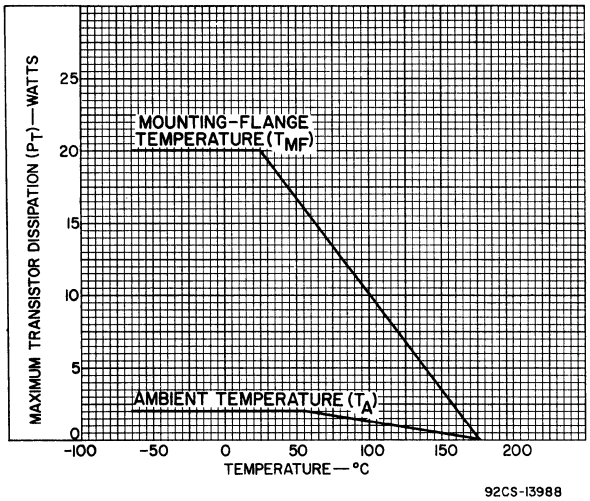


Fig.1 - Rating Chart for RCA 2N4296, 2N4297, 2N4298, and 2N4299.

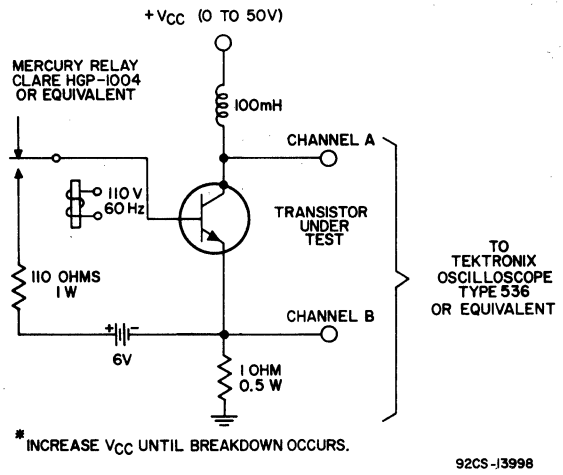
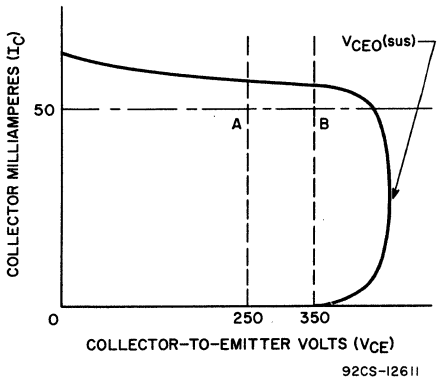


Fig.2a - Circuit used to measure Sustaining Voltage $V_{CEO}(sus)$.



The sustaining voltage $V_{CEO}(sus)$ is acceptable when the trace falls to the right of and above point "A" for types 2N4296 and 2N4297, and to the right of and above point "B" for types 2N4298 and 2N4299.

Fig.2b - Oscilloscope Display for measurement of $V_{CEO}(sus)$ (Test Circuit shown in Fig.2a).

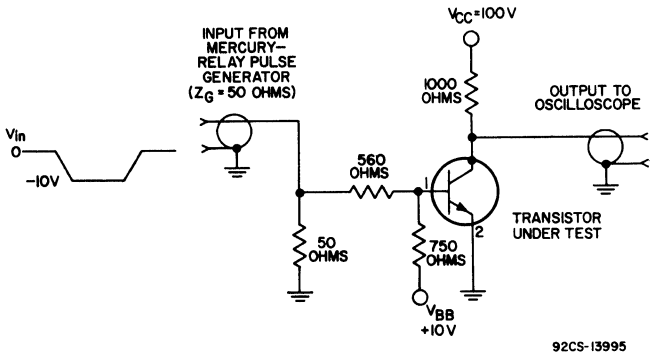


Fig.3a - Circuit used to measure Switching Times for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

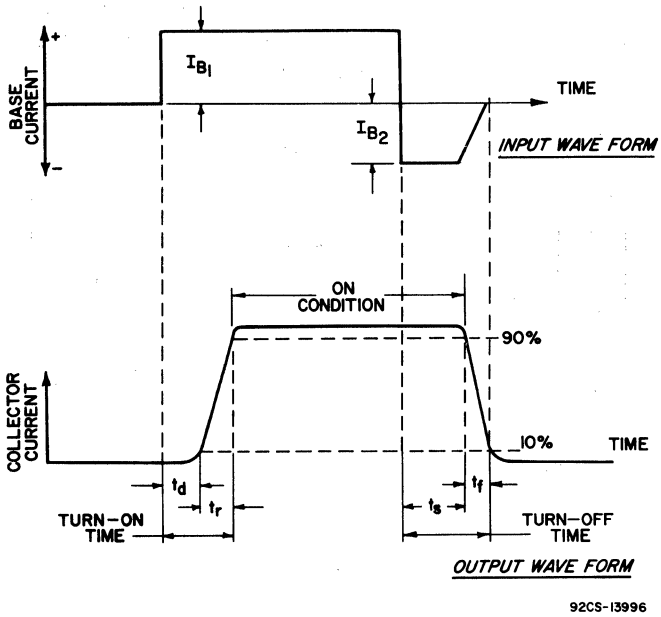


Fig.3b - Oscilloscope display for measurement of Switching Times (Test Circuit shown in Fig.3a)

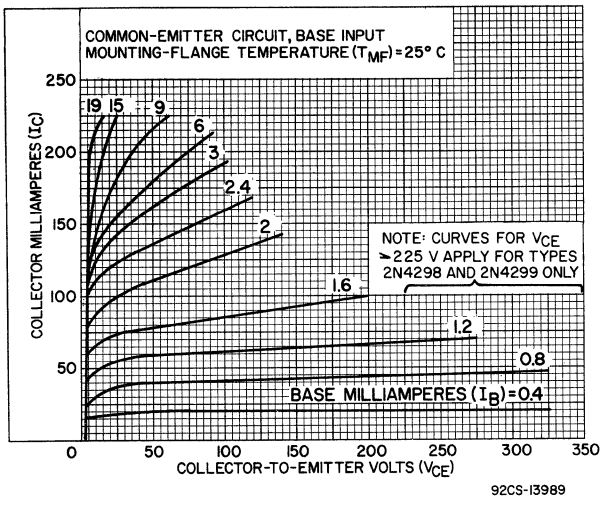


Fig.4 - Typical Collector Characteristics for RCA 2N4296, 2N4297, 2N4298, and 2N4299.

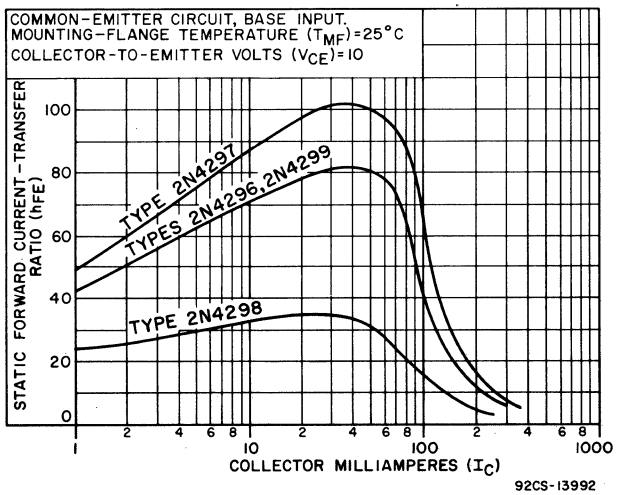


Fig.5 - Typical 25°C Static Forward Current-Transfer Ratio Characteristics for RCA 2N4296, 2N4297, 2N4298, and 2N4299.

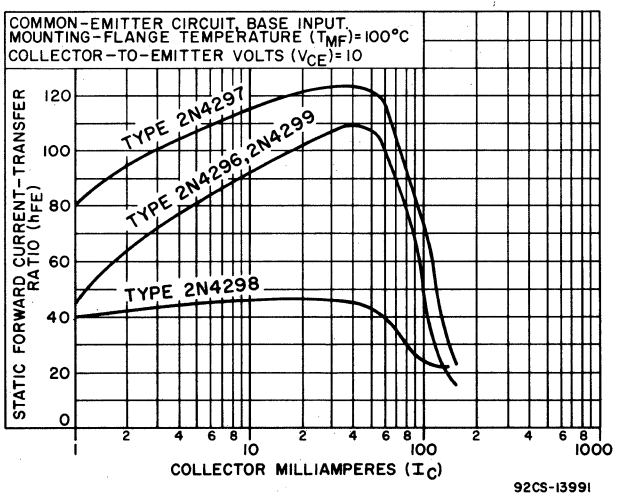


Fig.6 - Typical High-Temperature Static Forward Current Transfer Ratio Characteristics for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

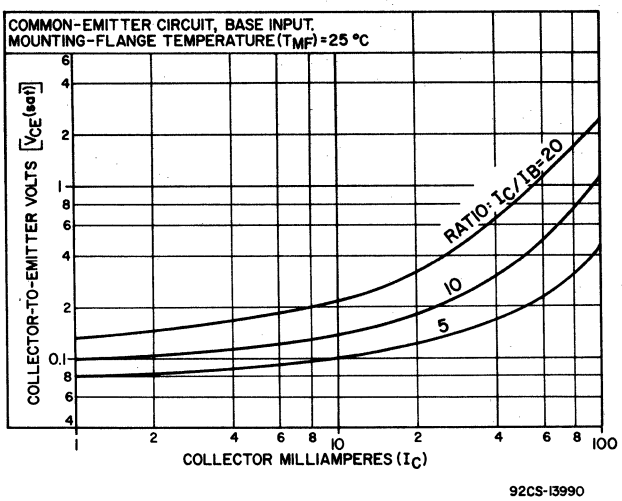


Fig.7 - Typical $V_{CE}(sat)$ vs I_C for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

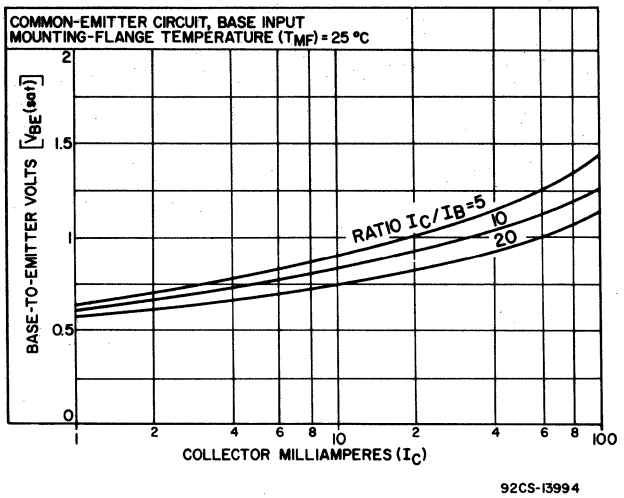


Fig.8 - Typical $V_{BE}(sat)$ vs I_C for RCA-2N4296, 2N4297, 2N4298, and 2N4299

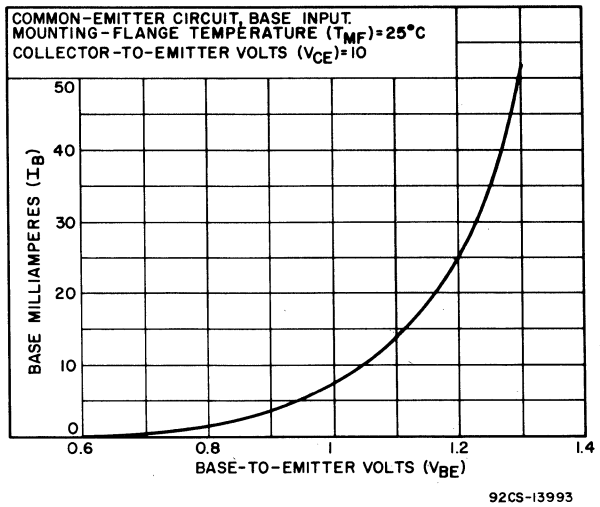


Fig.9 - Typical Input Characteristic for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

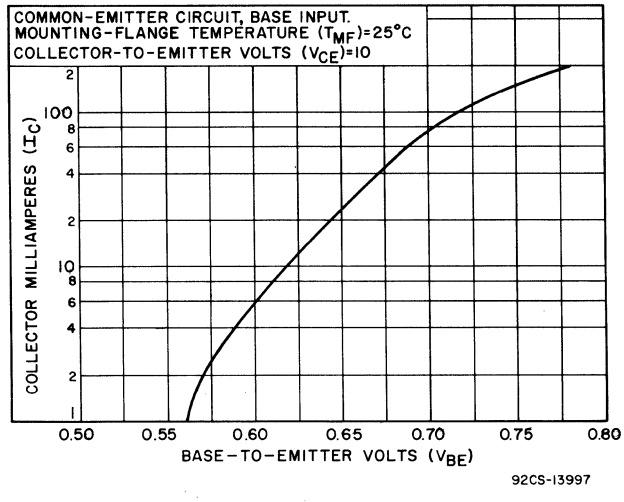
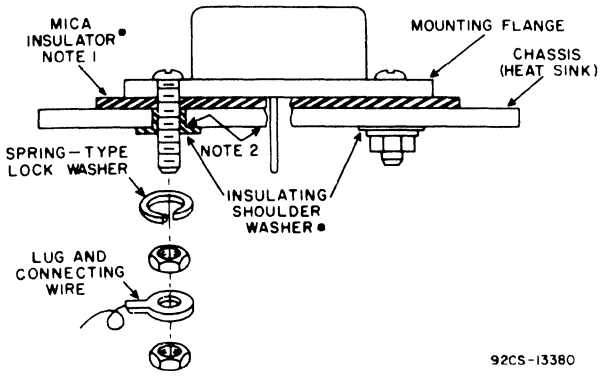


Fig.10 - Typical Transfer Characteristic for RCA-2N4296, 2N4297, 2N4298, and 2N4299.



NOTE 1: 0.002" thick mica or anodized aluminum insulator drilled or punched with burrs removed.

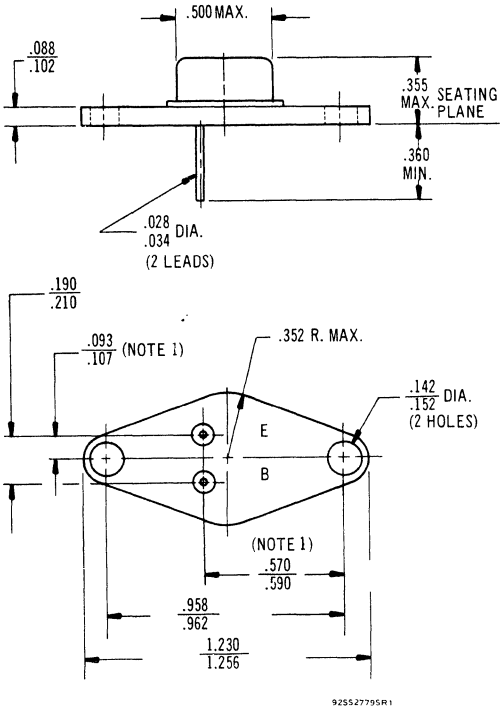
NOTE 2: Remove burrs from chassis holes.

• Supplied with each Transistor.

Types 2N4296 – 2N4299 fit socket PTS-4 (United International Dynamics Corp., 2029 Taft St., Hollywood, Fla.), or equivalent.

Fig.16 - Suggested Mounting Arrangement for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

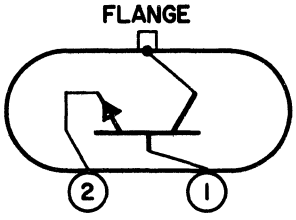
DIMENSIONAL OUTLINE
2N4296, 2N4297, 2N4298, 2N4299
JEDEC TO-66



Dimensions in Inches

NOTE 1: MEASURED AT SEATING PLANE

TERMINAL DIAGRAM
2N4296, 2N4297, 2N4298, 2N4299



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

RCA-2N4296, 2N4297, 2N4298, 2N4299

RCA POWER TRANSISTORS

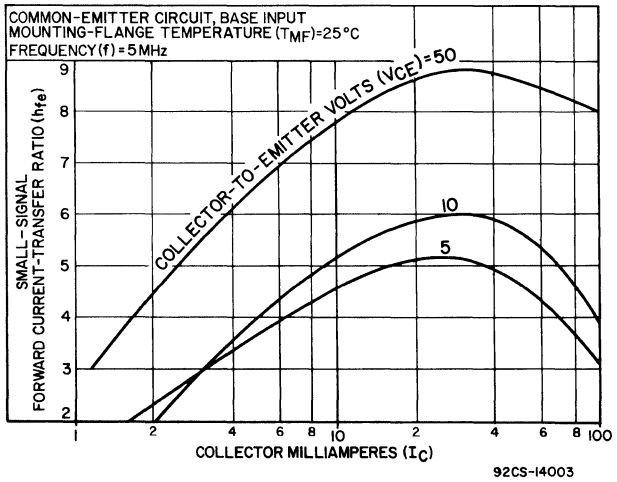


Fig.11 - Typical Small-Signal Beta Characteristics for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

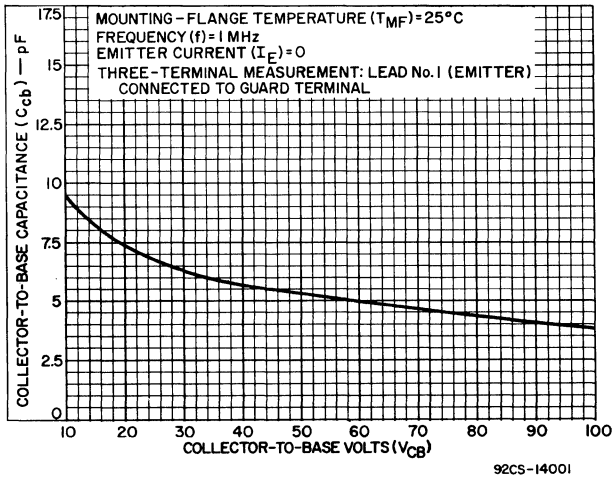


Fig.12 - Typical Collector-to-Base Feedback Capacitance vs Collector-to-Base Voltage for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

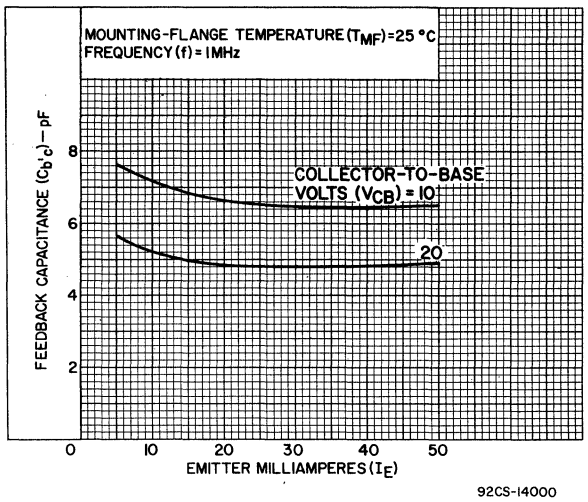


Fig.13 - Typical Feedback Capacitance vs Emitter Current for RCA-2N4296, 2N4297, 2N4298, and 2N4299.

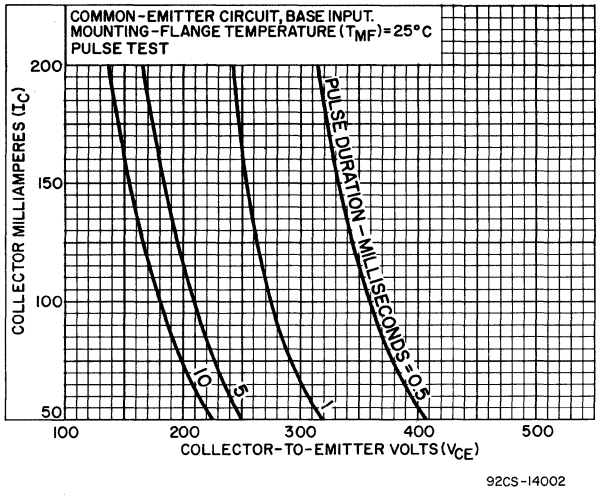


Fig.14 - Typical Forward-Bias Power-Handling Capabilities of RCA-2N4296, 2N4297, 2N4298, and 2N4299, in Second-Breakdown Region.

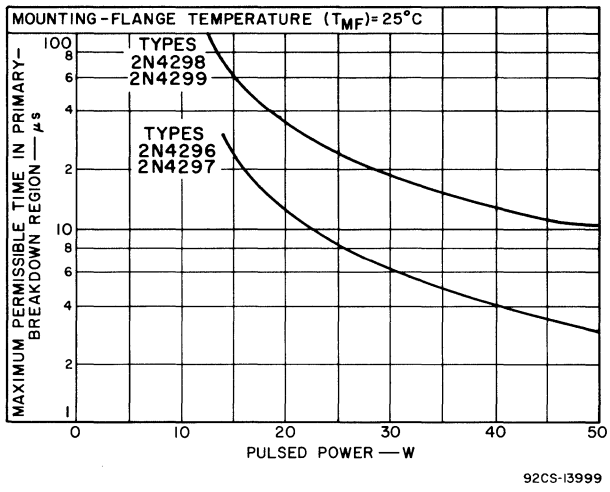


Fig.15 - Typical Reverse-Bias Power-Handling Capabilities of RCA-2N4296, 2N4297, 2N4298, and 2N4299, in Second-Breakdown Region.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

The devices described in this bulletin should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the devices.

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

It is essential that the mounting flanges of the 2N4296, 2N4297, 2N4298, and 2N4299 which are internally connected to the collectors, be securely fastened to heat sinks, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE TRANSISTOR.

The mounting-flange temperature of the 2N4296, 2N4297, 2N4298, and 2N4299 will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the transistor-mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

In applications where the 2N4296, 2N4297, 2N4298, or 2N4299 is mounted on a chassis which is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized aluminum washer having high thermal conductivity, or a 0.002" thick mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the emitter lead and base lead. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that an insulating washer be used between each bolt and the chassis.

A suggested mounting arrangement is shown in Fig.16.

SECOND BREAKDOWN

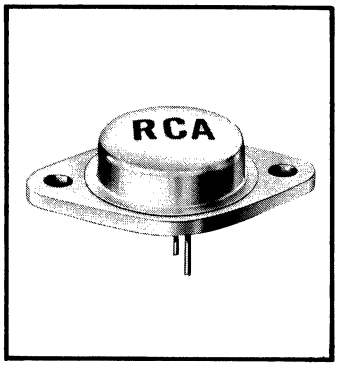
Second breakdown in transistors is characterized by a sudden drop in the collector voltage and a sudden increase in the collector current. Because this current is very high (greater than 1 ampere), the power level is also very high and transistors subjected to this condition will almost always be permanently damaged. The phenomenon of second breakdown is not completely understood and various theories have been presented as to why it occurs. However, the damaging effects of this phenomenon are clearly evident and are manifested as small "burn" or "hot" spots in areas of minute crystallographic defects or non-uniform impurity regions in the base and active collector regions. At these burn spots, the silicon material actually melts and forms a collector-to-emitter short circuit. The high temperatures that produce these burn spots are caused by thermal runaway. To determine the second-breakdown threshold, the circuit designer should have a method of measuring the energy-dissipating capability of the transistor.

Additional information on Second Breakdown is given in RCA Application Notes SMA-30 "Second-Breakdown in Transistors under conditions of Cutoff" and AN204 "Operation of Memory-Core-Driver Transistors in the Primary-Voltage Breakdown Region.

RCA POWER TRANSISTORS

2N4347
2N3442

"HOMETAXIAL"-BASE* SILICON N-P-N HIGH-VOLTAGE POWER TRANSISTORS



JEDEC TO-3

RCA-2N4347 and 2N3442** are Hometaxial-base,* silicon n-p-n transistors intended for a wide variety of high-power, high-voltage applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

Both devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

*"Hometaxial" was coined by RCA from "homogeneous" and "axial." Hometaxial types employ a structure in which the base region has homogeneous resistivity silicon material in the axial direction (emitter-to-collector). These devices are made by using the single-diffused process.

**Formerly Dev. Type Nos. TA2809, and TA2468A, respectively.

NEW!

Maximum area-of-operation curves for DC & pulse operation

Derating curves for $I_{s/b}$-limited and dissipation-limited operation

Now possible to determine maximum operating conditions for operation free from second breakdown

General-Purpose Types for Military, Industrial, and Commercial Applications

2N4347
- High dissipation capability -- 100 W
- V_{CEV}(sus) = 140 V min.
- R(sat) = 0.5 Ω max.

2N3442
- High dissipation capability -- 117 W
- V_{CEV}(sus) = 160 V min.
- R(sat) = 0.33 Ω max.

MAXIMUM RATINGS

Absolute-Maximum Values		2N4347	2N3442	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With -1.5 V (V_{BE}) of reverse bias	V_{CEV}	140	160	V
With base open	V_{CEO}	120	140	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	10	A
PEAK COLLECTOR CURRENT	–	10	15	A
CONTINUOUS BASE CURRENT	I_B	3	7	A
TRANSISTOR DISSIPATION:	P_T			
At case temperature up to 25°C		100	117	W
At case temperature above 25°C		See Figs. 1 & 2.	See Figs. 2 & 3.	
TEMPERATURE RANGE:				
Storage & Operating (Junction)		-65 to 200		°C
PIN TEMPERATURE (During soldering):				
At distance ≥1/32" from seating plane for 10 s max.		255	255	°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.

2N4347 & 2N3442 6/66
Supersedes 2N3442 Data included in 2N3440 bulletin dated 6/64

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS				Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Type 2N4347		Type 2N3442		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	140					0		-	-	-	1	mA
	I_{CEV}		120		-1.5				-	2	-	-	mA
	I_{CEV}		140		-1.5				-	-	-	1	mA
At T_C = 150°C	I_{CEV}		120		-1.5				-	10	-	-	mA
	I_{CEV}		140		-1.5				-	-	-	10	mA
Emitter-Cutoff Current	I_{EBO}			7		0			-	5	-	5	mA
DC Forward-Current Transfer Ratio	h_{FE}		4			2			20	70	-	-	
			4			3			-	-	20	70	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 7 & 8.)* With base open	$V_{CEO}(sus)$					0.2 to 3		0	120[a]	-	140[a]	-	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$				-1.5	0.1 to 1.5			140[a]	-	160[a]	-	V
Base-to-Emitter Voltage	V_{BE}		4			2			-	2.0	-	-	V
			4			3						1.7	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					2		0.2	-	1.0	-	-	V
						3		0.3				1.0	V
Power Rating Test	PRT		67			1.5			1.0[b]	-	-	-	s
			78			1.5			-	-	1.0[c]	-	s
Thermal Resistance: Junction-to-Case	θ_{J-C}								-	1.75	-	1.5	°C/W

[a] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CEV}(sus)$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig.7.

[b] At 100 W. [c] At 117 W.

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MAXIMUM OPERATING AREAS FOR TYPE 2N4347

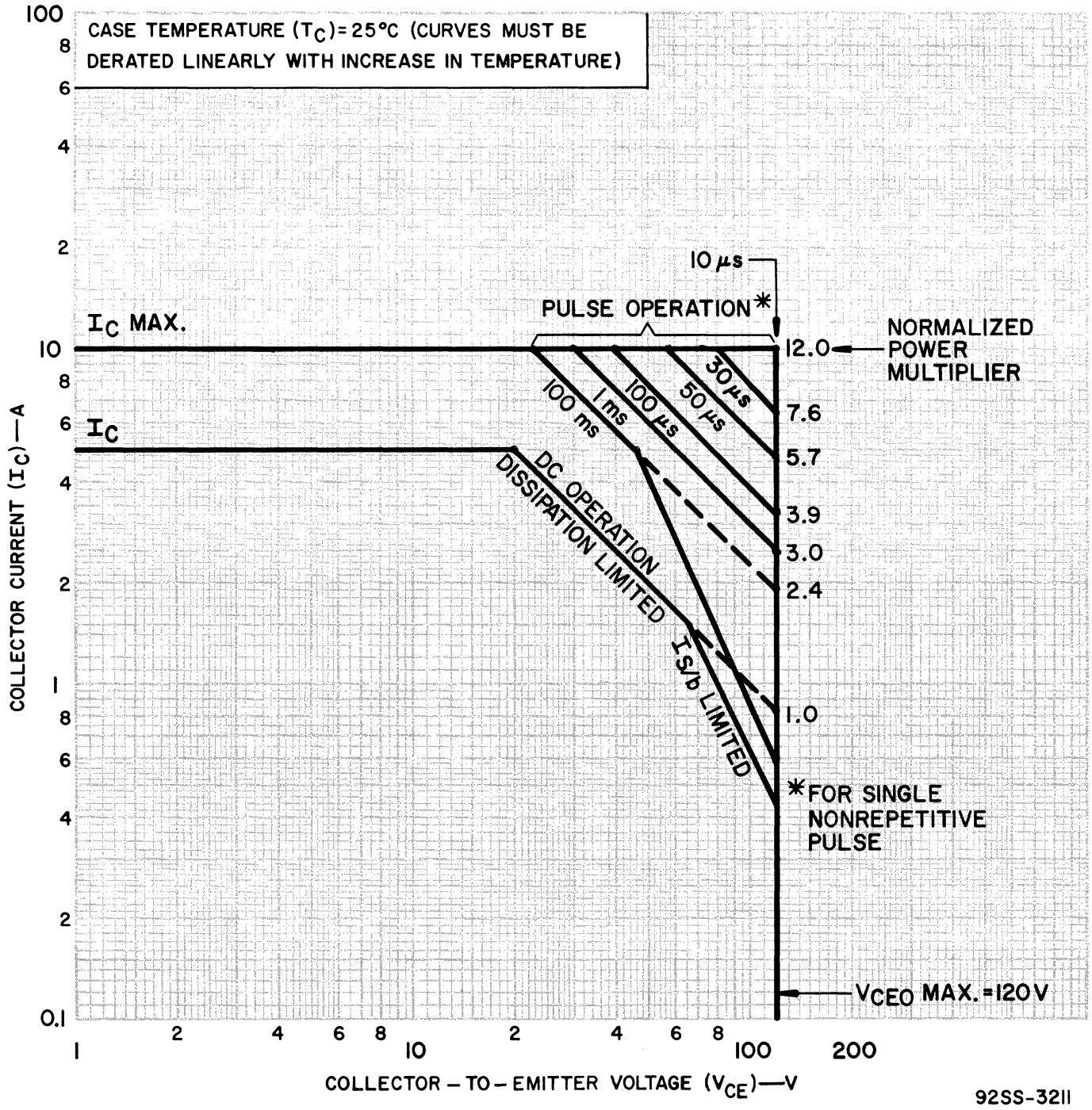


Fig. 1

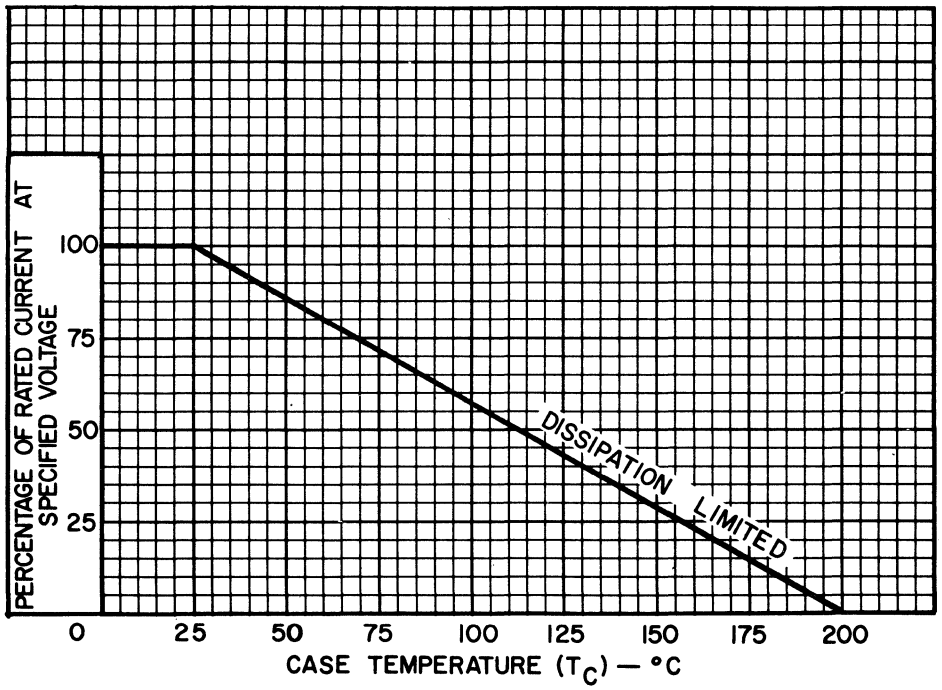
MAXIMUM AREA-OF-OPERATION

The maximum-operating-area curves for the 2N4347 and 2N3442 shown in Figures 1 and 3, respectively, have a slope equal to -1 on a log-log plot when a thermal limitation exists and a slope equal to -2 when a second-breakdown limitation exists.

Figures 1 and 3 show constant-slope (constant-power) lines for pulse conditions shorter than 1 ms. However, for longer pulse widths, the area of operation is bounded by a line having a slope approximately equal to -2. In addition to the boundary showing a second-breakdown limitation, an extension of the dissipation-limited boundary line (for derating) is shown as a dashed line.

The second-breakdown limitation need not be derated with temperature. Since, all ratings shown are based upon a case temperature of 25°C, all boundary lines and their dashed-line extensions must be derated linearly to zero at case temperature of 200°C; see Figure 2.

DISSIPATION DERATING CURVE
FOR TYPES 2N4347 & 2N3442



92LS-1469

Fig. 2

MAXIMUM OPERATING AREAS FOR TYPE 2N3442

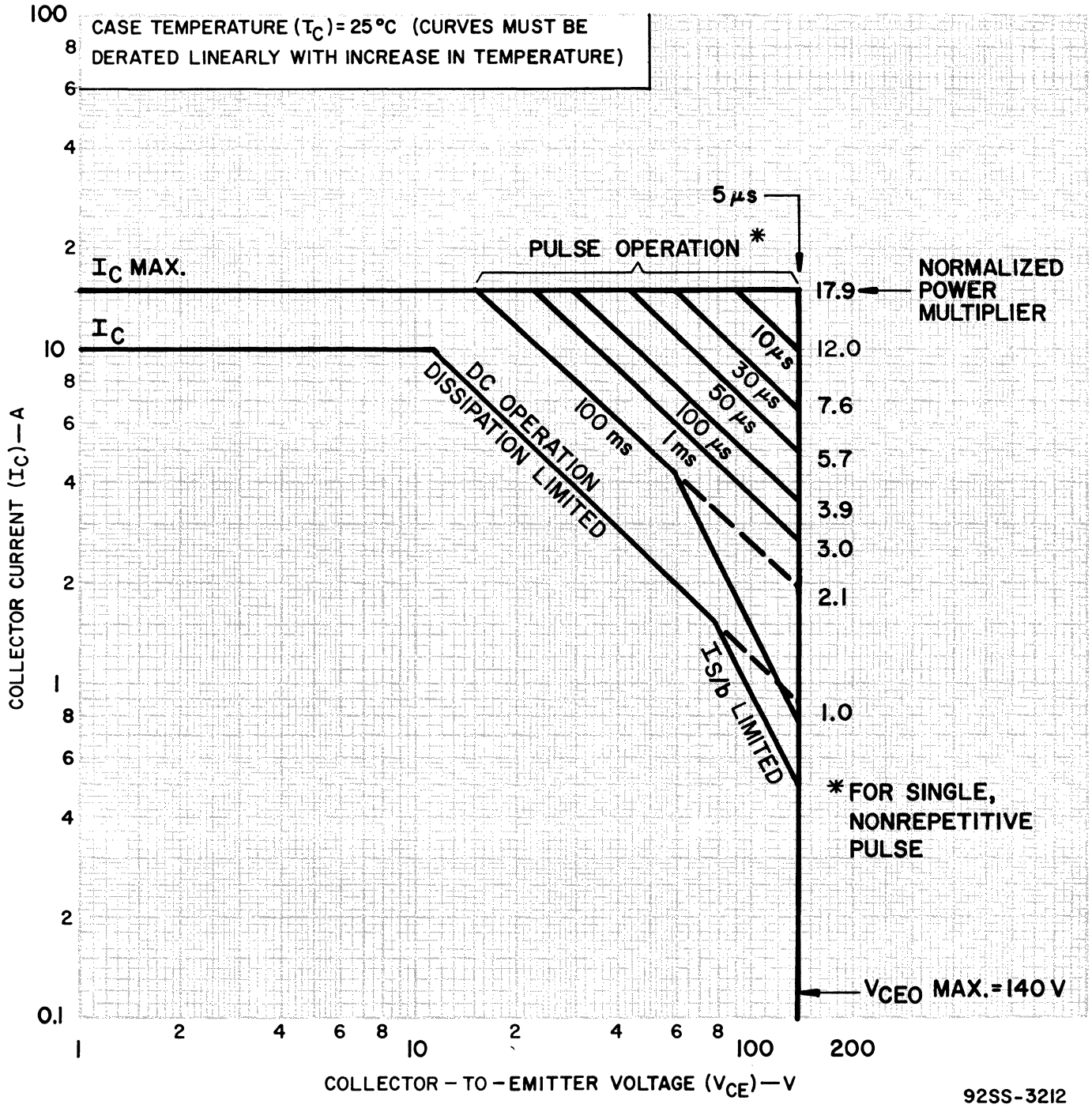


Fig. 3

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the on condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in Figure 4 are recommended when designing circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals; also, Figure 4 can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers). In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore the allowable energy shown in Figure 4 for a 200 millihenry coil as calculated from $E_{S/b} = \frac{1}{2}LI^2$ (where L is a series load or leakage inductance and I is the peak collector current from Figure 4) will be conservative for smaller inductance loads. For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPES 2N4347 & 2N3442

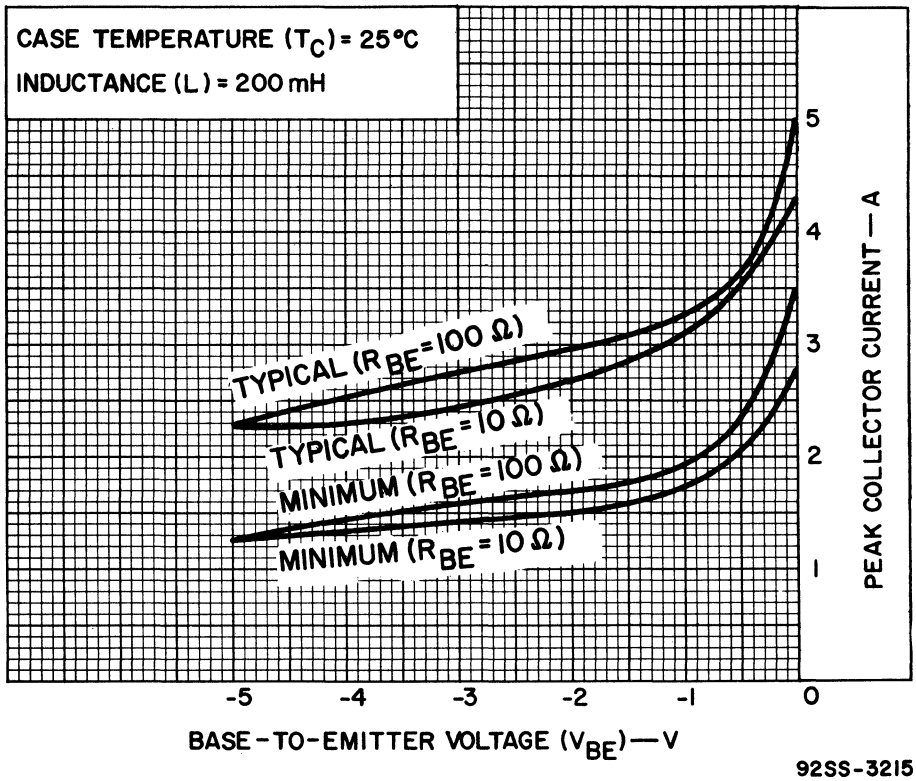


Fig. 4

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N4347

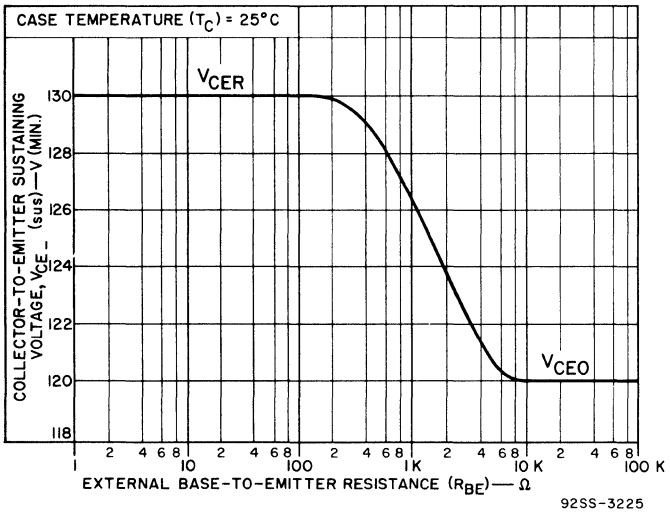


Fig. 5

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3442

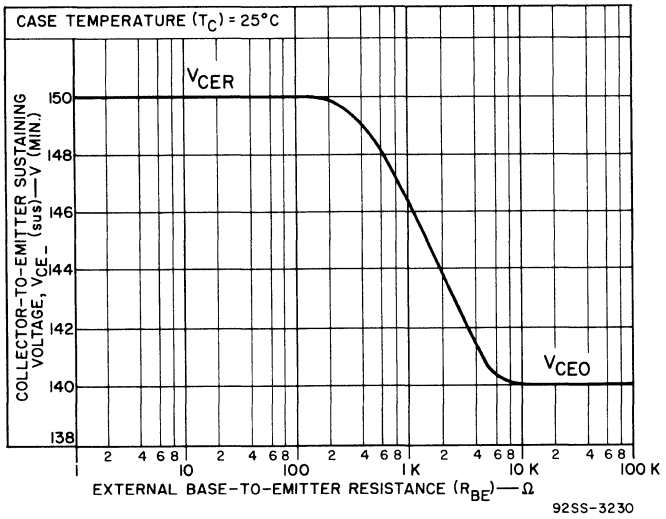


Fig. 6

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES $V_{CEO(sus)}$ & $V_{CEV(sus)}$ FOR TYPES 2N4347 & 2N3442

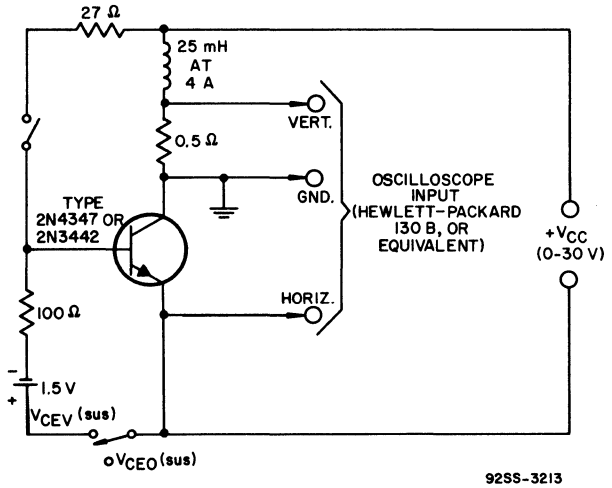
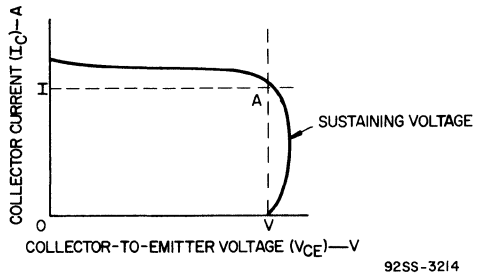


Fig. 7

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN IN FIG. 7)



NOTE:
THE SUSTAINING VOLTAGE $V_{CEO(sus)}$ OR $V_{CEV(sus)}$ IS ACCEPTABLE WHEN THE TRACE FALLS TO THE RIGHT AND ABOVE POINT "A" FOR TYPES 2N4347 AND 2N3442.
(FOR VALUES OF I & V, SEE ELECTRICAL CHARACTERISTICS)

Fig. 8

TYPICAL DC BETA vs. COLLECTOR CURRENT FOR TYPE 2N4347

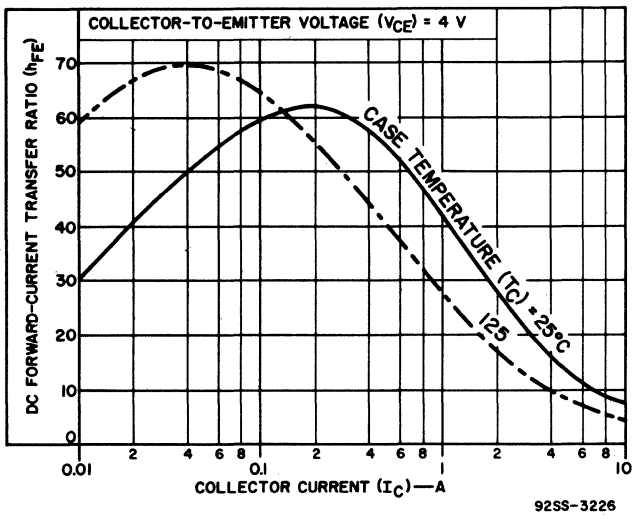


Fig. 9

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N4347

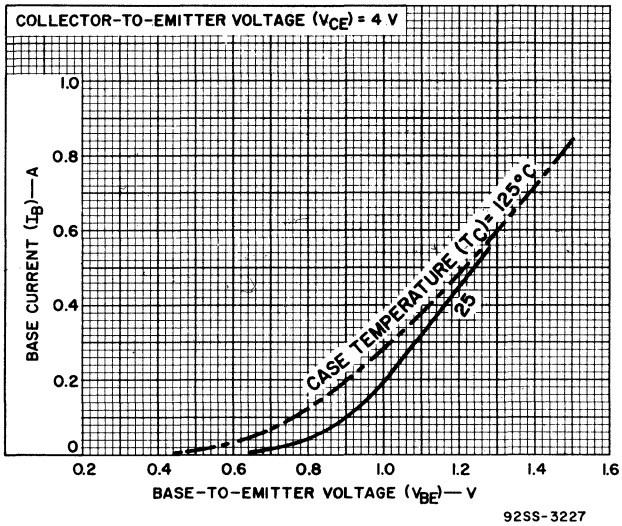


Fig. 10

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N4347

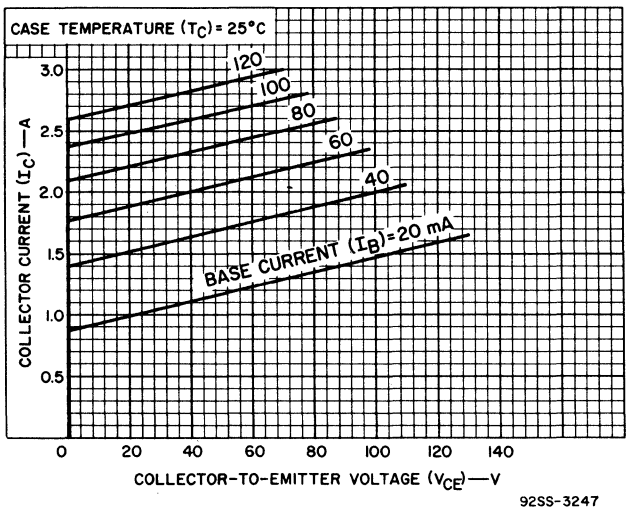


Fig. 11

TYPICAL OUTPUT CHARACTERISTICS FOR TYPE 2N4347

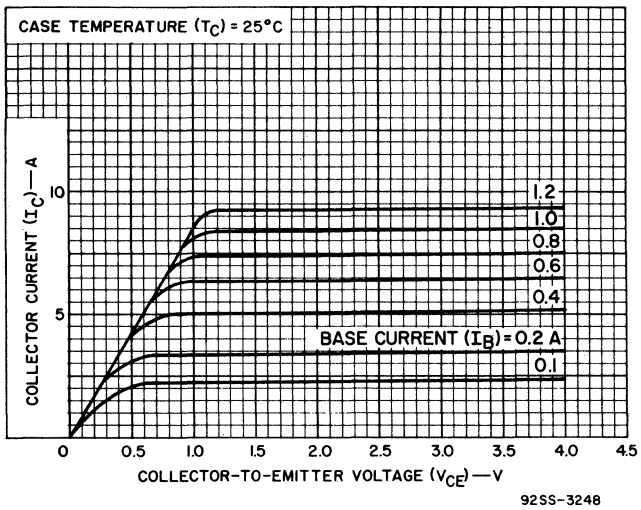


Fig. 12

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N4347

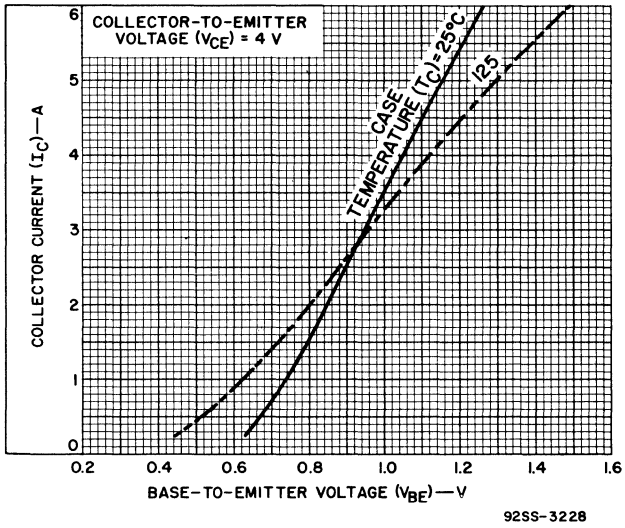


Fig. 13

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS FOR TYPE 2N4347

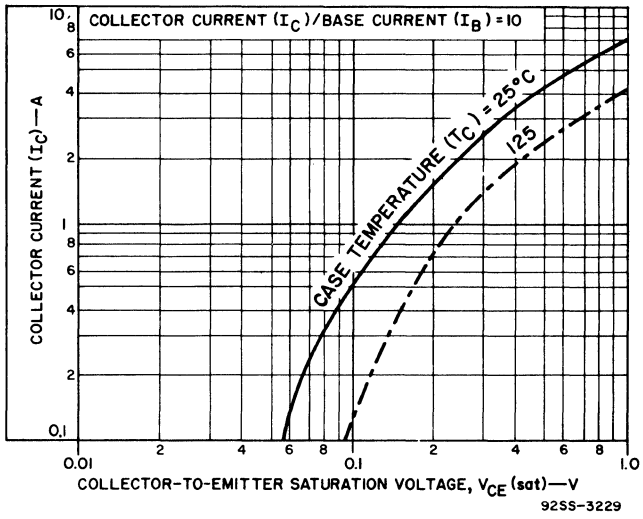


Fig. 14

TYPICAL DC BETA vs. COLLECTOR CURRENT FOR TYPE 2N3442

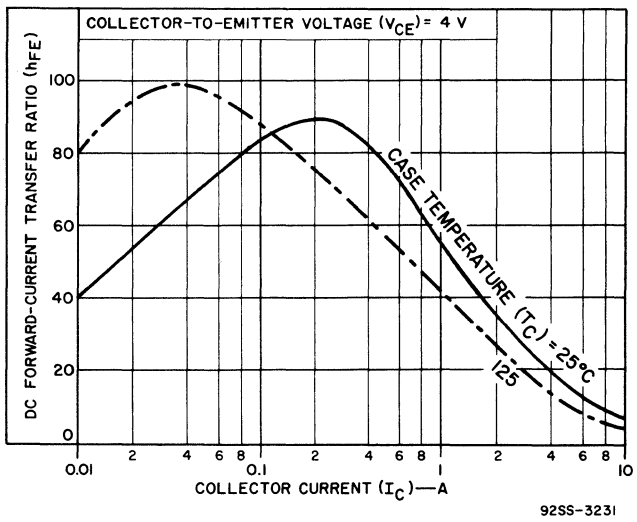


Fig. 15

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3442

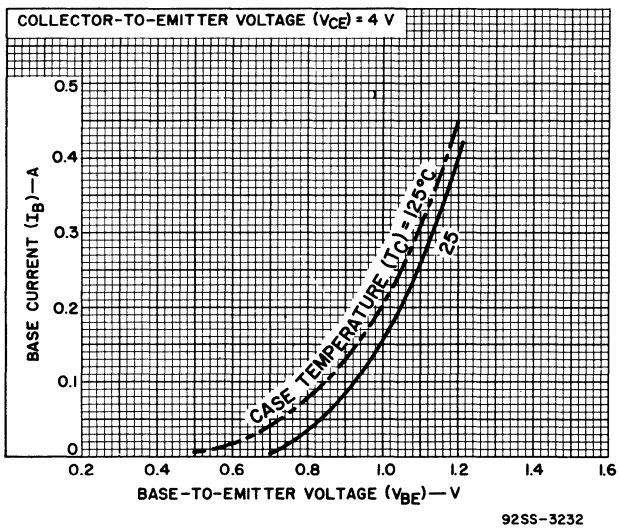


Fig. 16

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N3442

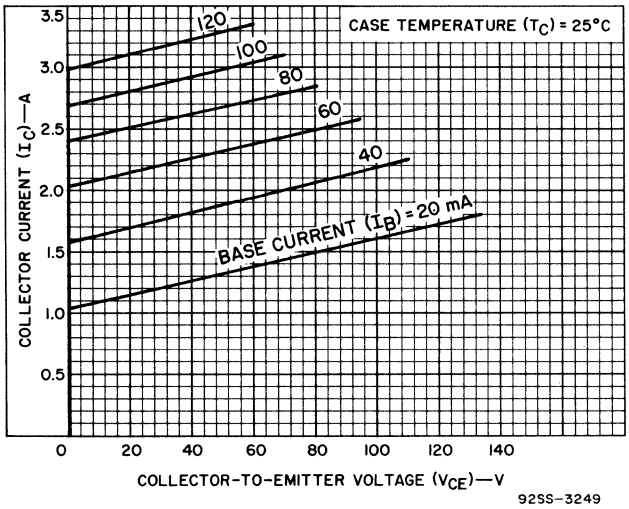


Fig. 17

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N3442

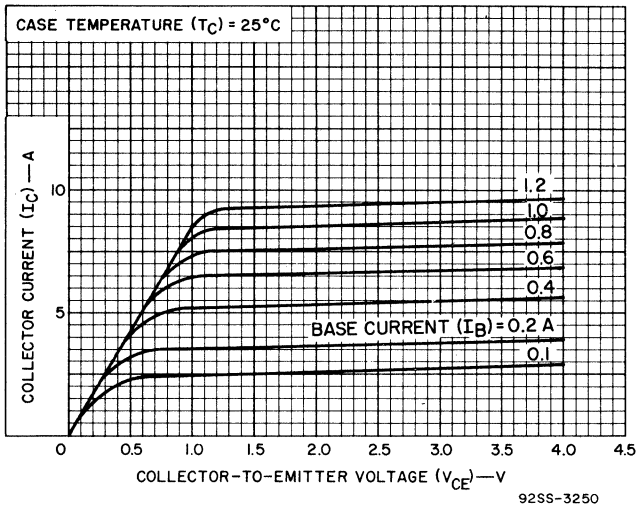


Fig. 18

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPE 2N3442

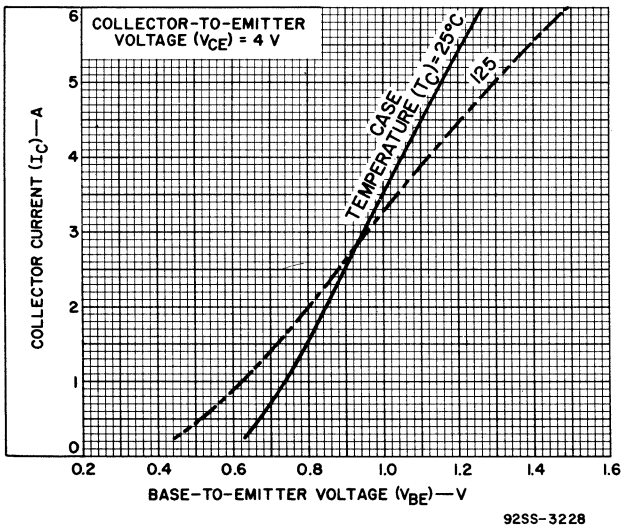


Fig. 19

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS
FOR TYPE 2N3442

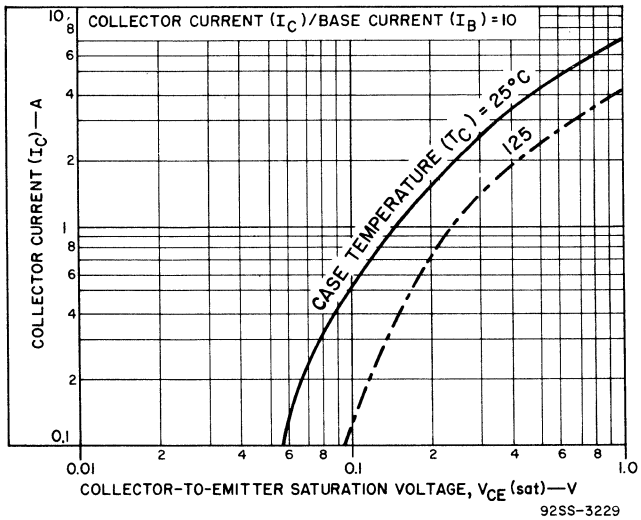
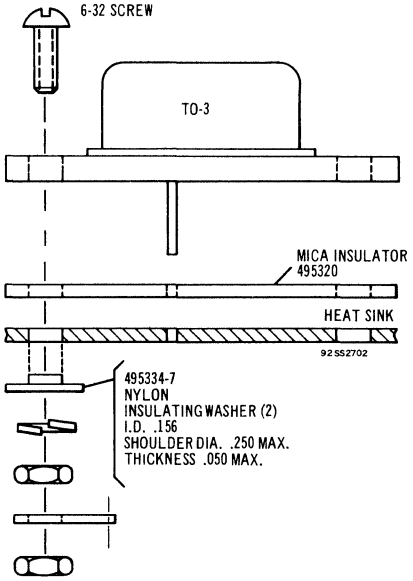


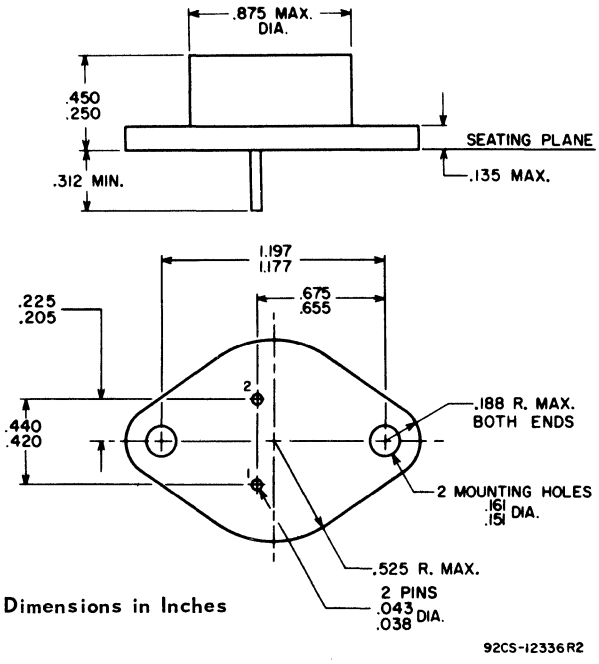
Fig. 20

SUGGESTED HARDWARE FOR TYPES 2N4347 AND 2N3442



NOTE: Hardware With Part Numbers Supplied.

DIMENSIONAL OUTLINE FOR TYPES 2N4347 AND 2N3442 JEDEC No. TO-3



TERMINAL CONNECTIONS

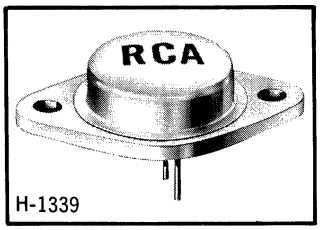
Pin 1 - Base
Pin 2 - Emitter
Case, Flange - Collector


RCA

RCA POWER TRANSISTORS

2N4348
2N3773

"HOMETAXIAL"-BASE* SILICON N-P-N HIGH-CURRENT HIGH-VOLTAGE POWER TRANSISTORS



2N4348, 2N3773
JEDEC TO-3

General-Purpose Types for Military, Industrial, and Commercial Applications

RCA-2N4348 and 2N3773** are Hometaxial-base*, silicon n-p-n transistors intended for a wide variety of high-voltage, high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

Both devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

*"Hometaxial" was coined by RCA from "homogeneous" and "axial" to describe a single-diffused transistor with a base region of homogeneous resistivity silicon in the axial direction (emitter-to-collector).

**Formerly Dev. Type Nos. TA2908, and TA2645A, respectively.

NEW!

Maximum area-of-operation curves for DC & pulse operation

Derating curves for $I_{S/b}$-limited and dissipation-limited operation

Now possible to determine maximum operating conditions for operation free from second breakdown.

2N4348

- High dissipation capability - - 120 W
- V_{CEV} (sus) = 140 V min.
- 5-A specification for: h_{FE}, V_{BE}, & V_{CE} (sat)
- Low saturation voltage with high beta

2N3773

- High dissipation capability -- 150 W
- V_{CEV} (sus) = 160 V min.
- 8-A specification for: h_{FE}, V_{BE}, & V_{CE} (sat)
- Low saturation voltage with high beta

MAXIMUM RATINGS *Absolute-Maximum Values:*

		2N4348	2N3773	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With −1.5 V (V_{BE}) of reverse bias	V_{CEV}	140	160	V
With base open	V_{CEO}	120	140	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	10	16	A
PEAK COLLECTOR CURRENT	–	30	30	A
CONTINUOUS BASE CURRENT	I_B	4	4	A
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25°C		120	150	W
At case temperatures above 25°C		See Figs. 1 & 2.	See Figs. 2 & 3.	
TEMPERATURE RANGE:				
Storage & Operating (Junction)		−65 to 200		°C
PIN TEMPERATURE (During soldering):				
At distance ≥ 1/32" from seating plane for 10 s max.		230	230	°C

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N4348 & 2N3773 6/66
Supersedes 2N3773 data included in 2N3771 bulletin dated 6/65

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS				Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Type 2N4348		Type 2N3773		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		120					0	–	–	–	2	mA
	I_{CEV}		120		-1.5				–	2	–	–	mA
	I_{CEV}		140		-1.5				–	–	–	2	mA
At T_C = 150°C	I_{CEV}		120 140					0 0	– –	10 –	– –	– 10	mA
Emitter-Cutoff Current	I_{EBO}			7		0			–	5	–	5	mA
DC Forward-Current Transfer Ratio	h_{FE}		4 4			5 8[a]			15 –	60 –	– 15	– 60	
Collector-to-Emitter Sustaining Voltage: *(See Figs. 7 & 8.)* With base open	$V_{CEO}(sus)$					0.2 to 3		0	120[b]	–	140[b]	–	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$				-1.5	0.1 to 1.5			140[b]	–	160[b]	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0	5mA		7	–	7	–	V
Base-to-Emitter Voltage	V_{BE}		4 4			5 8[a]			– –	2.0 –	– –	– 2.2	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					5 8[a]		0.5 0.8	– –	1.0 –	– –	– 1.4	V V
Power Rating Test	PRT		80 100			1.5 1.5			1.0[c] –	– –	– 1.0[d]	– –	s s
Thermal Resistance: Junction-to-Case	θ_{J-C}								–	1.46	–	1.17	°C/W

[a]Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz.

[b]**CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CEV}(sus)$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 7.

[c]At 120 W.

[d]At 150 W.

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MAXIMUM OPERATING AREAS FOR TYPE 2N4348

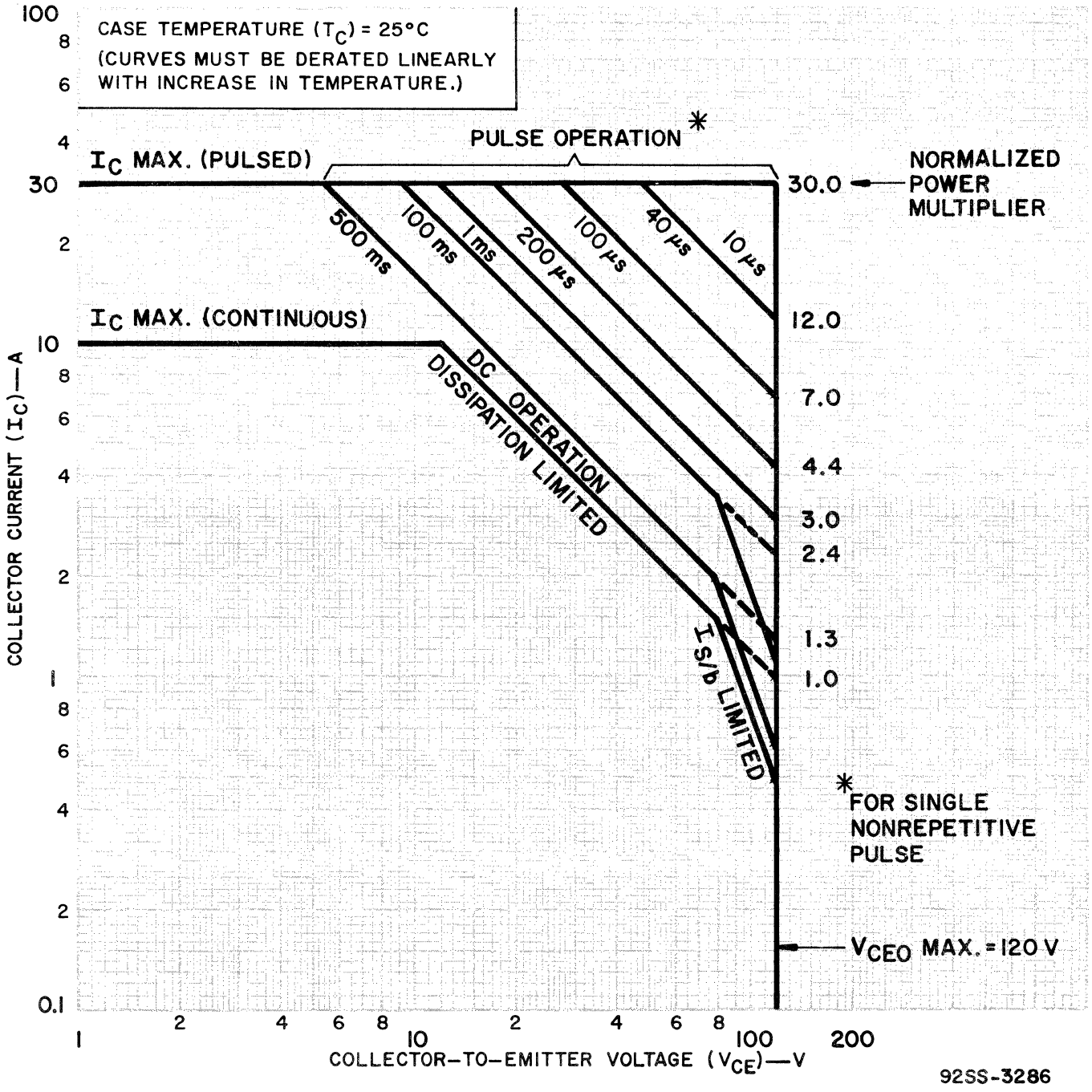


Fig. 1

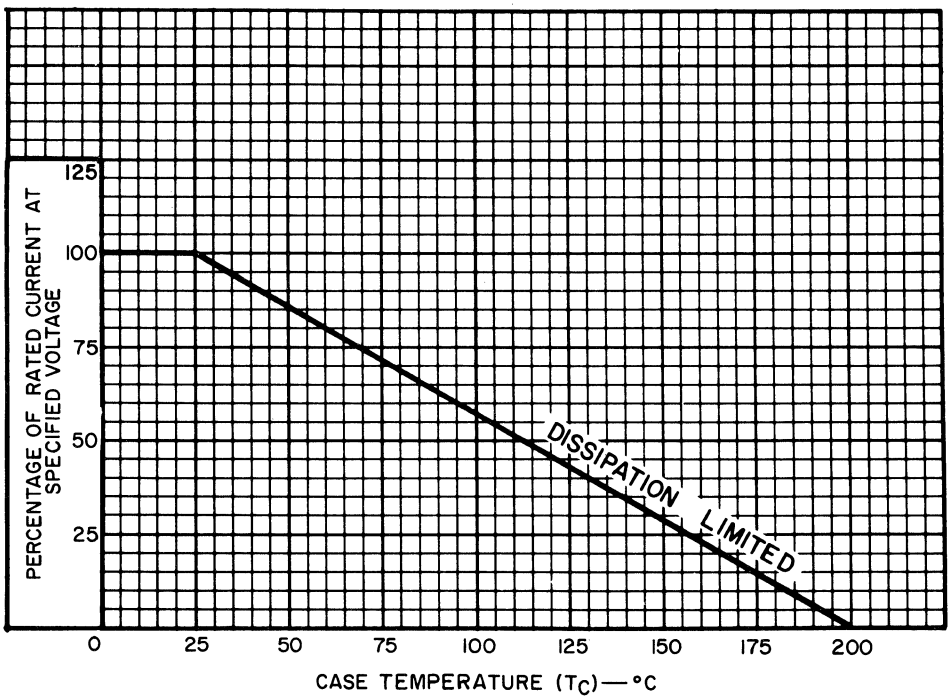
MAXIMUM AREA-OF-OPERATION

The maximum-operating-area curves for the 2N4348 and 2N3773 shown in Figures 1 and 3, respectively, have a slope equal to -1 on a log-log plot when a thermal limitation exists and a slope equal to -2 when a second-breakdown limitation exists.

Figures 1 and 3 show constant-slope (constant-power) lines for pulse conditions shorter than 1 millisecond. However, for longer pulse widths, the area-of-operation is bounded by a line having a slope approximately equal to -2. In addition to the boundary showing a second-breakdown limitation, an extension of the dissipation-limited boundary line (for derating) is shown as a dashed line.

The second-breakdown limitation need not be derated with temperature. Since all ratings shown are based upon a case temperature of 25 °C, all boundary lines and their dashed-line extensions must be derated linearly to zero at case temperature of 200 °C; see Figure 2.

DISSIPATION DERATING CURVE
FOR TYPES 2N4348 & 2N3773



92LS-1469

Fig. 2

MAXIMUM OPERATING AREAS FOR TYPE 2N3773

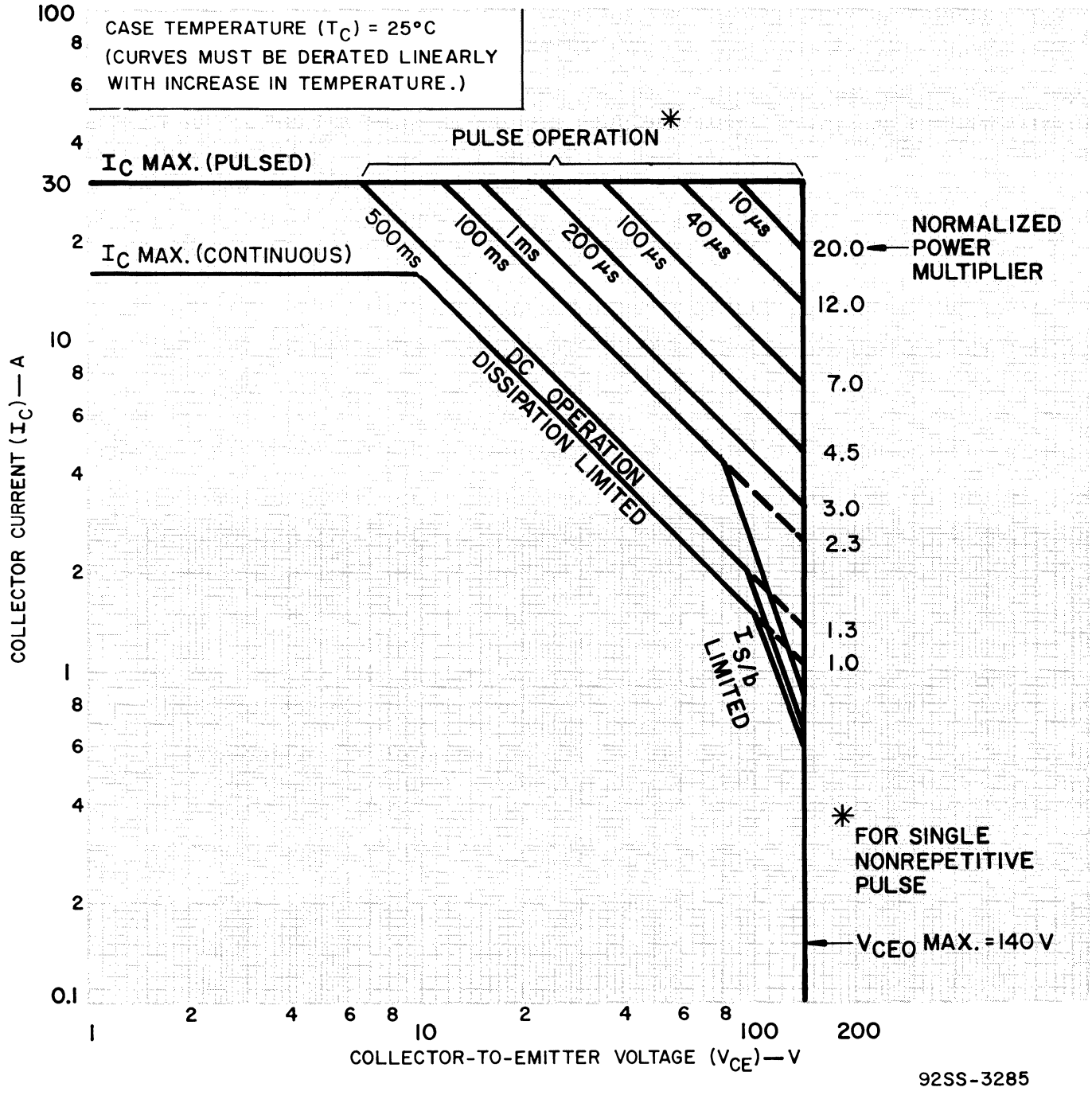


Fig. 3

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

The energy required to induce second breakdown when the transistor is turned off depends on the current during the on condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The curves shown in Figure 4 are recommended when designing circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals; also, Figure 4 can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers). In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore the allowable energy shown in Figure 4 for a 200-millihenry coil as calculated from $E_{S/b} = \frac{1}{2}LI^2$ (where L is a series load or leakage inductance and I is the peak collector current from Figure 4) will be conservative for smaller inductive loads. For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPES 2N4348 AND 2N3773

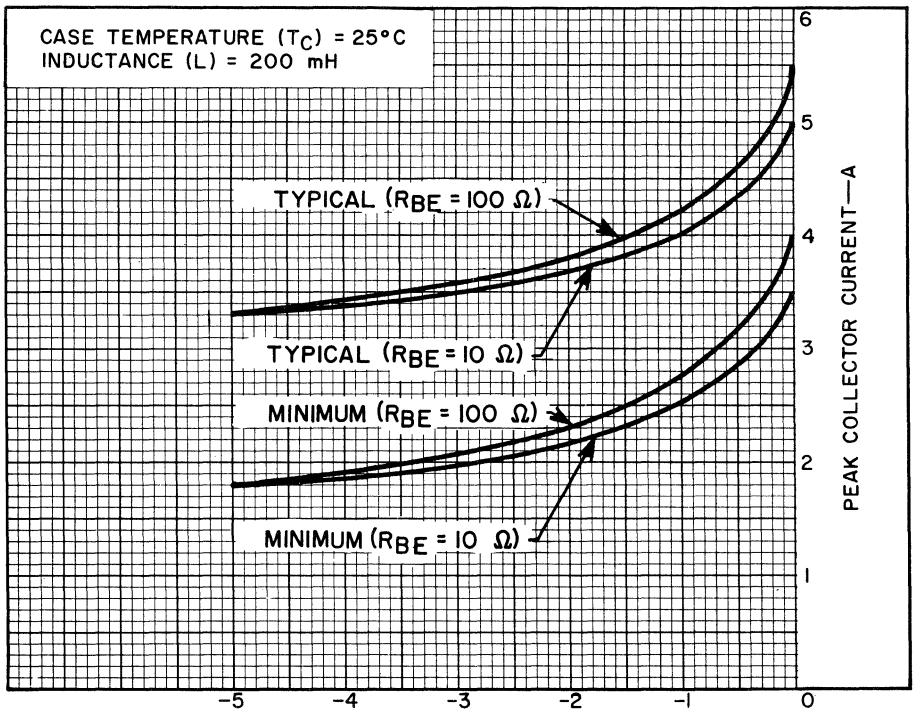


Fig. 4

92SS-3302

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N4348

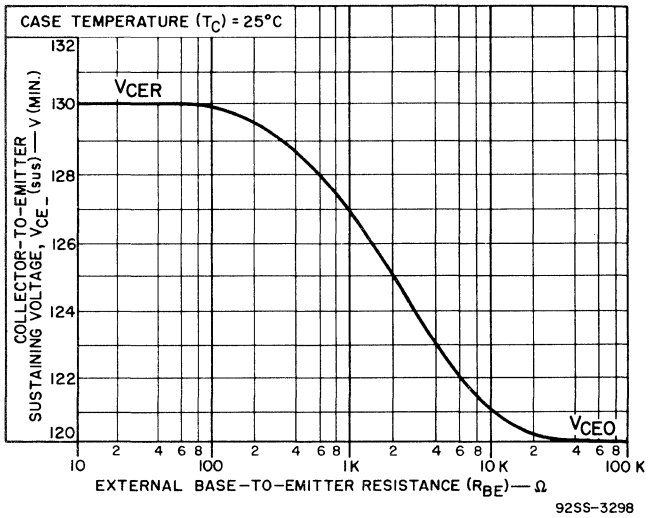


Fig. 5

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE FOR TYPE 2N3773

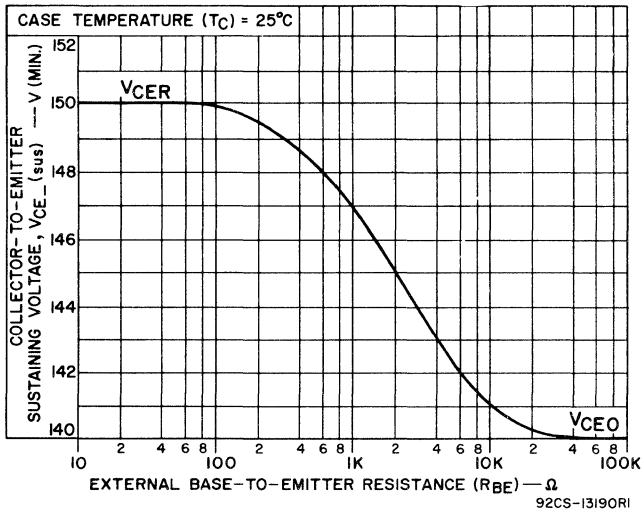


Fig. 6

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES V_{CEO} (sus) AND V_{CEV} (sus) FOR TYPES 2N4348 AND 2N3773

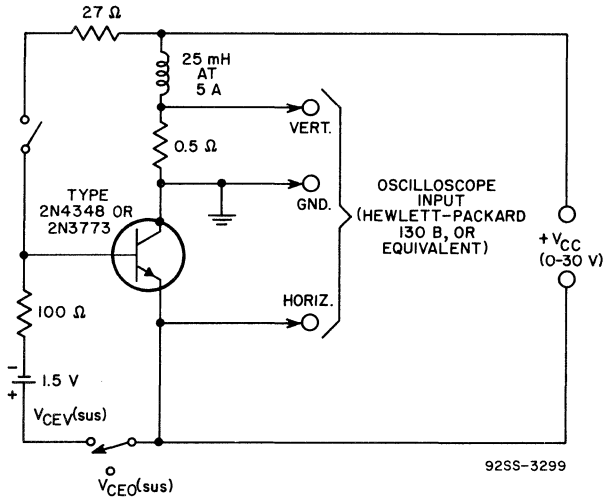
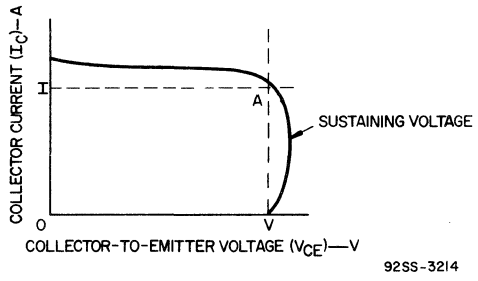


Fig. 7

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN IN FIG.7)



NOTE:

The sustaining Voltage V_{CEO} (sus) or V_{CEV} (sus) is acceptable when the trace falls to the right and above point "A" for types 2N4348 and 2N3773. (For values of current and voltage, see Electrical Characteristics)

Fig. 8

TYPICAL DC-BETA CHARACTERISTICS
FOR TYPE 2N4348

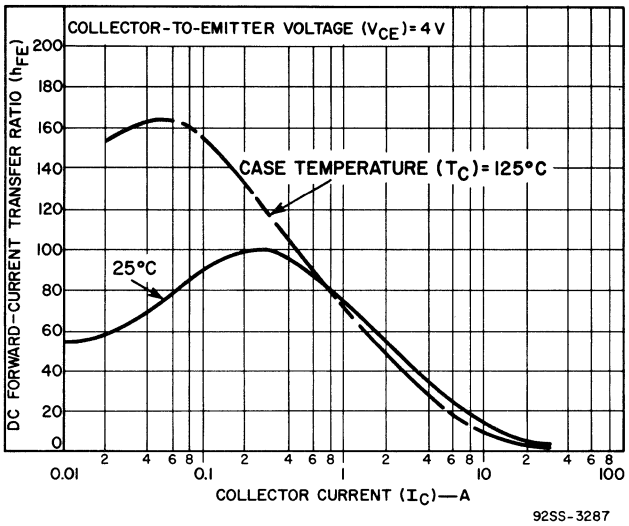


Fig. 9

TYPICAL INPUT CHARACTERISTICS
FOR TYPE 2N4348

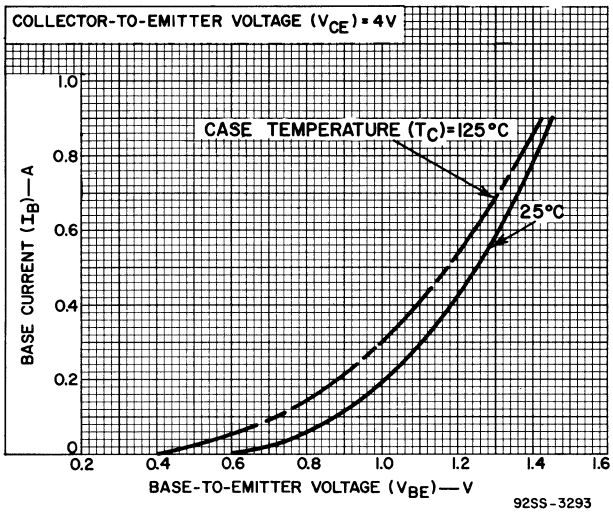


Fig. 10

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N4348

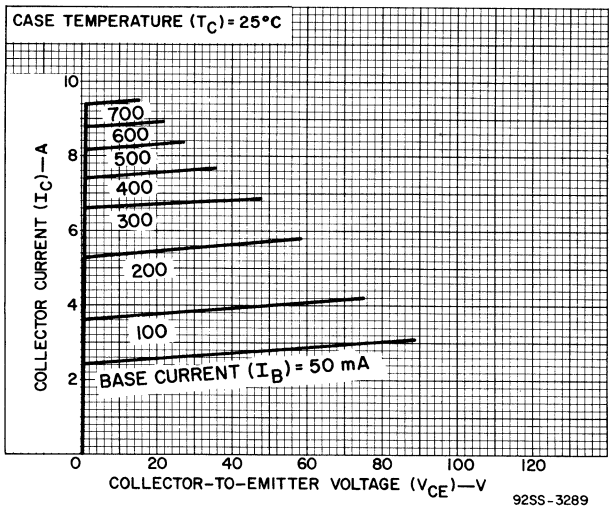


Fig. 11

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N4348

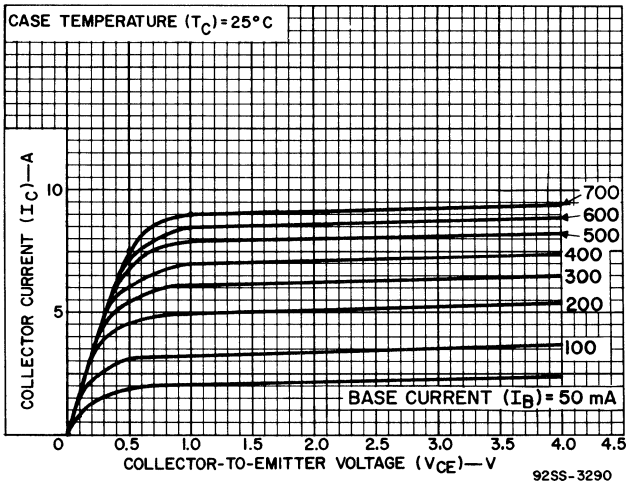


Fig. 12

TYPICAL TRANSFER CHARACTERISTICS FOR TYPE 2N4348

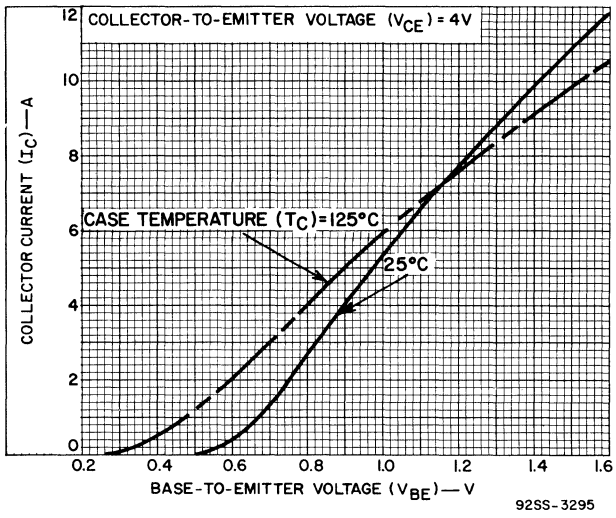


Fig. 13

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS FOR TYPE 2N4348

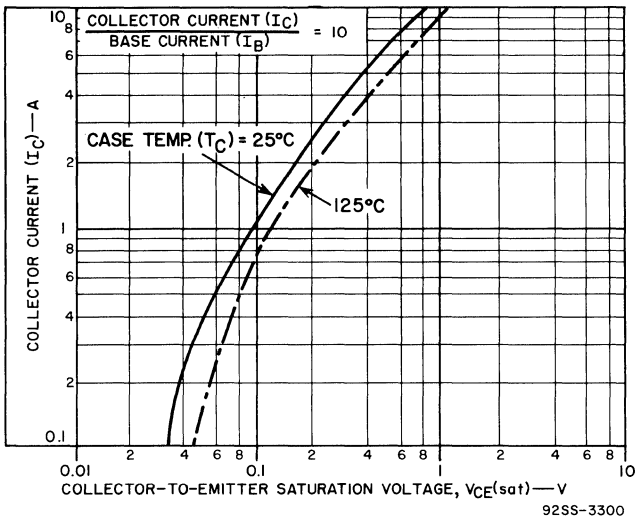


Fig. 14

TYPICAL DC-BETA CHARACTERISTICS FOR TYPE 2N3773

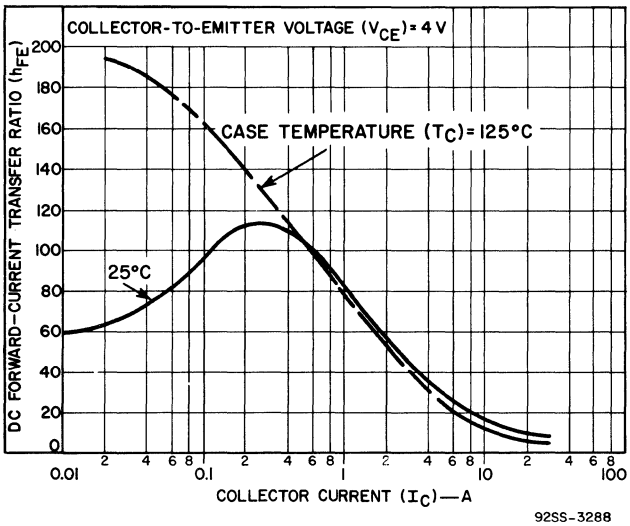


Fig. 15

TYPICAL INPUT CHARACTERISTICS FOR TYPE 2N3773

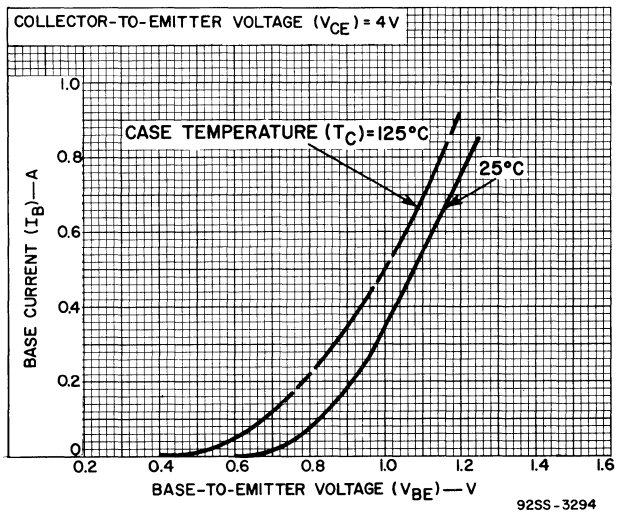


Fig. 16

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N3773

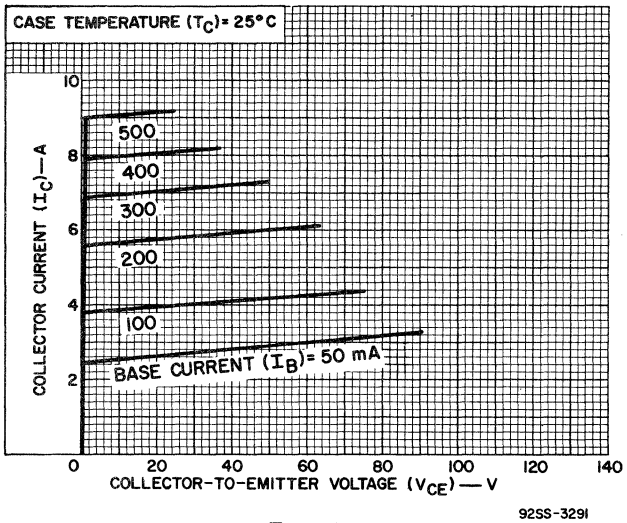


Fig. 17

TYPICAL OUTPUT CHARACTERISTICS
FOR TYPE 2N3773

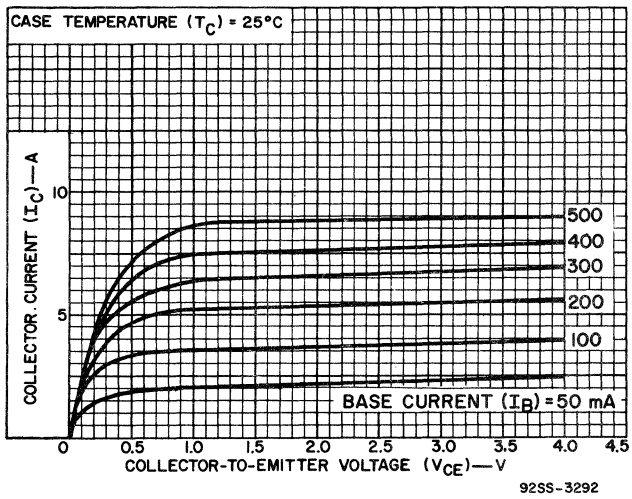


Fig. 18

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPE 2N3773

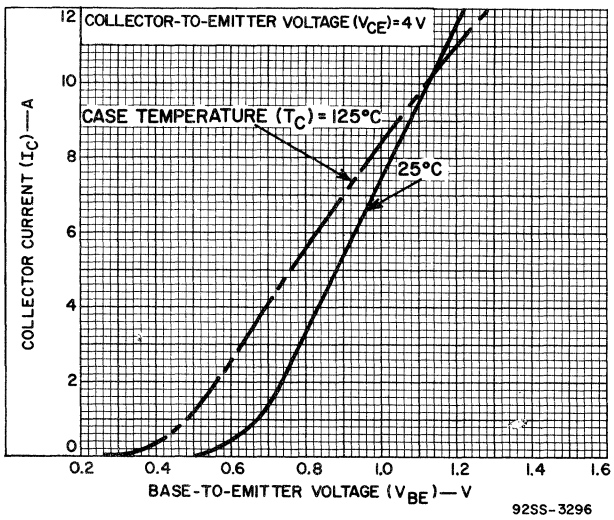


Fig. 19

TYPICAL SATURATION-VOLTAGE CHARACTERISTICS
FOR TYPE 2N3773

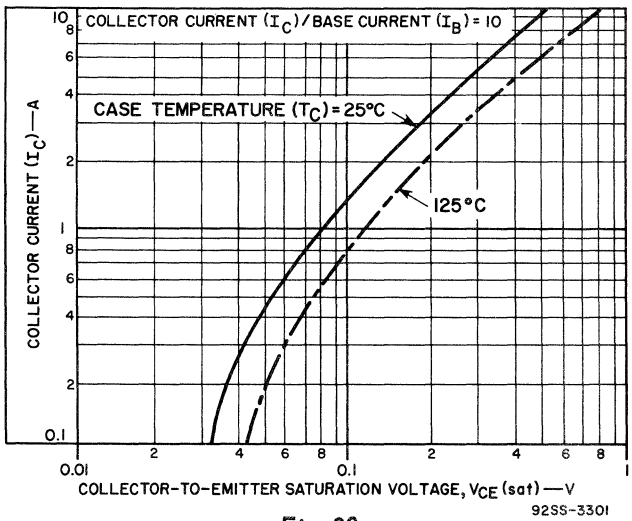
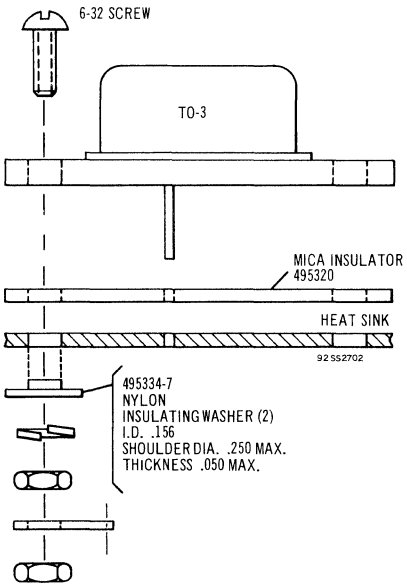


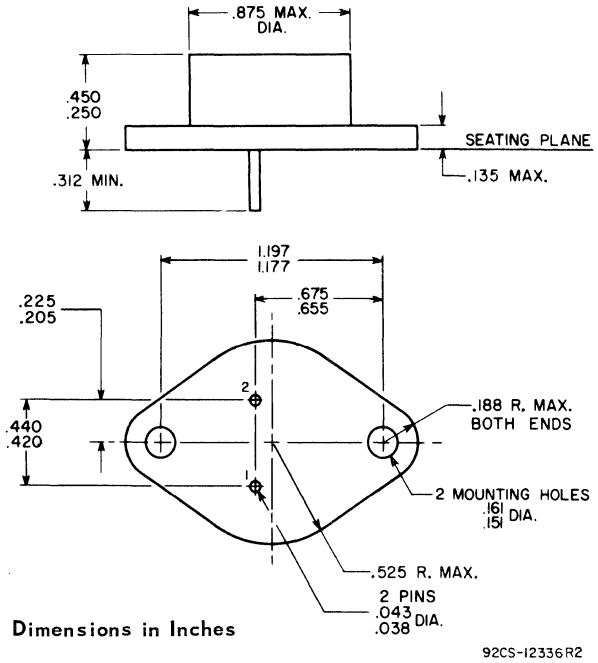
Fig. 20

SUGGESTED HARDWARE FOR TYPES 2N4348 AND 2N3773



NOTE: Hardware With Part Numbers Supplied.

DIMENSIONAL OUTLINE FOR TYPES 2N4348 AND 2N3773 JEDEC TO-3



Dimensions in Inches

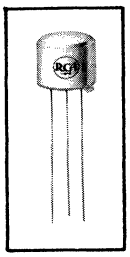
92CS-12336R2

TERMINAL CONNECTIONS

Pin 1 - Base
Pin 2 - Emitter
Case, Flange - Collector


RCA

NPN SILICON HIGH-VOLTAGE TRANSISTOR



For Nixie-▲ and Relay-Driver Applications in Industrial Equipment

RCA-2N4390* is a high-voltage silicon npn transistor, intended for direct "on-off" control of high-voltage, low-power devices such as Nixies▲ and relays, and for other control applications in industrial equipment.

This device features high collector-to-emitter breakdown voltage capability, low saturation voltage, and low leakage currents.

The 2N4390 utilizes a compact, 3-lead hermetically sealed metal package in which the collector is internally connected to the case.

* Formerly Dev. #TA7000.

▲ Registered Trade Mark: Burroughs Corp.

MAXIMUM RATINGS, Absolute-Maximum Values

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120 max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	6 max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	120 max. V
COLLECTOR CURRENT, I_C	Limited by Dissipation
TRANSISTOR DISSIPATION, P_T:	
At ambient temperatures up to 25°C	500 max. mW
At ambient temperatures above 25°C	See Fig. 1
AMBIENT TEMPERATURE RANGE:	
Storage	-65 to 175°C
Operating	-65 to 175°C
LEAD TEMPERATURE (During soldering):	
At distances not closer than 1/32 inch to surface for 10 seconds max.	265 max. °C

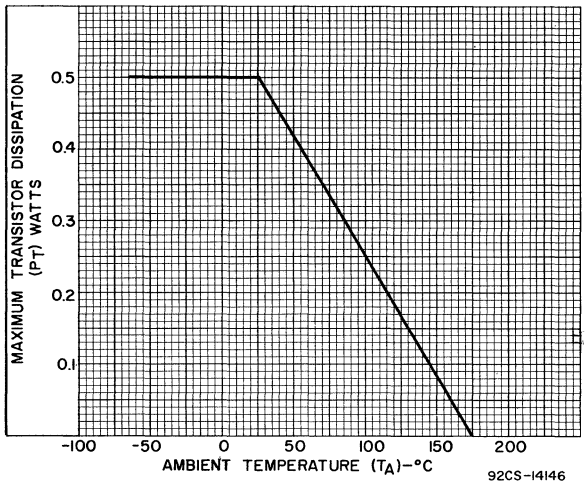


Fig. 1 - Rating chart for type 2N4390.

FEATURES

- high collector-to-emitter breakdown voltage — BV_{CEO} = 120 V min.
- low saturation voltage — $V_{CE(sat)}$ = 0.2 V max. at I_C = 2 mA; 0.3 V max. at I_C = 20 mA
- low leakage currents — I_{CEV} = 1 μA max. at V_{CE} = 70 V; I_{BEV} = 1 μA max. at V_{CE} = 70 V
- wide operating temperature range — -65 to +175°C
- hermetically sealed 3-lead metal package; collector internally connected to case

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ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS		Units
		Ambient Temperature	Frequency	DC Collector-to-Emitter Voltage	DC Collector-to-Base Voltage	DC Emitter-to-Base Voltage	DC Emitter Current	DC Collector Current	DC Base Current	2N4390		
		T_A	f	V_{CE}	V_{CB}	V_{EB}	I_E	I_C	I_B			
		°C	MHz	V	V	V	mA	mA	mA	Min	Max	
Collector-Cut-off Current	I_{CEV}	25		70		1				-	1	μA
Base-Cutoff Current	I_{BEV}	25		70		1				-	1	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.1		120	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	25						1	0	120	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.1	0		6	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25 25						20 2	2 0.2	- -	0.3 0.2	V V
Base-to-Emitter Voltage	V_{BE}	25 25						20 2	2 0.2	- -	0.85 0.75	V V
Static Forward Current Transfer Ratio	h_{FE}	25 25		1 1				2 20		20 20	- -	
Small-Signal Forward Current-Transfer Ratio	$\|h_{fe}\|$	25	4	10				20		12.5	-	
Collector-to-Base Feedback Capacitance	C_{cb}	25	1		10		0			-	6	pF
Common-Base, Open-Circuit Input Capacitance	C_{ib}	25	1			0.5	0			-	40	pF
				V_{CC}	$V_{BE}(off)$	I_{B1}	I_{CS}	I_{B2}				
				V	V	mA	mA	mA				
Delay Time Rise Time (See Fig.2)	t_d t_r	25 25		3.4 3.4	1.5 1.5	2 2	20 20			- -	150 500	ns ns
Storage Time Fall Time (See Fig.2)	t_s t_f	25 25		3.4 3.4		2 2	20 20	-2 -2		- -	800 500	ns ns

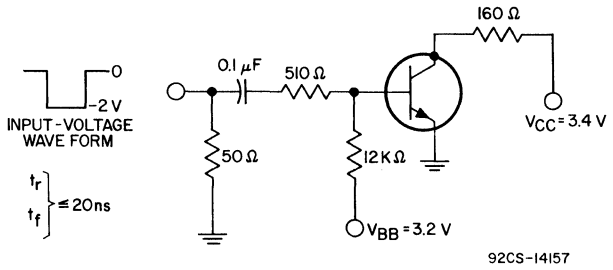


Fig.2 - Circuit used to measure turn-on time and turn-off time for type 2N4390.

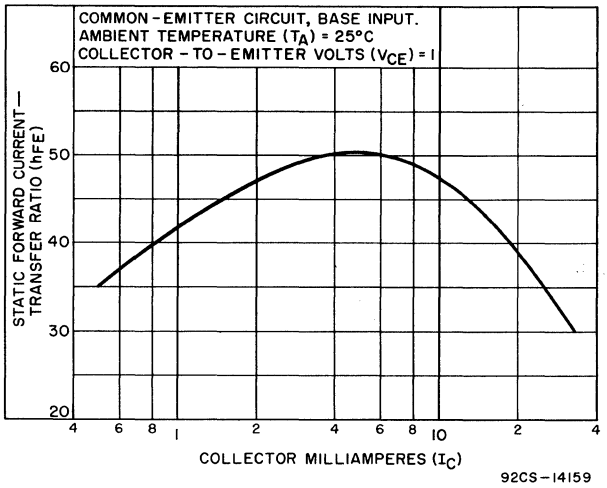


Fig.3 - Typical h_{FE} characteristics for type 2N4390.

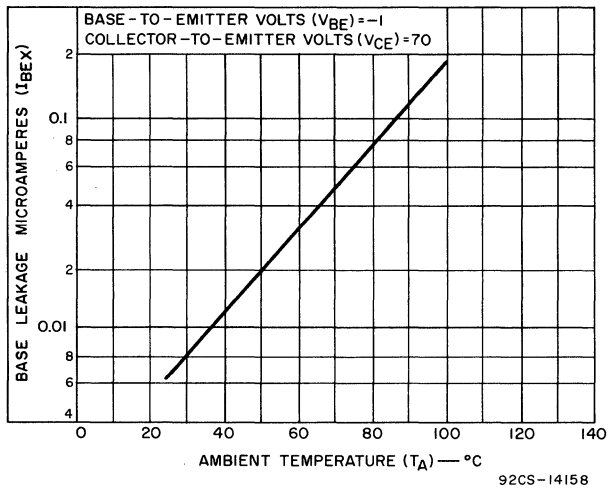


Fig.4 - Typical I_{BEX} vs. temperature characteristics for type 2N4390.

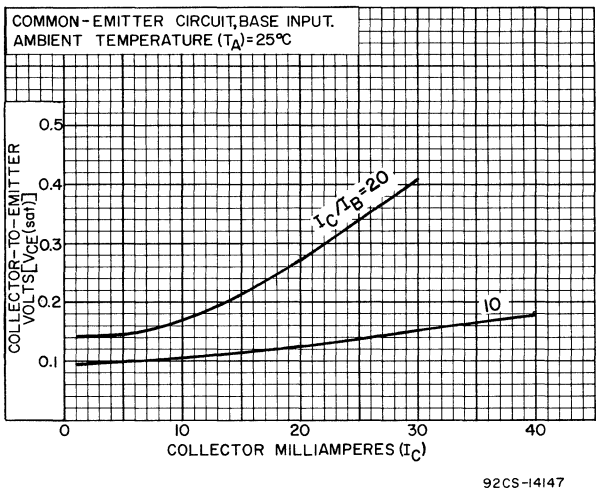


Fig.5 - Typical $V_{CE}(sat)$ characteristics for type 2N4390.

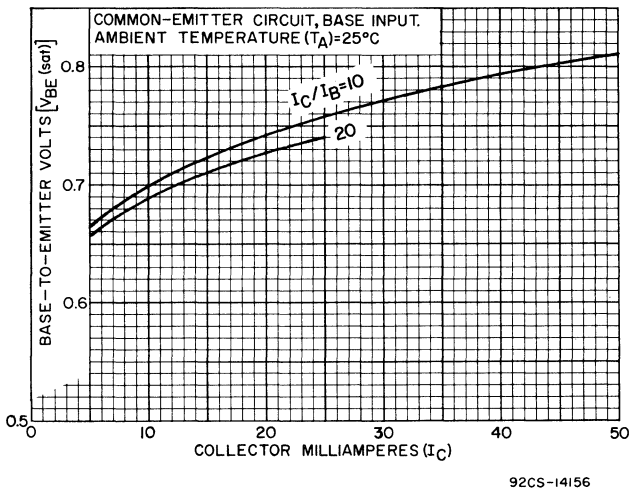
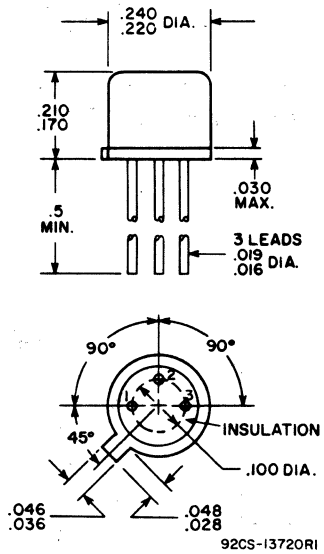


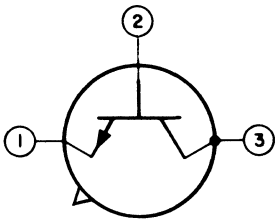
Fig.6 - Typical V_{BE} characteristics for type 2N4390.

DIMENSIONAL OUTLINE FOR RCA-2N4390



Dimensions in Inches

TERMINAL DIAGRAM FOR RCA-2N4390



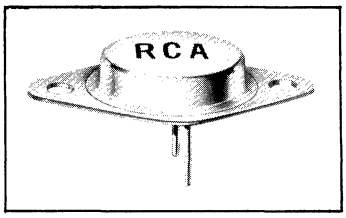
Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector, Case

2N4395
2N4396

SILICON NPN POWER TRANSISTORS



JEDEC TO-3

High-Current General-Purpose Types for Critical Industrial Equipment

RCA-2N4395 and 2N4396* are high-current power transistors of the epitaxial-base, silicon npn type, with a wide range of application in industrial equipment.

These transistors, which differ in voltage ratings, static beta limits, and switching characteristics, feature high breakdown-voltage and dissipation capabilities as well as high current capabilities, very low saturation voltages, and high switching speeds. These features make the 2N4395 and 2N4396 highly desirable for dc-to-dc converter, dc-to-ac inverter, relay-driver, and other applications requiring "on-off" control of relatively large amounts of power.

The 2N4395 and 2N4396 also feature highly uniform static-beta characteristics over their full range of collector current, a feature which makes them useful as current and voltage regulators, and as af power amplifiers and modulators in mobile communications equipment.

The 2N4395 and 2N4396 are hermetically sealed in JEDEC TO-3 metal packages.

*Formerly Developmental Types TA7068 and TA7069 respectively.

APPLICATIONS

- high power af amplifiers
- relay drivers
- dc-to-dc converters
- dc-to-ac inverters
- current regulators
- switching regulators
- shunt voltage regulators
- shunt voltage-regulator drivers
- ultrasonic oscillators

FEATURES

- high collector-current capability – I_C = 5 A max.
- high dissipation capability – P_T = 62.5 W max. at T_{MF} to 25°C
- high breakdown-voltage capability – BV_{CEO} = 60 V min. for 2N4396
- low saturation voltages – $V_{CE(sat)}$ = 0.8 V max. at I_C = 4 A; $V_{BE(sat)}$ = 1.5 V max. at I_C = 4 A
- high switching speeds at high I_C –

	2N4395	2N4396
t_{on}	= 0.8 μs max.	1.0 μs max.
t_{off}	= 1.5 μs max.	2.0 μs max.

- hermetically sealed JEDEC TO-3 package

Maximum Ratings, *Absolute-Maximum Values:*

	2N4395	2N4396	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	60	80 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	40	60 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4 max.	V
COLLECTOR CURRENT, I_C	5	5 max.	A
PEAK COLLECTOR CURRENT, i_C	15	15 max.	A
TRANSISTOR DISSIPATION, P_T:			
For mounting-flange temperatures[a] up to 25°C.	62.5	62.5 max.	W
For mounting-flange temperatures[a] above 25°C	See Fig.1		
TEMPERATURE RANGE:			
Storage and operating (junction).	-65 to 150		°C
LEAD TEMPERATURE (During soldering)			
At distances ≥ 1/16 inch from seating surface for 10 seconds maximum	265	265 max.	°C

[a] Measured at center of seating surface.

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Printed in U.S.A.
2N4395, 2N4396 10-66

ELECTRICAL CHARACTERISTICS, at a Mounting-Flange Temperature (T_{MF}) of 25°C unless otherwise specified.

Characteristics	Symbols	TEST CONDITIONS				LIMITS						Units
		DC Base-To-Emitter Voltage V_{BE}	DC Collector-To-Emitter Voltage V_{CE}	DC Base Current I_B	DC Collector Current I_C	Type 2N4395			Type 2N4396			
		V	V	A	A	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		$V_{CB}=60$ $V_{CB}=80$			- -	- -	0.1 -	- -	- -	- 0.1	mA mA
Collector-Cutoff Current	I_{CEV}	-1 -1	35 35	$T_{MF}=85°C$ $T_{MF}=25°C$		- -	- -	1 0.5	- -	- -	1 0.5	mA mA
Emitter-Cutoff Current	I_{EBO}	-4 -1.5			0 0	- -	- -	10 2.5	- -	- -	10 2.5	mA mA
Base-to-Emitter Breakdown Voltage	BV_{EBO}				$I_E=0.01$	4	-	-	4	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			0	0.1	40	-	-	60	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			0.2 0.8	2 4	- -	0.25 -	- 0.8	- -	0.25 -	- 0.8	V V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			0.8	4	-	-	1.5	-	-	1.5	V
"Second-Breakdown" Collector Current	$I_C(s/b)$*		25			4	-	-	4	-	-	A
Static Forward Current-Transfer Ratio	h_{FE}		1 1 1		1 2 4	75 50 20	- - -	- 170 -	60 40 20	- - -	- 170 -	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\lvert h_{fe} \rvert$	f=1 MHz f=1 kHz	10 10		0.5 0.5	4 100	7 -	- -	4 100	7 -	- -	
Turn-On Time (See Fig.12 for Test Circuit)	t_{on} (t_d+t_r)	$V_{BB}=-5$ V	$V_{CC}=25$ V	$I_{B_1}=0.2$ $I_{B_2}=-0.2$	2	-	-	0.8	-	-	1.0	μs
Turn-Off Time (See Fig.12 for Test Circuit)	t_{off} (t_s+t_f)	$V_{BB}=-5$ V	$V_{CC}=25$ V	$I_{B_1}=0.2$ $I_{B_2}=-0.2$	2	-	-	1.5	-	-	2.0	μs

* Pulse Measurement, Pulse Duration ≤ 50 ms, non-repetitive $I_{s/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

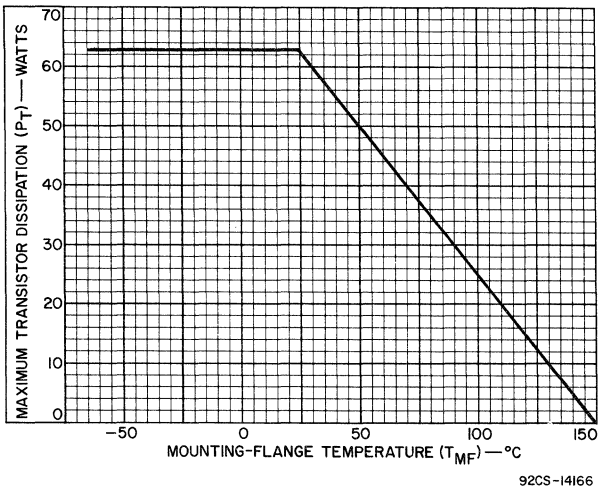


Fig.1 - Rating chart for RCA 2N4395 and 2N4396.

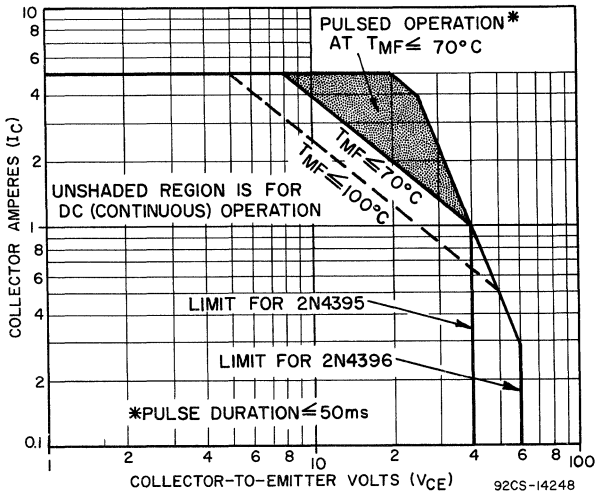


Fig.2 - Permissible operating regions for RCA 2N4395 and 2N4396.

TYPICAL CHARACTERISTICS FOR RCA 2N4395 AND 2N4396

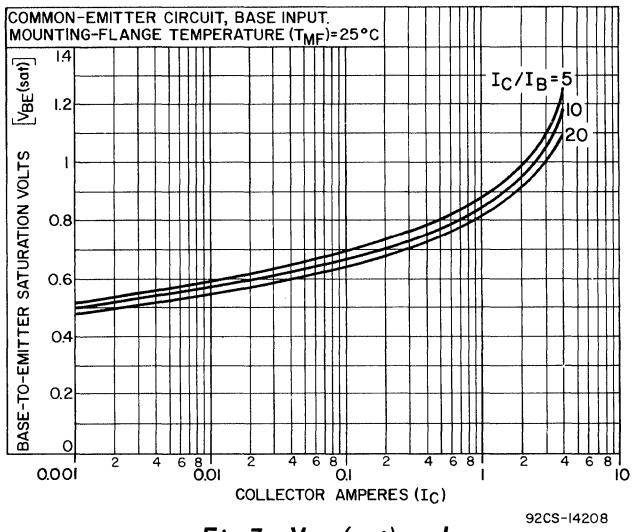


Fig.7 - $V_{BE}(sat)$ vs I_C

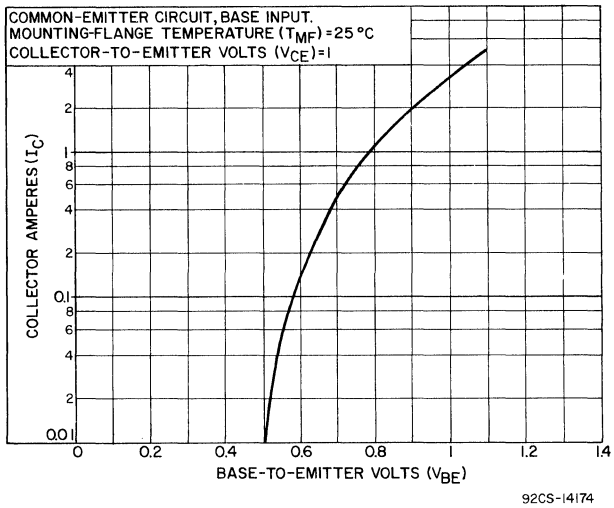


Fig.8 - Transfer characteristic.

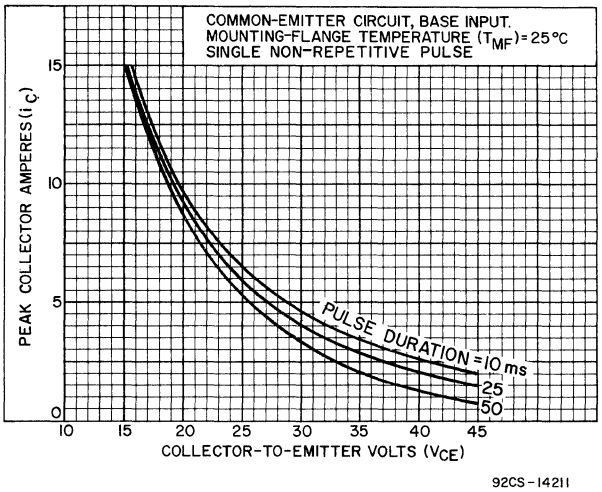


Fig.9 - Forward-bias second breakdown characteristics i_C vs V_{CE}.

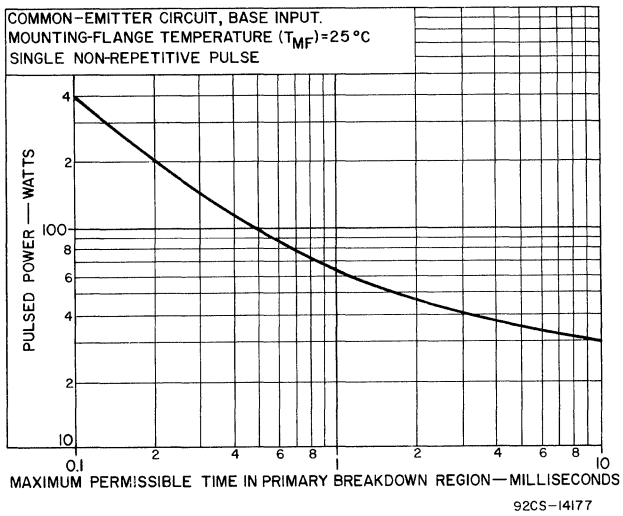


Fig.10 - Second-breakdown characteristic P_T vs t.

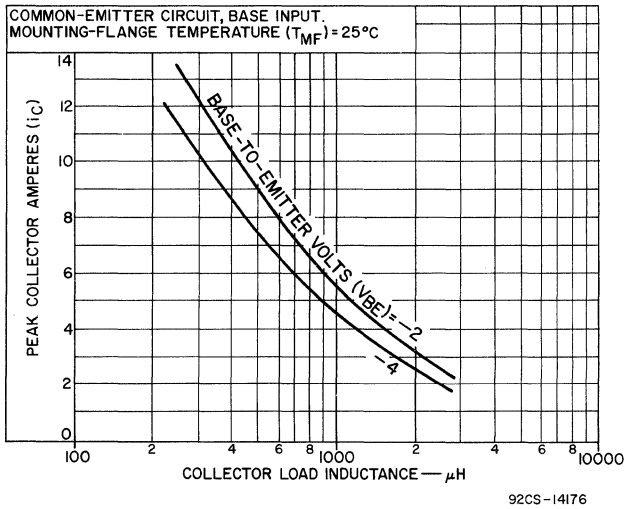


Fig.11 - Reverse-bias second breakdown characteristics i_C vs inductance.

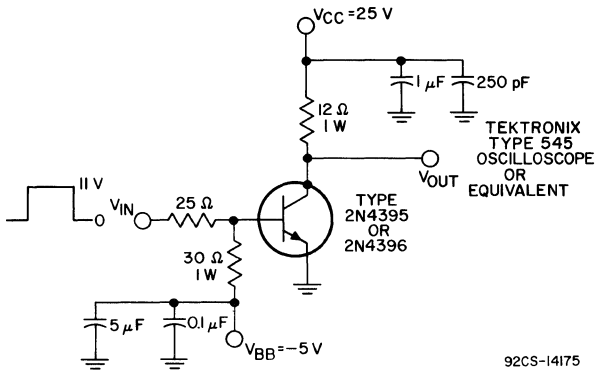


Fig.12 - Circuit used to measure turn-on time (t_{on}) and turn-off time (t_{off}) for RCA 2N4395 and 2N4396.

SECOND BREAKDOWN

Second breakdown in transistors is characterized by a sudden drop in the collector voltage and a sudden increase in the collector current. Because this current is very high (greater than 1 ampere), the power level is also very high and transistors subjected to this condition will almost always be permanently damaged. The phenomenon of second breakdown is not completely understood and various theories have been presented as to why it occurs. However, the damaging effects of this phenomenon are clearly evident and are manifested as small "burn" or "hot" spots in areas of minute crystallographic defects or non-uniform impurity regions in the base and active collector regions. At these burn spots, the silicon material actually melts and forms a collector-to-emitter short circuit. The high temperatures that produce these burn spots are caused by thermal runaway. To determine the second-breakdown threshold, the circuit designer should have a method of measuring the energy-dissipating capability of the transistor.

Additional information on Second Breakdown is given in RCA Application Notes SMA-30 "Second-Breakdown in Transistors under conditions of Cutoff" and AN204 "Operation of Memory-Core-Driver Transistors in the Primary-Voltage Breakdown Region.

TYPICAL CHARACTERISTICS FOR RCA 2N4395 AND 2N4396

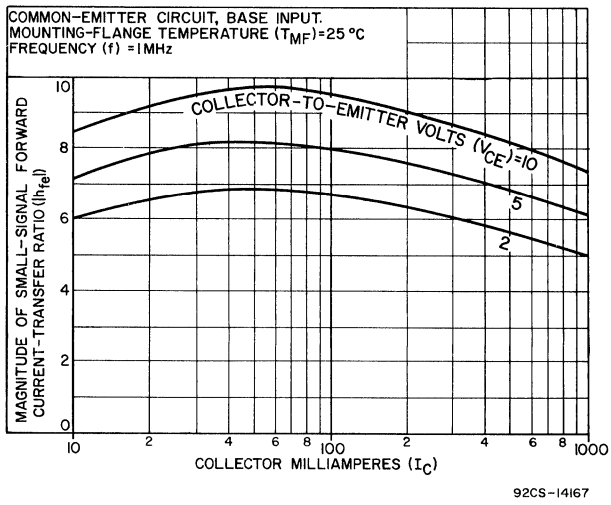


Fig.3 - $|h_{fe}|$ vs I_C

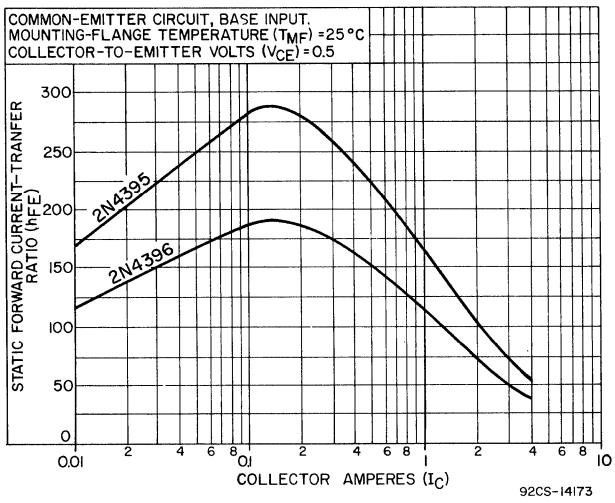


Fig.4 - h_{FE} vs I_C

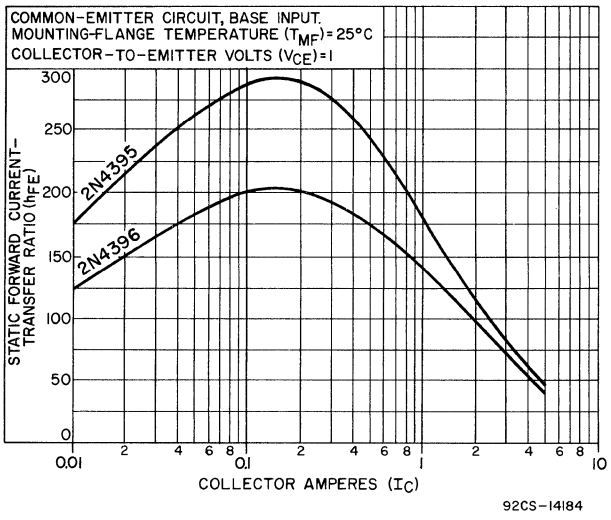


Fig.5 - h_{FE} vs I_C

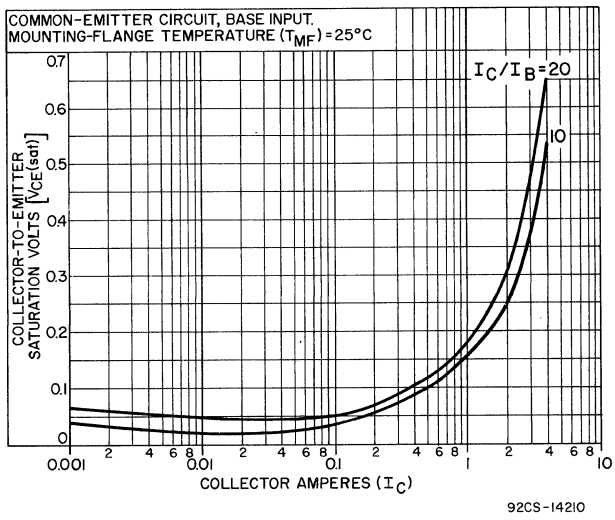
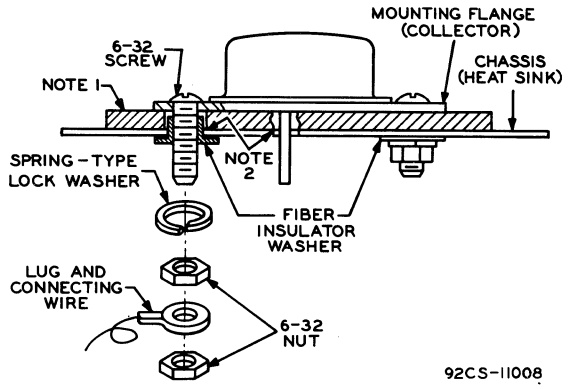


Fig.6 - $V_{CE(sat)}$ vs I_C



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

Mounting hardware items for RCA-2N4395 and 2N4396 are available from RCA Distributors under the following RCA Part Numbers:

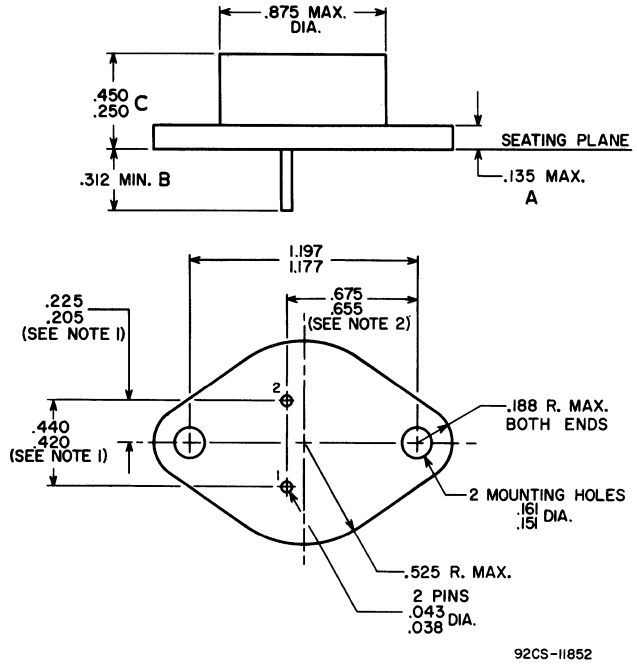
ITEM	RCA PART NO.
Mica Insulator	495320
Nylon Insulating Washer (2)	495334-7

Mica insulators are also available from Reliance Mica Co., 341-351 39th St., Brooklyn, N.Y. 10032, United Mineral & Chemical Corp., 16 Hudson St., N.Y., N.Y. 10014, and other suppliers of similar components.

Insulating shoulder washers are also available from Contour Plastics, Minneapolis, Minn. and other suppliers of similar components.

Sockets for RCA-2N4395 and 2N4396 and other semiconductor devices utilizing the JEDEC TO-3 package are made by several manufacturers, and are generally available from electronic parts distributors.

DIMENSIONAL OUTLINE
JEDEC No.TO-3



Dimensions in Inches

For RCA-2N4395 and 2N4396

Mounting-Flange Thickness (A) = 0.050" max.

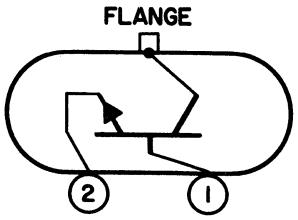
Pin Length (B) = 0.440" min. / 0.480" max.

Maximum Seated Height (C) = 0.325"

NOTE 1: THESE DIMENSIONS SHOULD BE MEASURED AT POINTS .050" (1.270MM) TO .055" (1.397MM) BELOW SEATING PLANE. WHEN GAUGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 2: TWO LEADS.

TERMINAL CONNECTIONS



Pin 1 - Base
Pin 2 - Emitter
Mounting Flange - Collector, Case

RCA RF TRANSISTORS
Low-Noise UHF "Forward-AGC" Type

2N4397

File No. 272

RCA 2N4397* is an epitaxial planar transistor of the silicon n-p-n type, with characteristics which make it very useful as a low-noise rf amplifier at frequencies up to 500 MHz. The 2N4397 is particularly useful for applications employing "forward-bias" AGC.

The RCA 2N4397 employs a New Terminal Arrangement in which the emitter and base connections are interchanged to provide maximum isolation between the output (collector) and the input (base) terminals. Although this new basing configuration does not appreciably change the measured device feedback capacitance, it permits the use of external inter-terminal shields to reduce the feedback due to external capacitances, particularly on printed circuit boards. This feature makes it possible to achieve greater circuit stability or higher useable gain per stage in critical circuit designs.

RCA 2N4397 features very low feedback capacitance, low noise, and high useful power gain. The high-temperature capability of this silicon device permits operation up to 200°C, junction temperature.

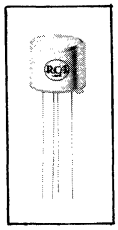
RCA 2N4397 utilizes a hermetically sealed JEDEC TO-104 metal case which is electrically isolated from the transistor electrodes. The case is provided with a separate lead which may be grounded to minimize collector-to-base interlead capacitance and coupling to other circuit components.

* Formerly Developmental No.TA7111.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	40 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max.	V
COLLECTOR CURRENT, I_C	Limited by Dissipation	
TRANSISTOR DISSIPATION, P_T:		
For ambient temperatures up to 25°C	200 max.	mW
For ambient temperatures above 25°C	Derate at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage	-65 to +200	°C
Operating (junction)	-65 to +200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/16 inch from seating surface for 10 seconds max.	265 max.	°C

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

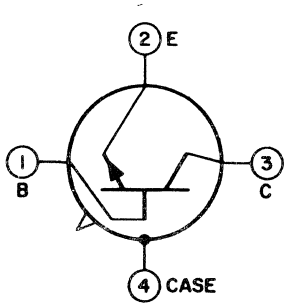


JEDEC TO-104

For Low-Noise UHF Applications in Industrial and Military Equipment Requiring "Forward-Bias" AGC

FEATURES

- New Terminal Arrangement. . . . . for superior high-frequency performance



Bottom View

1 - Base
2 - Emitter
3 - Collector
4 - Case

- controlled forward AGC characteristics — gain reduction (ΔG_{pe}) = 20 dB min. for change in I_c from 2 mA to 11 mA
- low noise figure — NF = 5 dB max. at 450 MHz
- very low collector-to-base feedback capacitance — C_{cb} = 0.25 pF max.
- high unneutralized power gain — G_{pe} = 11.5 dB min. at 450 MHz
- hermetically sealed JEDEC TO-104 metal package

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Printed in U.S.A.
2N4397 5-67

ELECTRICAL CHARACTERISTICS: *At an Ambient Temperature (T_A) of 25°C:*

Characteristics	Symbol	TEST CONDITIONS					LIMITS			Units
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N4397			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	–	10	–	0	–	–	–	0.02	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	–	–	–	0	0.001	40	–	–	V
Collector-to-Emitter Breakdown Voltage $I_B = 0$	$V_{(BR)CEO}$	–	–	–	–	1	40	–	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CES}$	Emitter-Base Termination Shorted				0.001	40	–	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	–	–	–	-0.01	0	3	–	–	V
Static Forward Current-Transfer Ratio	h_{FE}	–	–	10	–	2	40	–	180	–
Magnitude of Small-Signal Forward Current Transfer Ratio	$\lvert h_{fe} \rvert$[a]	1 kHz	–	10	–	2	40	–	200	–
		100	–	10	–	2	6	–	11	–
Collector-to-Base Feedback Capacitance	C_{cb}[b]	0.1 to 1	10	–	–	0	–	–	0.25	pF
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See Fig.2)	G_{pe}[a]	450		8	–	2	11.5	–	16.5	dB
Reduction in Small-Signal Power Gain with AGC (See Fig.1)	ΔG_{pe}[a]	For change in I_C from 2 mA to 11 mA					20	–	–	dB
Noise Figure (See Figs.1 and 2)	NF[a]	450	R_S[c] = 100 Ω	8	–	2	–	–	5	dB

[a] Lead No.4 (case) grounded.

[b] Three-terminal measurement: Lead No.2 (emitter) and lead No.4 (case) connected to guard terminal.

[c] R_S (Source Resistance) is the resistance looking back from the base terminal (1) toward the generator input.

TYPICAL Y-PARAMETER CHARACTERISTICS VS COLLECTOR CURRENT FOR 2N4397.

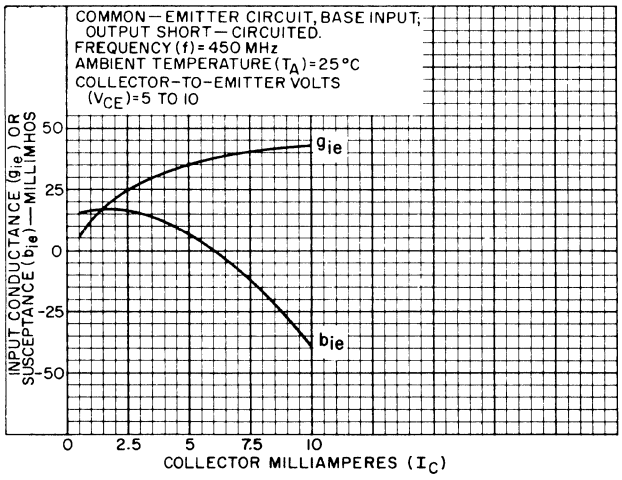


Fig.4 - Y_{ie} vs I_C.

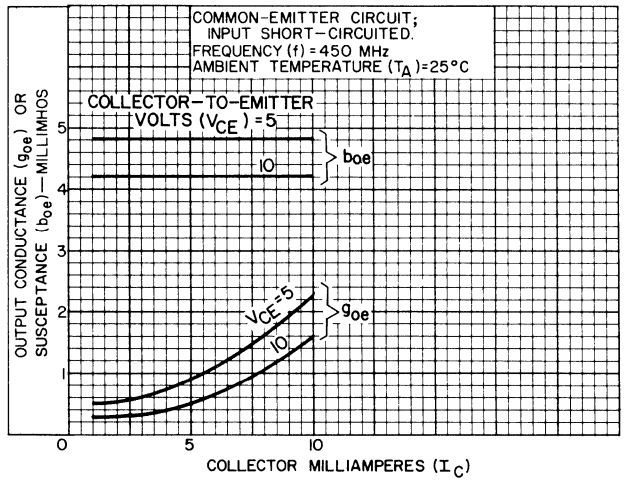


Fig.5 - Y_{oe} vs I_C.

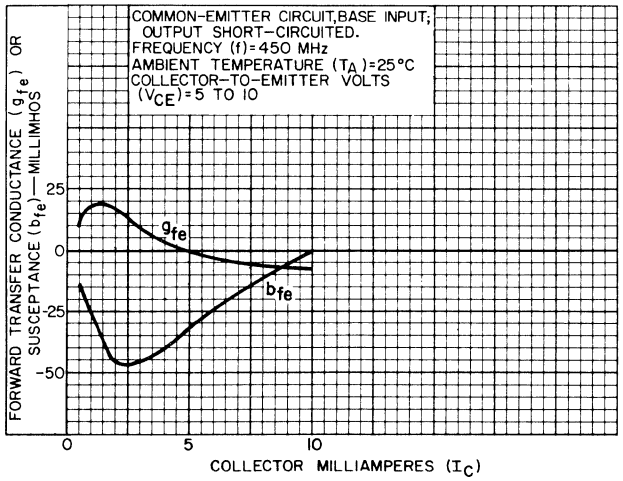


Fig.6 - Y_{fe} vs I_C.

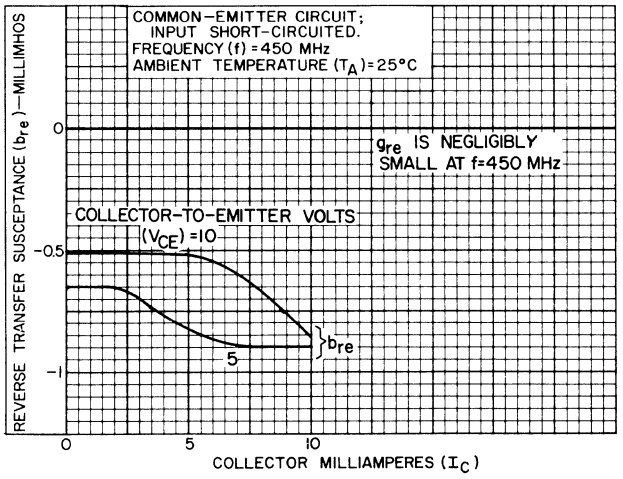


Fig.7 - Y_{re} vs I_C.

TYPICAL Y-PARAMETER CHARACTERISTICS VS FREQUENCY FOR 2N4397.

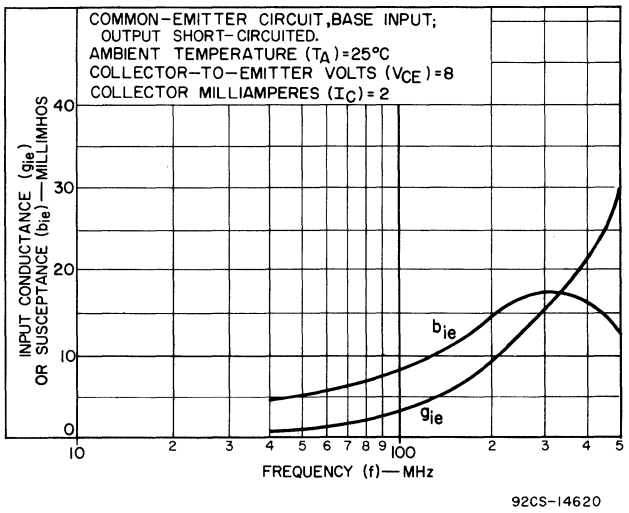


Fig.8 - Y_{ie} vs f.

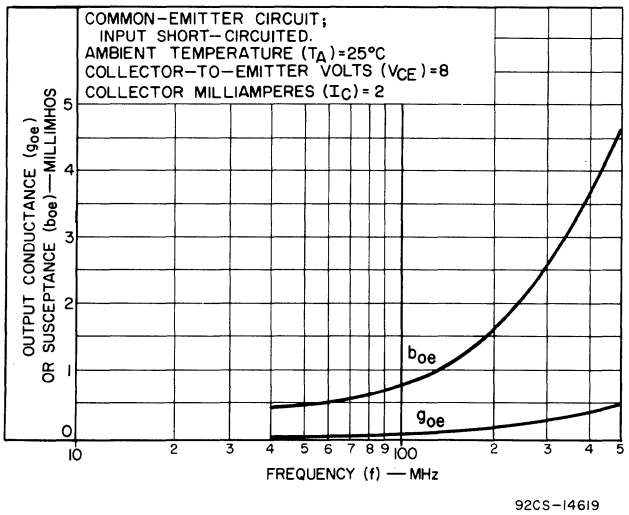


Fig.9 - Y_{oe} vs f.

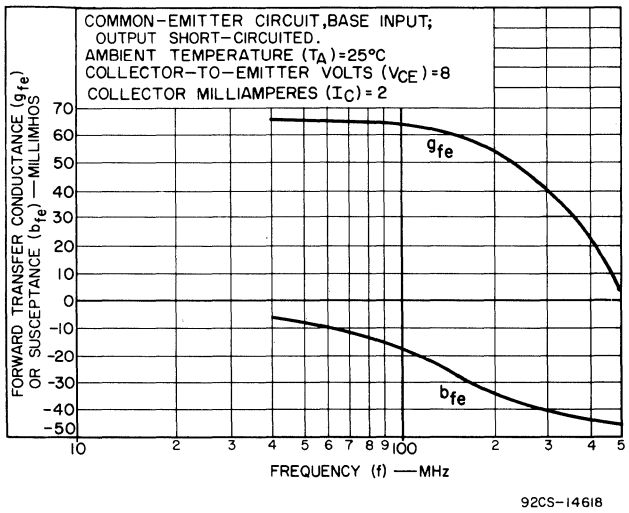


Fig.10 - Y_{fe} vs f.

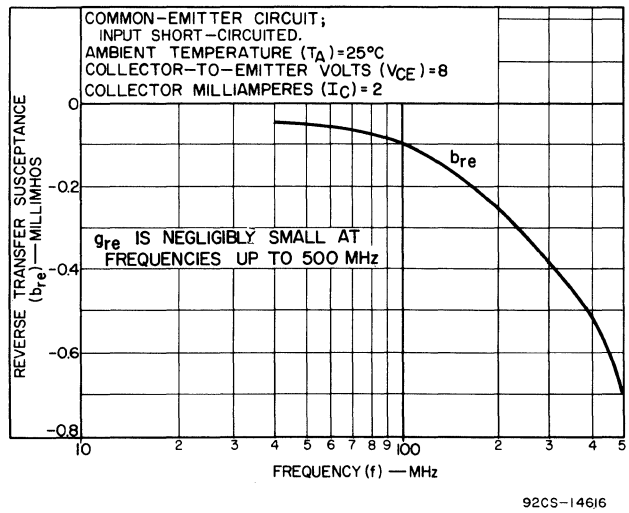
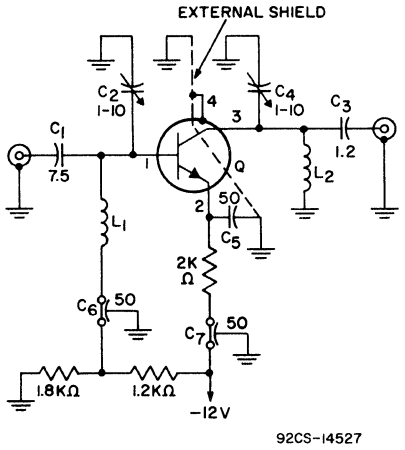


Fig.11 - Y_{re} vs f.



V_{CE} = 8 V
I_C = 2 mA
Socket – Barnes MG 404 100 mil diam Teflon or equiv.
All capacitors in pF
L_1 & L_2 – 1/4"Diam. brass bar 1"long
C_1 – Tubular ceramic 7.5 pF
Approx. 3/8"total lead length
C_2 & C_4 – Hammarlund Mac-10
variable air capacitor or equiv.
C_3 – Button ceramic 1.2 pF approx.
3/8"lead length
C_5 – Leadless ceramic disc. capac. 50 pF
C_6 & C_7 – Button ceramic feedthrough
capacitors 50 pF
Q = 2N4397

Fig.1 - 450-MHz Power Gain and Noise Figure Test Circuit for 2N4397.

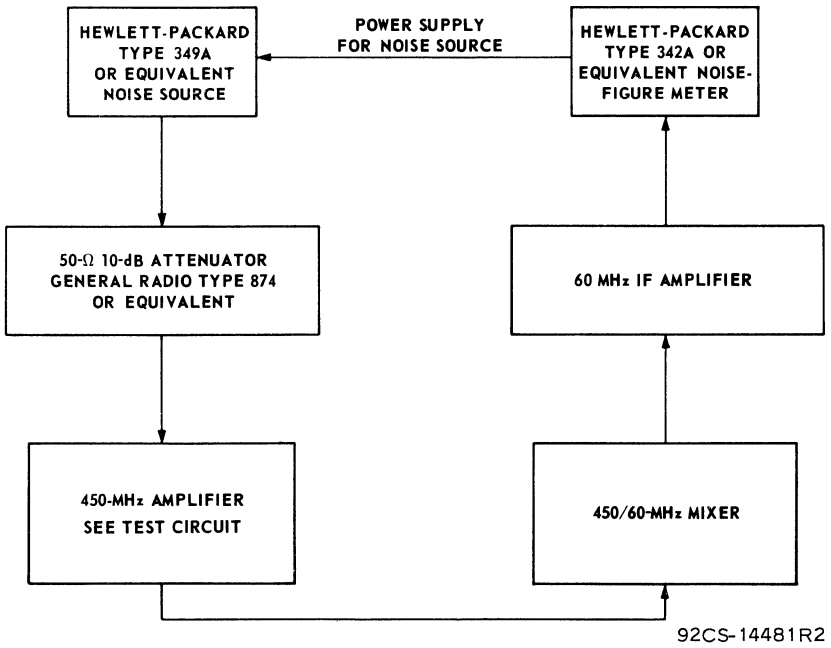


Fig.2 - Block Diagram of Noise-Figure Test Circuit for 2N4397.

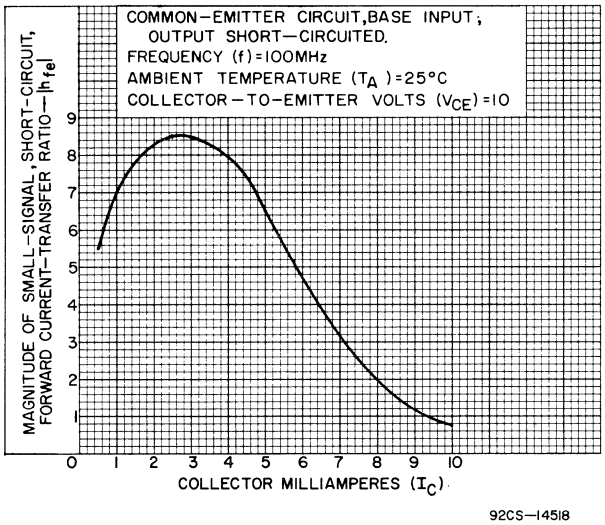
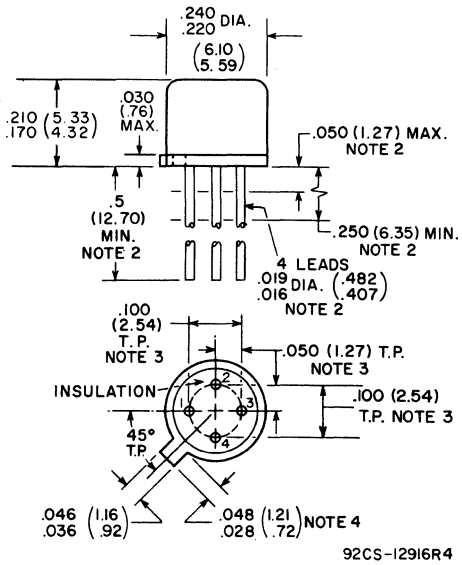


Fig.3 - Typical Magnitude of Small-Signal Beta Characteristics for 2N4397.

DIMENSIONAL OUTLINE
TO-104



Dimensions in Inches and Millimeters

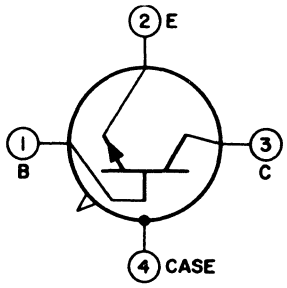
Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) +0.001" (0.025 mm) -0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

ATTENTION!
NEW TERMINAL
ARRANGEMENT
Bottom View



1 - Base
2 - Emitter
3 - Collector
4 - Case

OPERATING CONSIDERATIONS

The flexible leads of the 2N4397 are usually soldered to the circuit elements. As in the case of any high-frequency semiconductor device, the tips of soldering irons should be grounded, and appropriate precautions should be taken to protect the device against high electric fields.

This device should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the device.

SILICON N-P-N "overlay" TRANSISTOR

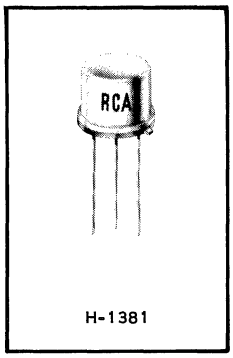
2N4427

File No. 228

RCA-2N4427 is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended for class–A, –B, or –C amplifier, frequency-multiplier, or oscillator circuits; it may be used in output, driver, or pre-driver stages in VHF and UHF equipment.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a single base and collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, and frequency capability.

High-Gain Driver for VHF-UHF



JEDEC TO-39

- **At 175 MHz, 1-Watt Output with 10 dB gain (min.), 12-Volt Collector Supply Voltage**
- **At 470 MHz, 0.4-Watt Output with 5 dB gain (typ.), 12-Volt Collector Supply Voltage**

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	20	volts
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2	volts
COLLECTOR CURRENT	I_C	0.4	amperes
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		3.5	watts
At case temperatures above 25° C		See *Fig.14*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

POWER OUTPUT vs. FREQUENCY

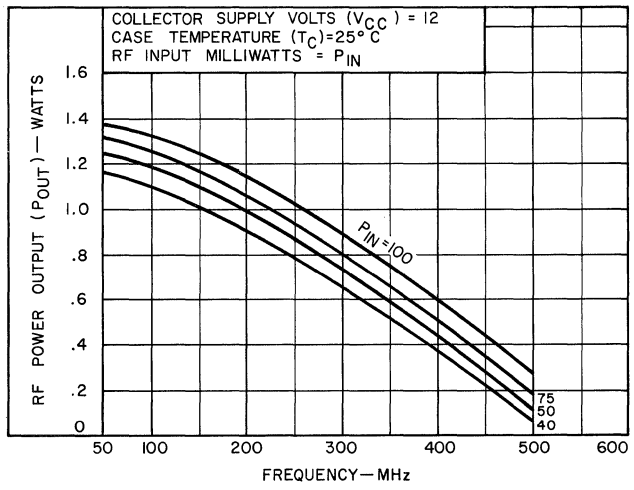


Fig. 1

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Marca(s) Registrada(s)

Printed in U.S.A.
2N4427 10/66

175 MHz OPERATION

POWER OUTPUT vs. POWER INPUT

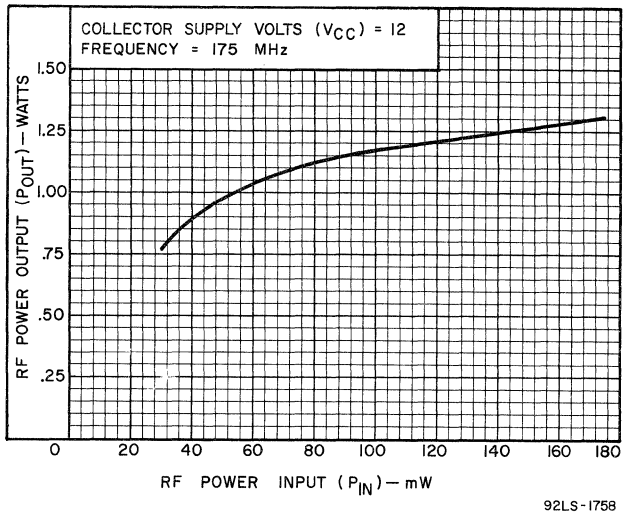
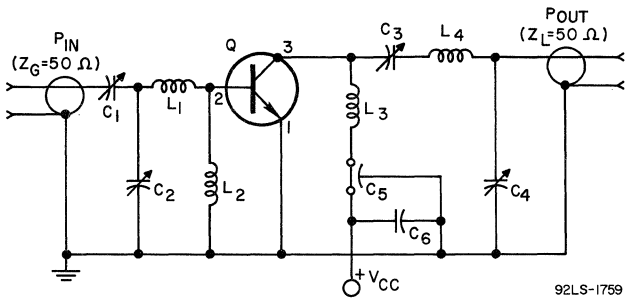


Fig. 2

RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



C_1, C_2, C_3, & C_4: 3-30 pF
C_5: 1,000 pF
C_6: 0.01 µF
L_1: 2 turns No.16 wire, 3/16" ID, 1/4" long
L_2: Ferrite choke, Z = 450 ohms
L_3: 2 turns No.16 wire, 1/4" ID, 1/4" long
L_4: 4 turns No.16 wire, 3/8" ID, 3/8" long
Q: 2N4427

Fig. 3

470 MHz OPERATION

POWER OUTPUT vs. POWER INPUT

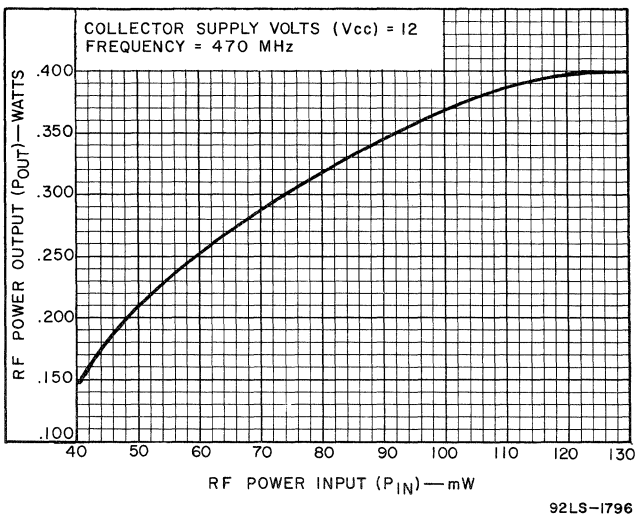
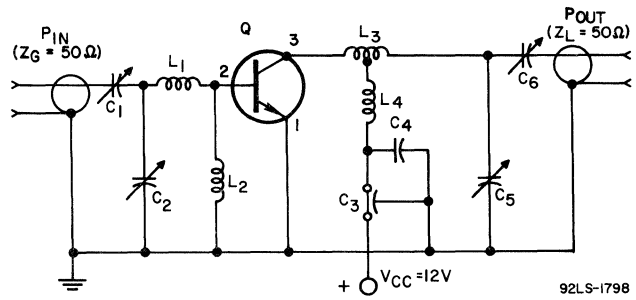


Fig.4

RF AMPLIFIER CIRCUIT



C_1, C_2, C_5, & C_6: 0.9 – 7 pF
C_3: 0.001 µF
C_4: 0.02 µF
L_1: 1 turn No.20 wire 3/16" ID Space wire diameter
L_2: 0.47 µH Nytronics Corp., or equivalent
L_3: 2 turns No.18 wire 1/4" ID Space wire diameter C.T.
L_4: 2 turns No.20 wire 3/16" ID Space wire diameter
Q: 2N4427

Fig.5

GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

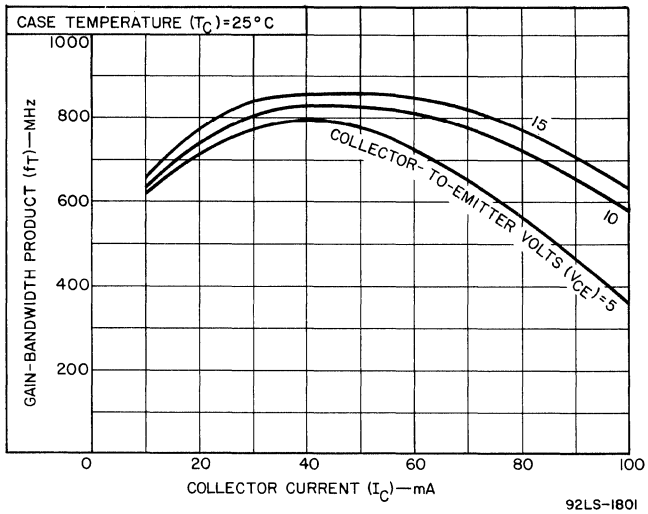


Fig.12

VARIATION OF COLLECTOR-TO-BASE CAPACITANCE

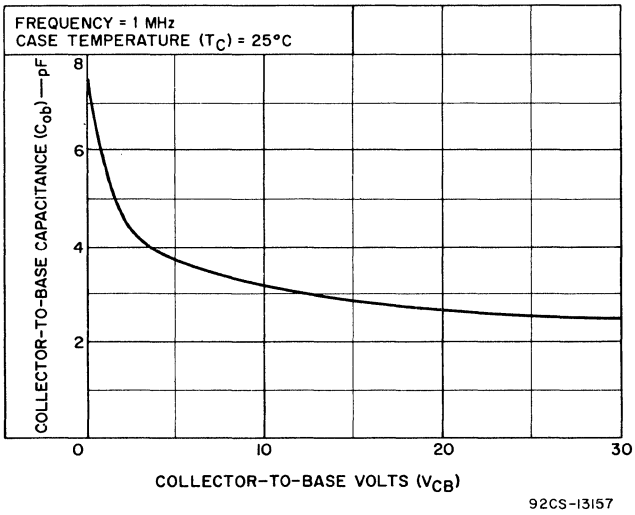


Fig.13

DISSIPATION DERATING CURVE

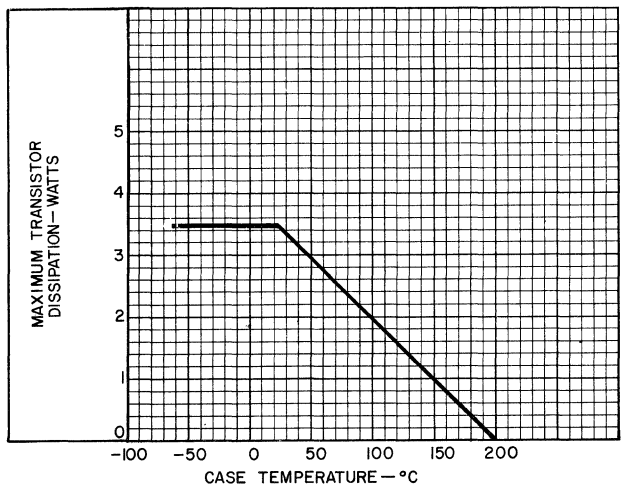
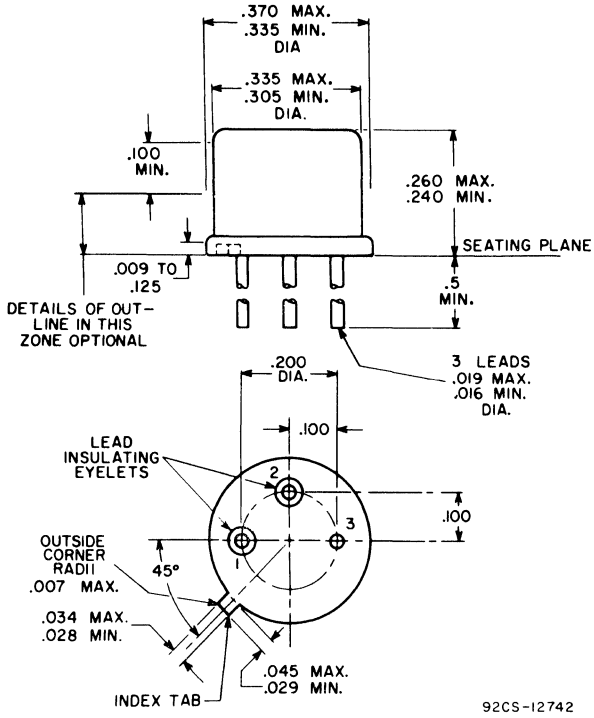


Fig.14

DIMENSIONAL OUTLINE JEDEC TO-39



DIMENSIONS IN INCHES

TERMINAL CONNECTIONS

Lead No.1 - Emitter
Lead No.2 - Base
Case, Lead No.3 - Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.
Part I - *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.
Part II - *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.
2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

Information furnished by RCA is believed to be accurate and reliable. However, no responsibility is assumed by RCA for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of RCA.

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS					Limits		Units
		DC Collector Volts		DC Current (mA)					
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		12		0		–	20	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}			0		0.1	40	–	V
Collector-to-Emitter Voltage (Sustaining)	$V_{CER}(sus)$[a]					5	40	–	V
	$V_{CEO}(sus)$				0	5	20	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0.1		0	2.0	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				20	100	–	0.5	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	12					–	4.0	pF
RF Power Output Class-C Amplifier, Unneutralized At 175 MHz (See *Fig.3*)	P_{OUT}		12[b]				1.0[c]	–	W

[a] With external base-emitter resistance (R_{BE}) = 10 Ω.

[b] V_{CC} value.

[c] For P_{IN} = 0.1 W; minimum efficiency = 50%.

SERIES INPUT RESISTANCE & REACTANCE vs. FREQUENCY

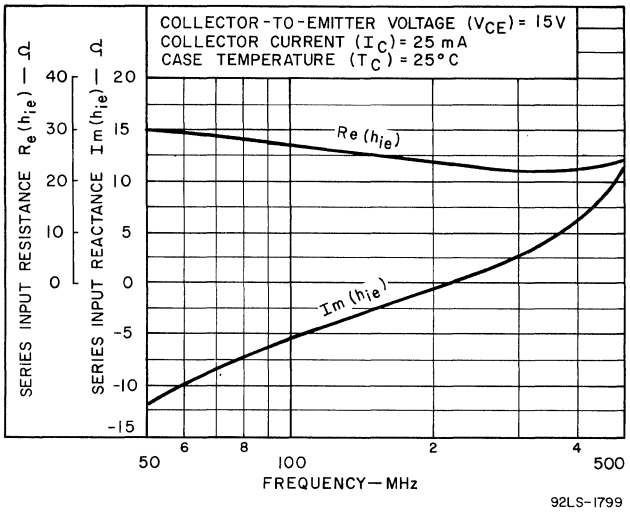


Fig.6

PARALLEL OUTPUT RESISTANCE & CAPACITANCE vs. FREQUENCY

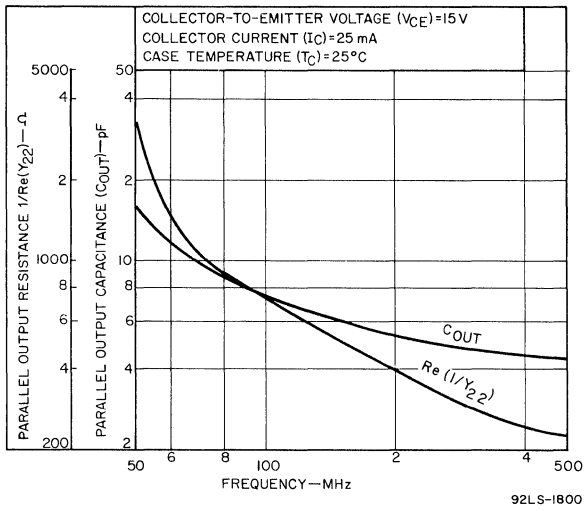


Fig.7

SERIES INPUT RESISTANCE vs. FREQUENCY

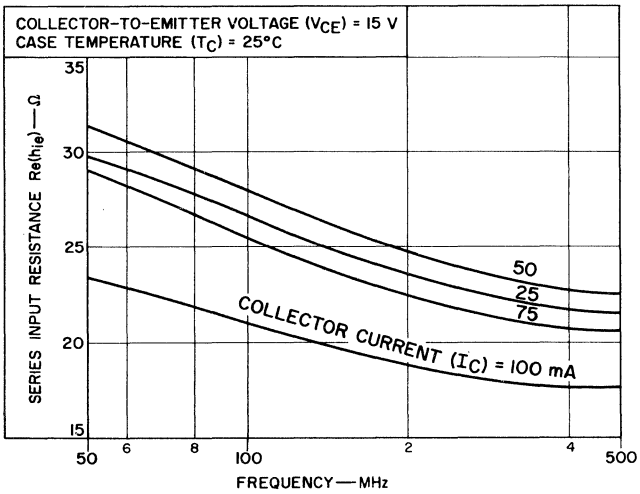


Fig.8

PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

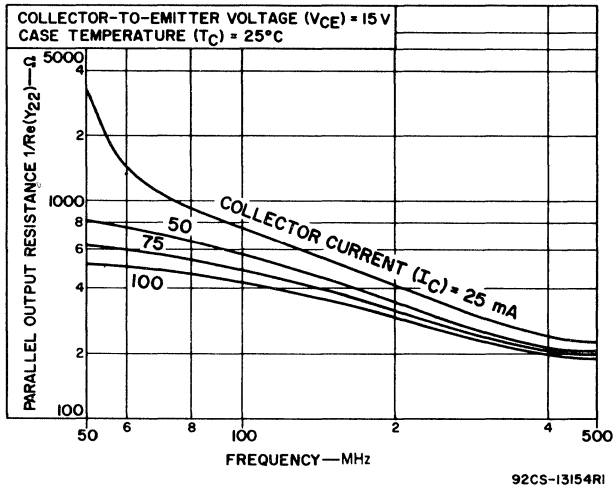


Fig.9

SERIES INPUT REACTANCE vs. FREQUENCY

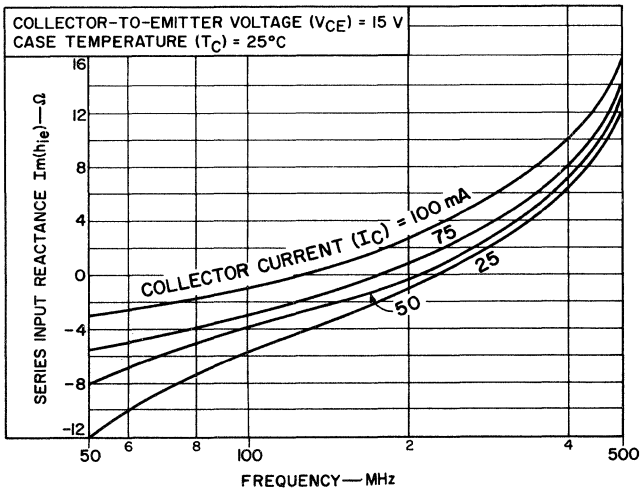


Fig.10

PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

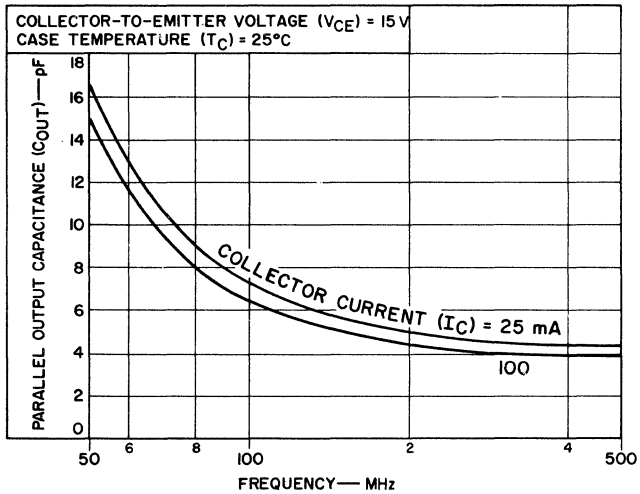


Fig.11


RCA

SILICON N-P-N "overlay" TRANSISTOR

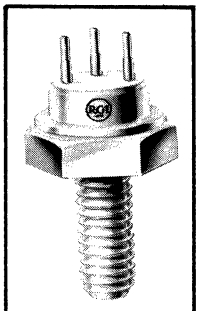
2N4440

File No. 217

RCA-2N4440* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended for Class A▲, –B and –C rf amplifier, multiplier, or oscillator operation for military and industrial communications service (175 to 400 MHz).

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.

*Formerly RCA-Dev. No.TA2875.



JEDEC TO-60

For Class A, –B or –C VHF –UHF Military and Industrial Communications

5 Watts Output Min. at 400 MHz

6.5 Watts Output Typ. at 225 MHz

RATINGS▲

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = –1.5 volts	V_{CEV}	65	V
With base open	V_{CEO}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	1.5	A
TRANSISTOR DISSIPATION▲	P_T		
At case temperatures up to 25° C		11.6	W
At case temperatures above 25° C		See *Fig.4*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulated wafer for 10 s max.		230	°C

▲Secondary breakdown considerations limit maximum DC operating conditions. . .contact your RCA Representative for specific data.

TYPICAL POWER OUTPUT vs. FREQUENCY

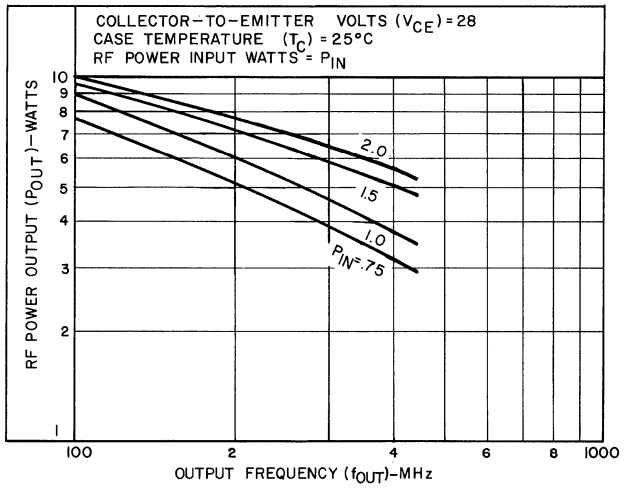


Fig. 1

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Printed in U.S.A.
2N4440 10/66
Supersedes File No.217 9/66

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	0.1	mA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	65	–	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	0 to 200[a]	40[b]	–	volts
	BV_{CEV}			−1.5			0 to 200[a]	65[b]	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					100	500	–	1	volts
Collector-to-Base Capacitance Measured at 1 MHz	C_{ob}	30			0			–	10	pF
RF Power Output Amplifier, Unneutralized At 225 MHz (See *Fig.2*) 400 MHz (See *Fig.3*)	P_{OUT}		28 28					6.5[c] (typ.) 5.0[d] –		watts
Gain-Bandwidth Product	f_T		28				150	500 (typ.)		MHz
Base-Spreading Resistance Measured at 400 MHz	$r_{bb'}$		28				250	10 (typ.)		ohms
Collector-to-Case Capacitance	C_s							–	6	pF

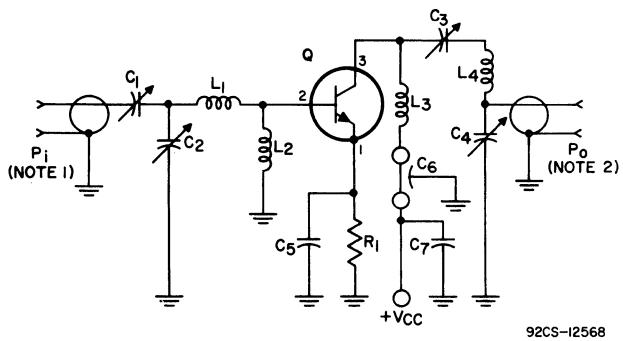
[a]Pulsed through an inductor (25 mH); duty factor = 50%.

[b]Measured at a current where the breakdown voltage is a minimum.

[c]For P_{IN} = 1.7 W; minimum efficiency = 55%.

[d]For P_{IN} = 1.7 W; minimum efficiency = 45%.

RF AMPLIFIER CIRCUIT POWER OUTPUT TEST
(225 MHz operation)



NOTE 1: Generator impedance = 50 ohms.

NOTE 2: Load impedance = 50 ohms.

C_1: 2-25 pF
C_2, C_3, C_4: 4-40 pF
C_5: 50 pF, disc ceramic
C_6: 1500 pF
C_7: 0.005 µF, disc ceramic
L_1: 1 turn No.16 wire, 1/4" ID, 1/8" long
L_2: Ferrite choke, Z = 450 (± 20%) ohms
L_3: 0.47-µH choke
L_4: 2 turns No.16 wire, 3/8" ID, 7/16" long
Q : 2N4440
R_1: 1.35 ohms, non-inductive

Fig. 2

RF AMPLIFIER CIRCUIT POWER OUTPUT TEST
(440 MHz operation)

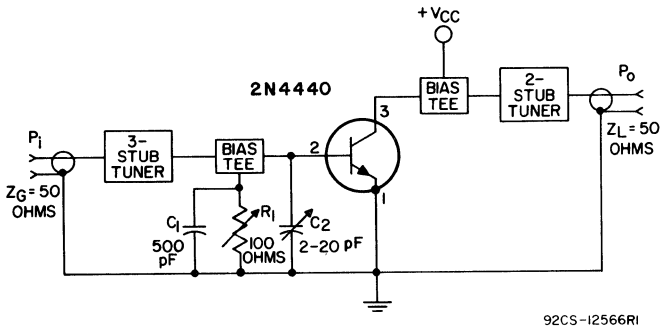


Fig. 3

DISSIPATION DERATING CURVE

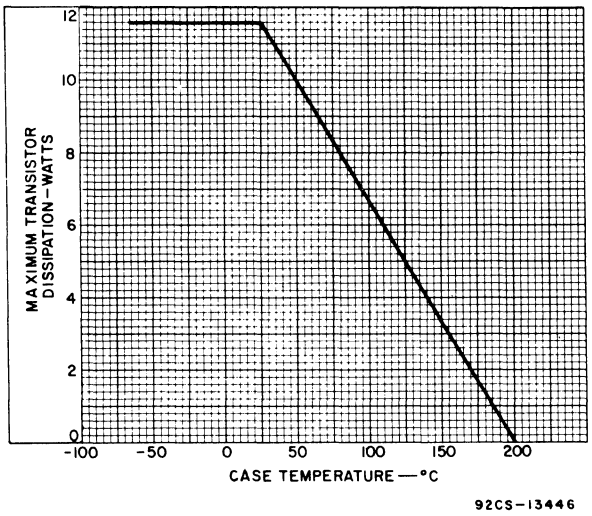


Fig. 4

TYPICAL SERIES INPUT REACTANCE vs. FREQUENCY

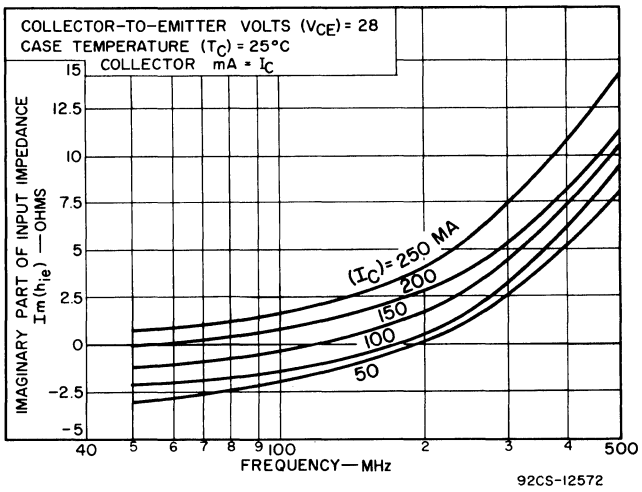


Fig. 5

TYPICAL OUTPUT CAPACITANCE vs. FREQUENCY

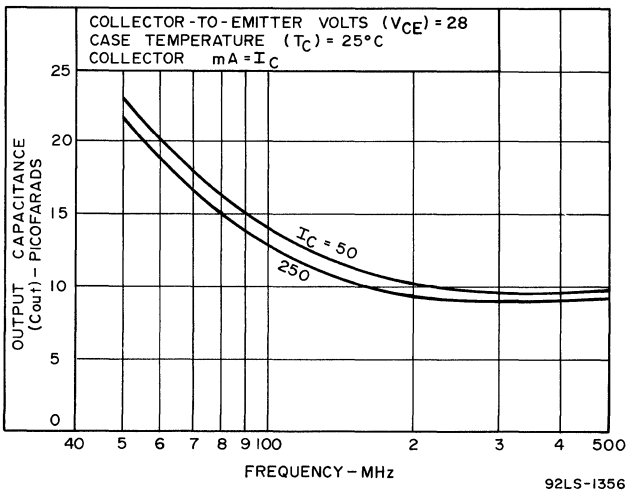


Fig. 6

TYPICAL SERIES INPUT RESISTANCE vs. FREQUENCY

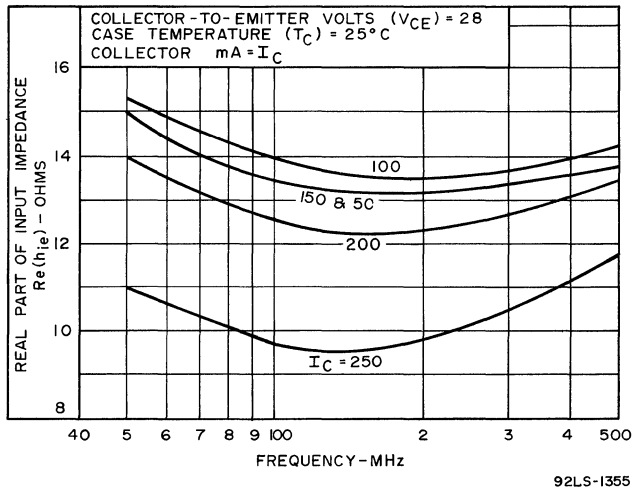


Fig. 7

TYPICAL GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

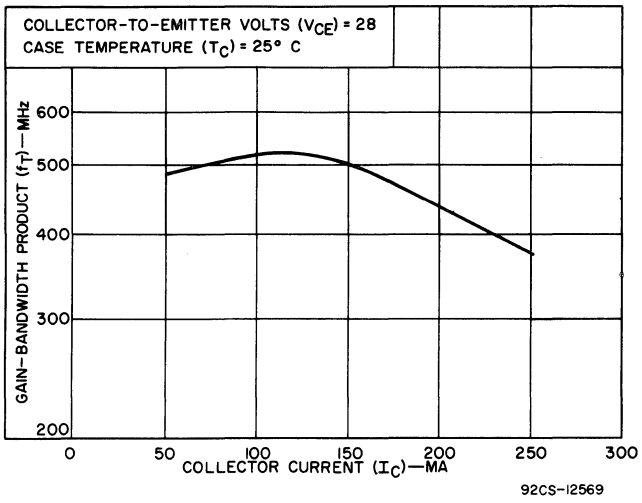


Fig. 8

TYPICAL OUTPUT RESISTANCE vs. FREQUENCY

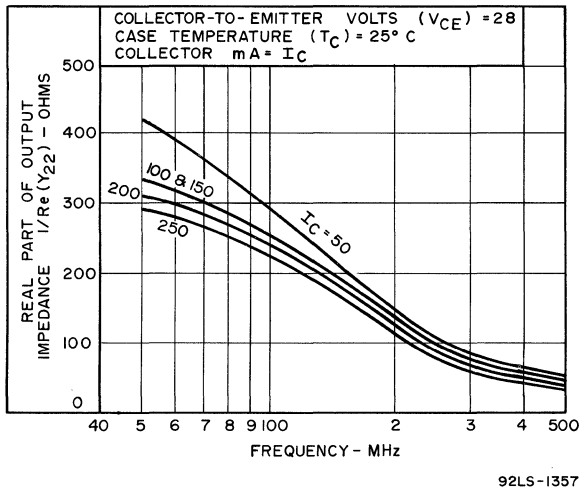
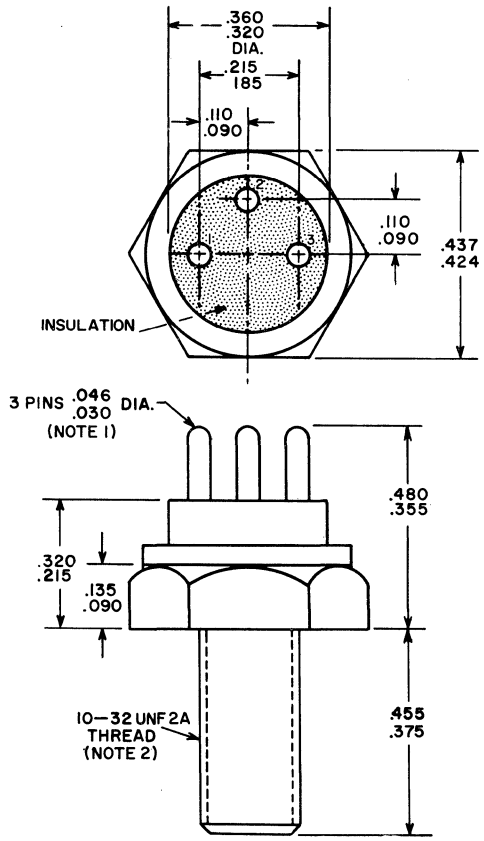


Fig. 9

DIMENSIONAL OUTLINE JEDEC TO-60



NOTE 1: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" and contacts which will accommodate pins having a diameter of 0.035" min., 0.045"max.

NOTE 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

NOTE 3: This device may be operated in any position.

TERMINAL CONNECTIONS

Pin No.1 - Emitter
Pin No.2 - Base
Pin No.3 - Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I - *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II - *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

SILICON N-P-N "overlay" TRANSISTORS

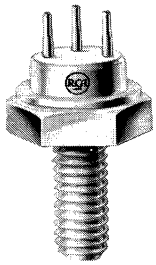
2N4932
2N4933

File No. 249

RCA-2N4932* and RCA-2N4933▲ are epitaxial silicon n-p-n planar transistors of the "overlay" emitter electrode construction. They are especially intended to provide high power as class C rf amplifiers for International VHF Mobile and Portable Communications service (66 to 88 MHz). The 2N4932 is designed to operate from a 13.5-volt power supply; the 2N4933, from a 24-volt power supply.

The transistors feature protection against load mismatch.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.



JEDEC TO-60

For International VHF Mobile and Portable Communication, 66 to 88 MHz

Operation From a Power Supply of –
13.5 volts (2N4932)
24 volts (2N4933)

Power Output (Min.) at 88 MHz
12 watts (2N4932)
20 watts (2N4933)

Load Protection
High Voltage Ratings

* Formerly RCA-Dev. No.TA2828
▲ Formerly RCA-Dev. No.TA2792

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

		2N4932	2N4933	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	70	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	25	35	V
With V_{BE} = −1.5V	V_{CEV}	50	70	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4.0		V
COLLECTOR CURRENT:				
Peak		10		A
Continuous	I_C	3.3		A
RF INPUT POWER	P_{in}			
At 88 MHz		3.5		W
Below 88 MHz		See *Fig.7*		
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25° C		70		W
At case temperatures above 25° C		See *Fig.1*		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		−65 to 200		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230		°C

DISSIPATION DERATING CURVE

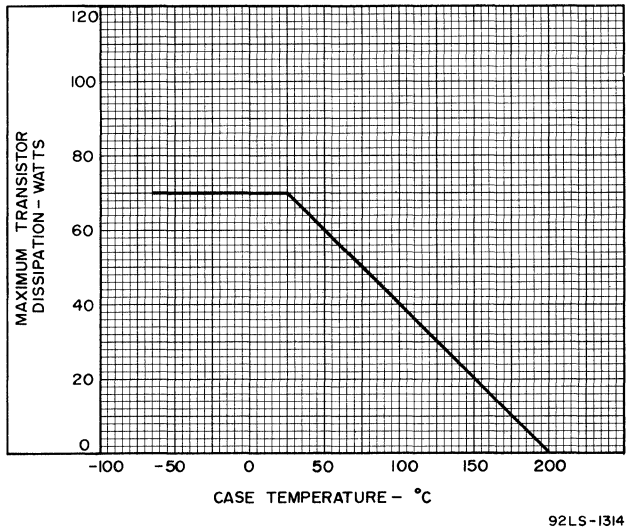


Fig.1

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Marca(s) Registrada(s)

Printed in U.S.A.
2N4932
2N4933
12/66

ELECTRICAL CHARACTERISTICS FOR 2N4932
Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		15			0			1.0	mA
	I_{CBO}	40			0				10	mA
Collector-to-Emitter Breakdown Voltage	$V_{CEV}(sus)$			−1.5			200[a]	50		V
	$V_{CEO}(sus)$					0	200[a]	25		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10		0	4		V
Collector-to-Base Capacitance	C_{ob}	15			0				120	pF
RF Power Output (See *Fig.2*)	P_{out}							12[c]		W

ELECTRICAL CHARACTERISTICS FOR 2N4933
Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0			1.0	mA
	I_{CBO}	50			0				10	mA
Collector-to-Emitter Breakdown Voltage	$V_{CEV}(sus)$			−1.5			200[a]	70		V
	$V_{CEO}(sus)$					0	200[a]	35		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10		0	4		V
Collector-to-Base Capacitance	C_{ob}	30			0				85	pF
RF Power Output (See *Fig.3*)	P_{out}							20[b]		W

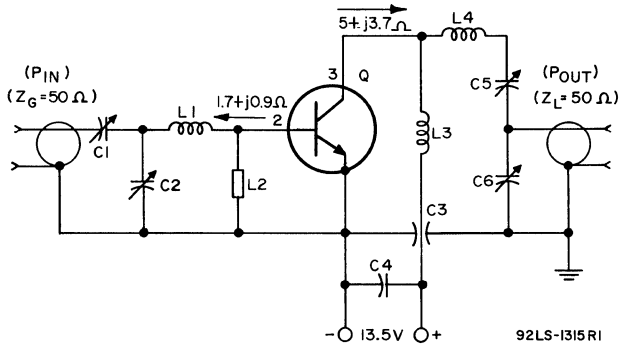
[a] Pulsed through an inductor (25mH), duty factor = 50%

[b] For P_{in} = 3.5 W, at 88 MHz; V_{cc} = 24V, minimum efficiency = 70%

[c] For P_{in} = 3.5 W, at 88 MHz; V_{cc} = 13.5V, minimum efficiency = 70%

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(66 to 88 MHz Operation)

2N4932



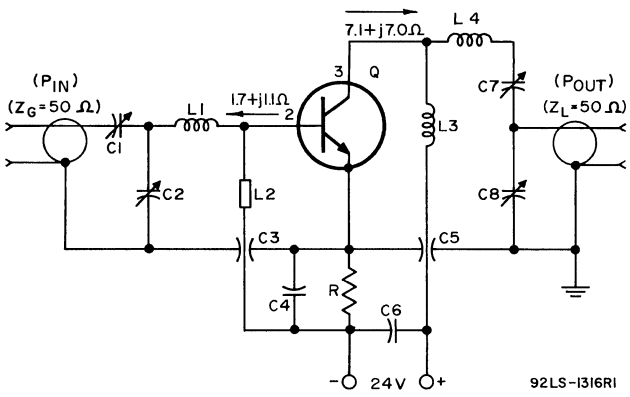
C_1 = 7-100 pF
C_2 = 14-150 pF
C_3 = 1000 pF
C_4 = .05 µF
C_5 = 70-350 pF
C_6 = 32-250 pF

L_1 = 1 turn, No.16 wire, 1/4" ID, 1/8" long
L_2 = Ferrite Choke, Z = 450 Ω, Ferroxcube #VK200 01-3B*
L_3 = 2 turns, No.16 wire, 1/4" ID, 3/8" long
L_4 = 2 turns, No.10 wire, 1/2" ID, 1/2" long
Q = 2N4932

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 2

2N4933



C_1 = 7-100 pF
C_2 = 14-150 pF
C_3, C_5 = 1000 pF
C_4, C_6 = .05 µF
C_7 = 70-350 pF
C_8 = 32-250 pF
R = 0.33 Ω

L_1 = 1 turn, No.16 wire, 1/4" ID, 1/8" long
L_2 = Ferrite Choke, Z = 450 Ω, Ferroxcube #VK200 01-3B*
L_3 = 3.5 turns, No.16 wire, 1/4" ID, 1/2" long
L_4 = 3 turns, No.10 wire, 1/2" ID, 3/4" long
Q = 2N4933

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 3

TYPICAL POWER OUTPUT vs POWER INPUT

2N4932

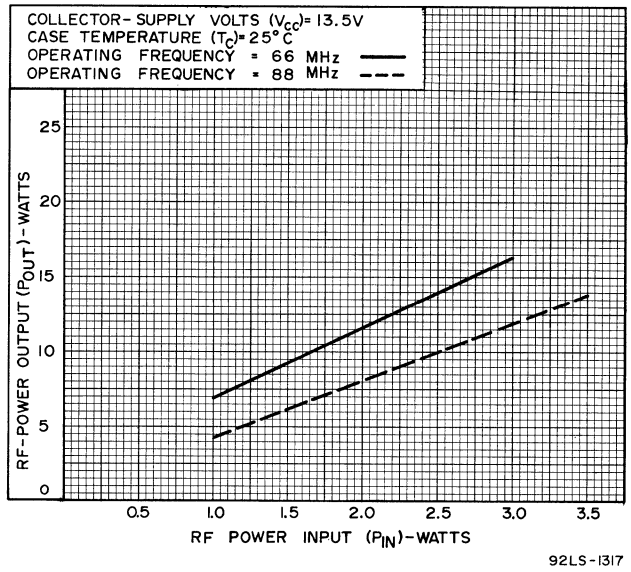


Fig. 4

2N4933

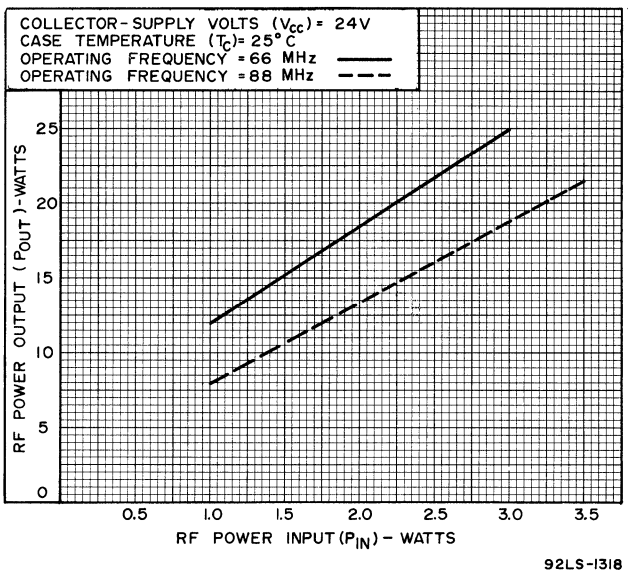


Fig. 5

SPECIAL PERFORMANCE DATA

The transistor can withstand any mismatch in load, which can be demonstrated in the following test:

1. The test is performed using the arrangement in *Fig.6*.
2. The tuning stub is varied through a half wavelength, which effectively varies the load from an open circuit to a short circuit.
3. Operating conditions: V_{cc} = 13.5V (2N4932), 24V (2N4933); RF input power = 3W @ 66 MHz.
4. Transistor Dissipation Rating must not be exceeded. During the above test, the transistor will not be damaged or degraded.

BLOCK DIAGRAM FOR MISMATCH TEST

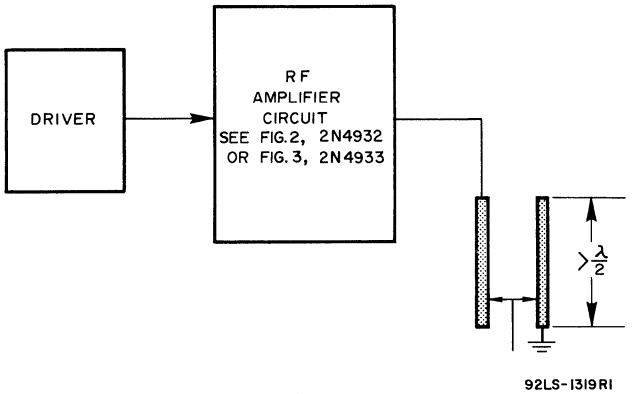


Fig. 6

INPUT DERATING CURVE

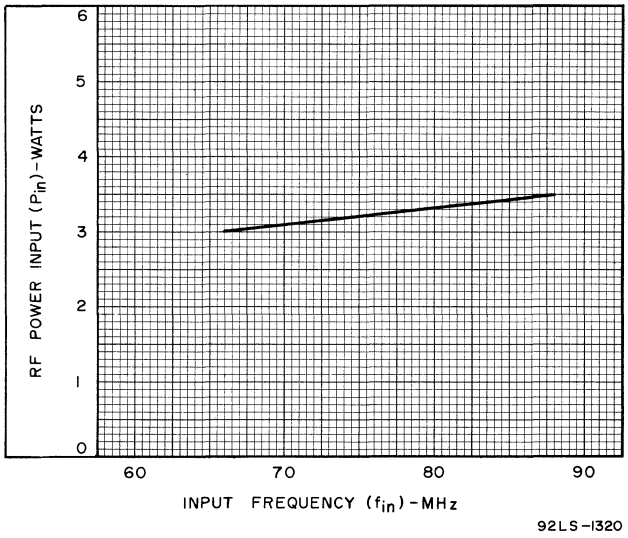
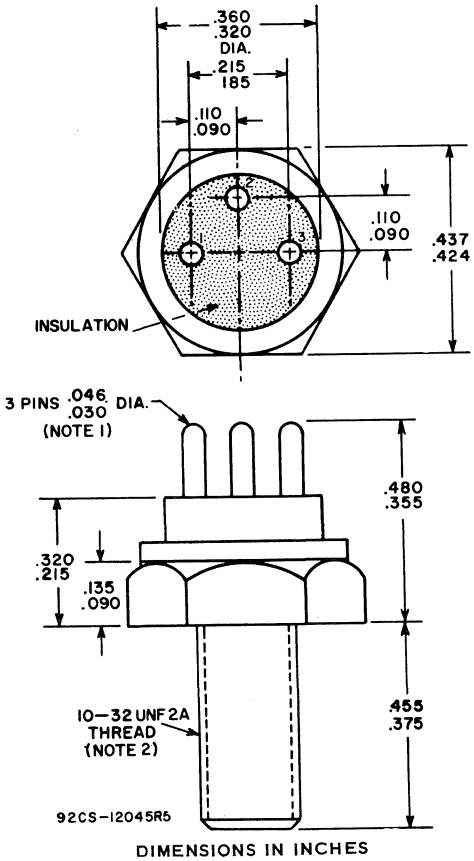


Fig. 7

DIMENSIONAL OUTLINE
JEDEC TO-60



DIMENSIONS IN INCHES

TERMINAL CONNECTIONS

Case, Mounting Stud, Pin No.1 - Emitter
Pin No.2 - Base
Pin No.3 - Collector

NOTE 1: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" and contacts which will accommodate pins having a diameter of 0.035" min., 0.046" max.

NOTE 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

NOTE 3: This device may be operated in any position.

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.
   Part I - *New Geometry Boosts Power,* D. R. Carley, P. L. McGeough, and J. F. O'Brien.
   Part II - *Putting the Overlay to Work at Hi-Frequency,* Dr. D. J. Donahue and B. A. Jacoby.
2. *Design Trade-Offs for RF Transistor Power Amplifiers,* R. Minton, RCA Publication No.ST-3250.
3. *Semiconductor High-Frequency Power Amplifier Design,* R. Minton, RCA Publication No.ST-3230.
4. *RF Power Transistors in Vehicular Radio Communications Equipment,* S. Matyckas, RCA Publication No.ST-3219.

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2N4934
2N4935
2N4936

SILICON N-P-N EPITAXIAL PLANAR TRANSISTORS



JEDEC TO-104

For VHF/UHF Applications in Industrial and Commercial Equipment

RCA-2N4934, 2N4935, and 2N4396* are epitaxial planar transistors of the silicon npn type with characteristics which make them extremely useful as low-noise rf amplifiers at frequencies up to 500 MHz.

These types employ a New Terminal Arrangement in which the emitter and base connections are interchanged to provide maximum isolation between the output (collector) and the input (base) terminals. Although this new basing configuration does not appreciably change the measured device feedback capacitance, it permits the use of external inter-terminal shields to reduce the feedback due to external capacitances, particularly on printed circuit boards. This feature makes it possible to achieve greater circuit stability or higher useable gain per stage in critical circuit designs.

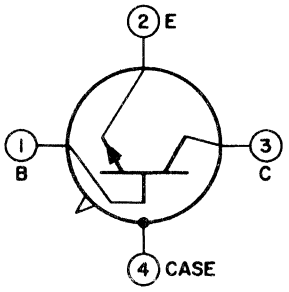
These devices feature very low feedback capacitance, low noise, and high useful power gains in their recommended applications. The high-temperature capability of these silicon devices permits operation up to 200°C.

RCA-2N4934, 2N4935, 2N4936 utilize a hermetically sealed metal case which is electrically isolated from the transistor electrodes. The case is provided with a separate lead which may be grounded to minimize collector-to-base interlead capacitance and coupling to other circuit components.

* Formerly Dev. No's TA7023, TA7024, TA7025, respectively.

FEATURES

- New Terminal Arrangement.....for superior high-frequency performance



1 - Base
2 - Emitter
3 - Collector
4 - Case

Bottom View

- high gain-bandwidth product — f_T = 700 MHz min.
- high unneutralized power gain — G_{pe} = 18 dB min for 2N4934 at 200 MHz; 21 dB min for 2N4935 at 200 MHz; 13 dB min for 2N4936 at 450 MHz
- low noise figure — NF = 3.5 dB max. for 2N4934 at 200 MHz; 3.0 dB max. for 2N4935 at 200 MHz; 4.5 dB max. for 2N4936 at 450 MHz
- very low collector-to-base feedback capacitance — C_{cb} = 0.25 pf max. at 0.1 to 1 MHz
- hermetically sealed TO-104 metal case
- high operating temperature capability to 200°C

Maximum Ratings, *Absolute-Maximum Values:*

	2N4934	2N4935	2N4936	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40	50	50	max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	30	40	40	max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	3	3	max. V
COLLECTOR CURRENT, I_C	Limited by dissipation			
TRANSISTOR DISSIPATION, P_T: At ambient temperatures Up to 25°C.	200 max.			mW
Above 25°C.	derate at 1.14 mW/°C			
TEMPERATURE RANGE: Storage and operating (Junction)	-65 to +200			°C
LEAD TEMPERATURE (During Soldering): At distances not less than 1/32" from seating surface for 10 seconds max.	265 max.			°C

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Printed in U.S.A.
2N4934 - 2N4936 3-67

ELECTRICAL CHARACTERISTICS, *At Ambient Temperature (T_A) of 25°C:*

CHARACTERISTIC	Symbol	TEST CONDITIONS					LIMITS									UNITS
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N4934			Type 2N4935			Type 2N4936			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-	15	-	0	-	-	-	10	-	-	10	-	-	10	nA
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	0.001	40	-	-	50	-	-	50	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	-	-	-	I_B=0	1	30	-	-	40	-	-	40	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	-0.001	0	3	-	-	3	-	-	3	-	-	V
DC Forward Current-Transfer Ratio	h_{FE}	-	-	8	-	2	40	-	170	60	-	200	60	-	250	-
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\|h_{fe}\|$ [a]	1 kHz 100 MHz	- -	8 8	- -	2 2	45 7	- -	195 16	70 7	- -	225 16	70 7	- -	280 16	-
Collector-to-Base Feedback Capacitance	C_{cb} [b]	0.1 to 1	8	-	0	-	-	0.2	0.25	-	0.2	0.25	-	0.2	0.25	pF
Collector-to-Base Time Constant	$r_b'C_c$ [a]	31.9	8	-	-2	-	1	-	8	1	-	6	1	-	6	ps
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See Figs. 1 and 4)	G_{pe} [a]	200 450	-	8	-	2	18 -	- -	26 -	21 -	- -	28 -	- 13	- -	- 18	dB
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe} [a]	450	-	8	-	2	-	-	-	-	-	-	-	20	-	dB
Measured Noise Figure	NF [a]	200 See Figs. 1 and 2	R_S = 200 Ω [c]	8	-	2	-	-	3.5	-	-	3.0	-	-	-	dB
		450 See Figs. 3 and 4	R_S = 100 Ω [c]	8	-	2	-	-	-	-	-	-	-	-	4.5	

[a] Lead No.4 (case) grounded.

[b] Three-terminal measurement: Lead No.2 (emitter) and lead No.4 (case) connected to guard terminal.

[c] R_S (Source Resistance) is the resistance looking back from the base terminal toward the generator input.

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Typical y-parameter characteristics for 2N4934, 2N4935 and 2N4936 at 200 MHz

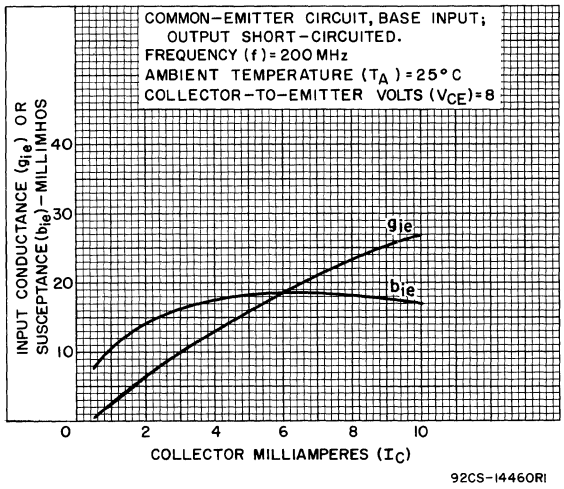


Fig.5 - Y_{ie} vs I_C

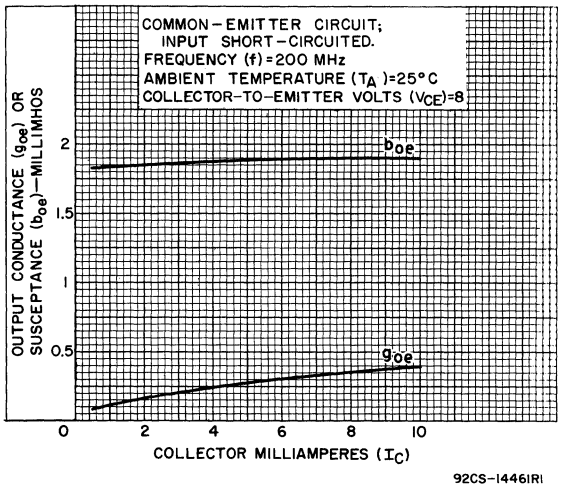


Fig.6 - Y_{oe} vs I_C

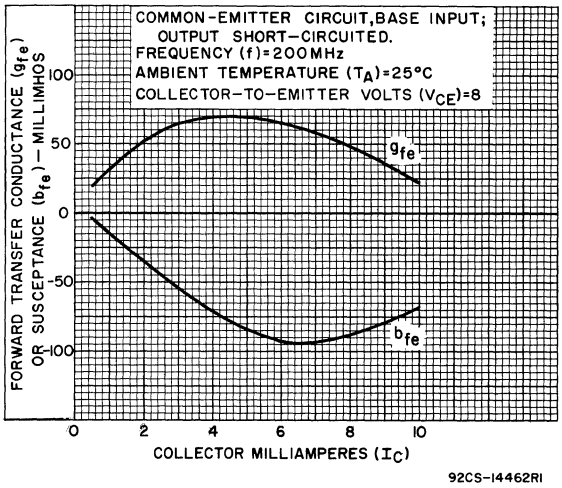


Fig.7 - Y_{fe} vs I_C

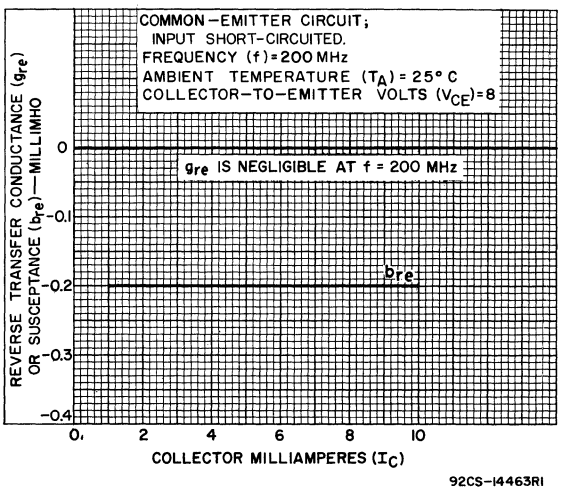


Fig.8 - Y_{re} vs I_C

Typical y-parameter characteristics for 2N4936 at 450 MHz

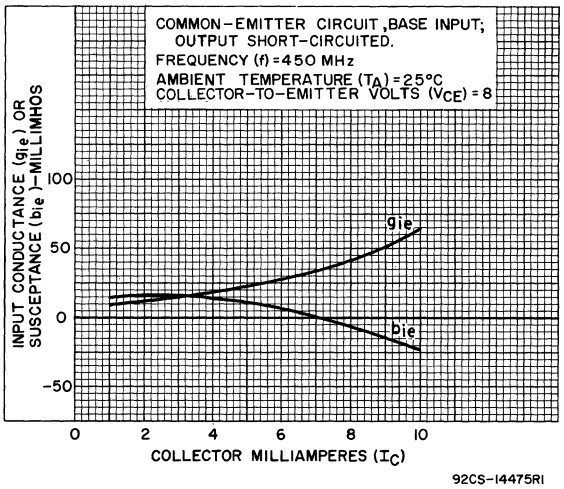


Fig.9 - Y_{ie} vs I_C

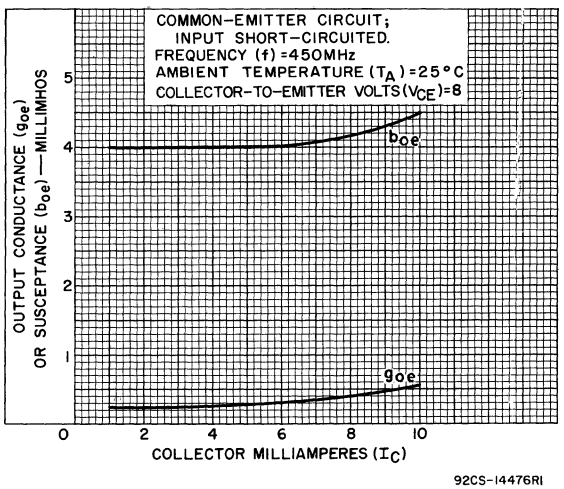


Fig.10 - Y_{oe} vs I_C

Typical y-parameter characteristics for 2N4936 at 450 MHz (cont'd)

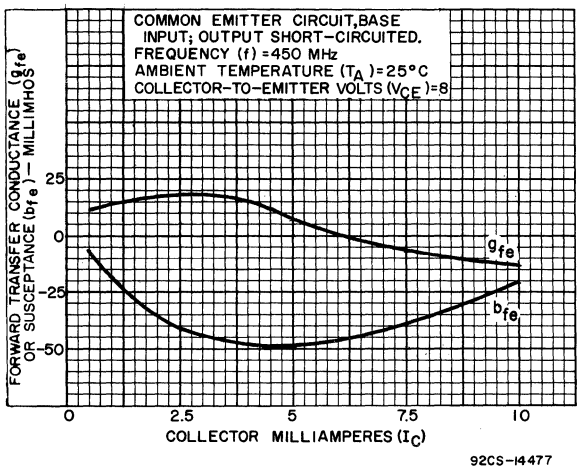


Fig.11 - Y_{fe} vs I_C

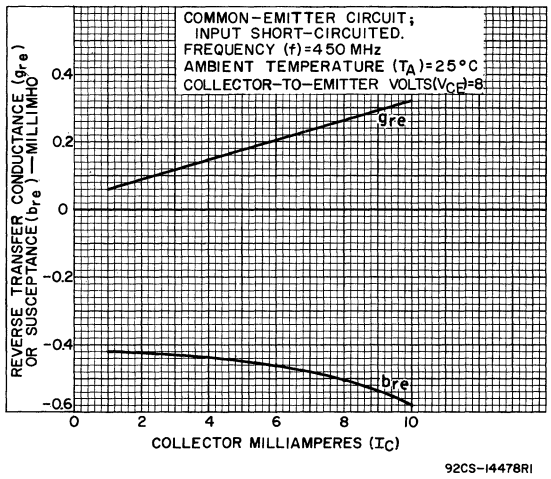


Fig.12 - Y_{re} vs I_C

Typical y-parameter characteristics for 2N4934, 2N4935 and 2N4936

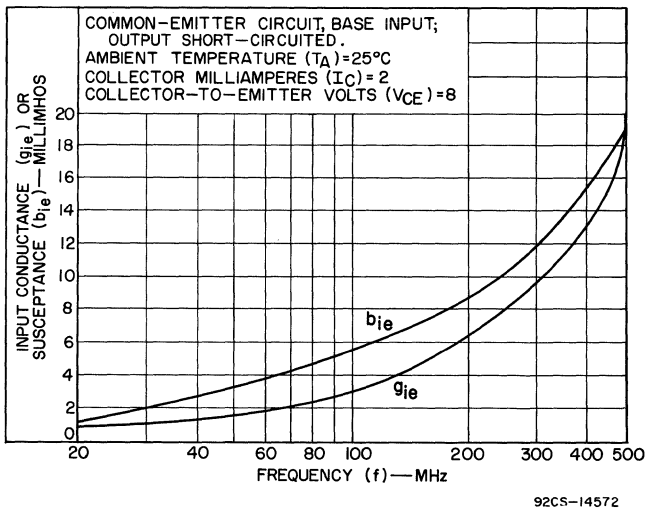


Fig.13 - Y_{ie} vs f

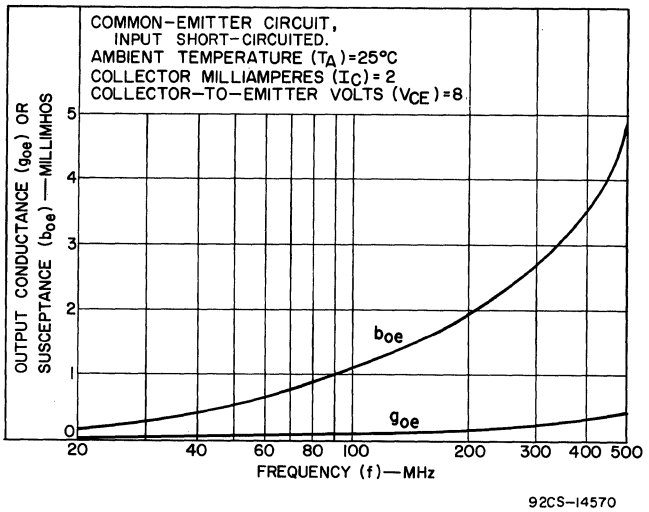


Fig.14 - Y_{oe} vs f

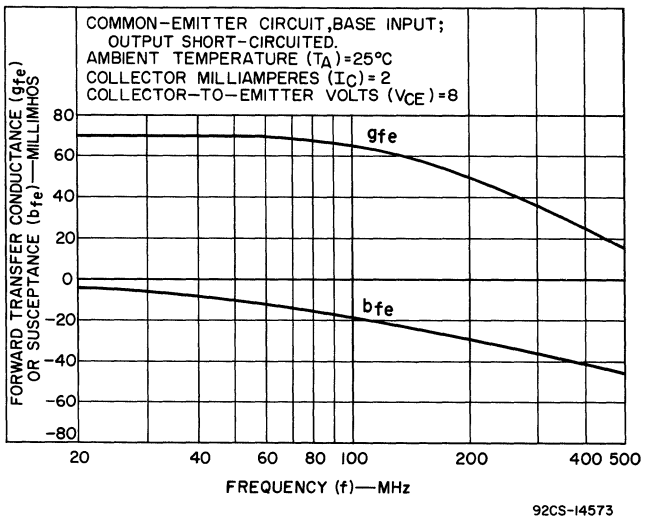


Fig.15 - Y_{fe} vs f

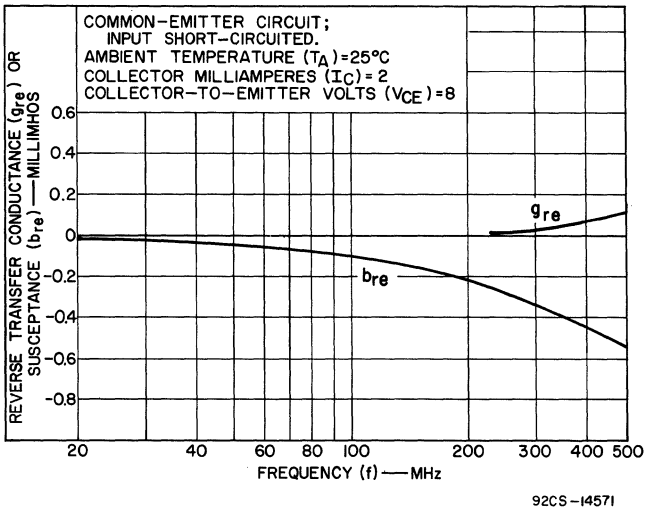
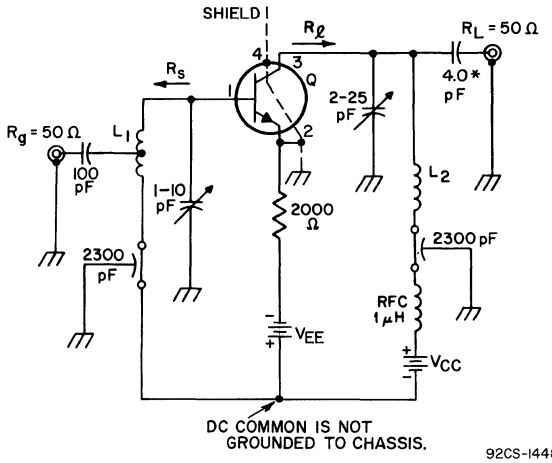


Fig.16 - Y_{re} vs f



All Capacitance Values in Picofarads

L_1 = 1/2 turn No.14 FORMVAR** wire; center-tapped; total wire length = 2 inches.

L_2 = 1/2 turn No.14 FORMVAR wire; total wire length = 1-1/2 inches

Q = Type 2N4934, 2N4935

Transistor Terminating Resistances

R_s = 200 Ω

R_ℓ = 850 Ω

R_s is the resistance looking back from the base terminal toward the generator input.

R_ℓ is the resistance looking from transistor collector terminal toward the load.

* Effective capacitance between collector and output terminal. The actual capacitor value is 3.3 pF.

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Fig. 1 - Unneutralized 200-MHz power gain and noise figure test circuit for 2N4934 and 2N4935.

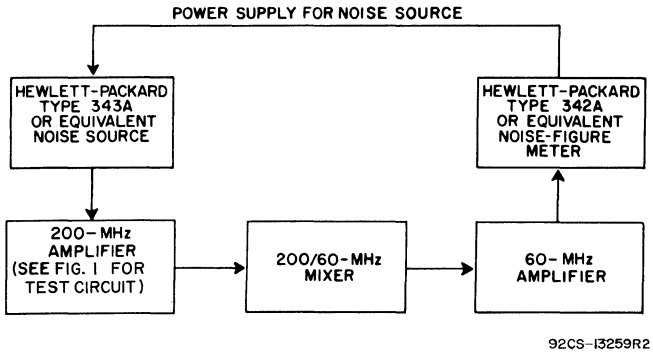


Fig. 2 - Block diagram of noise-figure test circuit for 2N4934 and 2N4935.

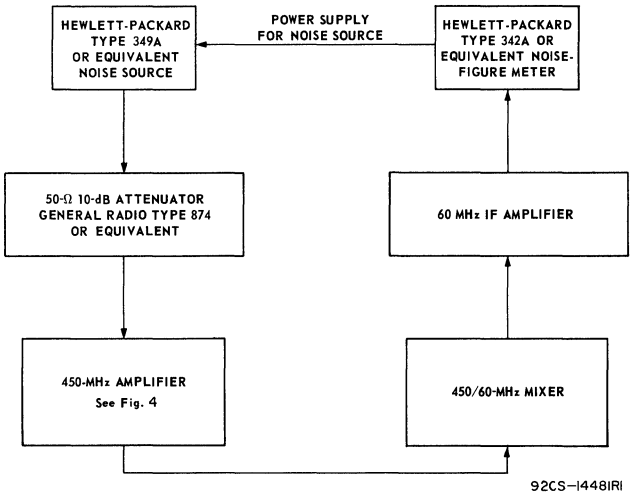
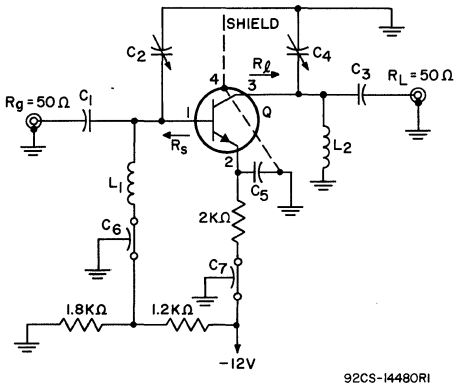


Fig. 3 - Block diagram of noise-figure test circuit for 2N4936.



All capacitors in picofarads

L_1, L_2 - 1/4-inch diameter brass bar 1 inch long

C_1 - Tubular ceramic 7.5 pF, approx. 3/8-inch total lead length

C_2, C_4 - Hammarlund MAC-10 variable air capacitor, or equivalent

C_3 - Button ceramic 1.2 pF, approx. 3/8-inch lead length

C_5 - Leadless ceramic disc capacitor - 50 pF

C_6, C_7 - Button ceramic feed thru capacitor - 50 pF

Q = 2N4936

R_s is the resistance looking back from the base terminal toward the generator input.

R_ℓ is the resistance looking from transistor collector terminal toward the load.

Fig. 4 - Unneutralized 450-MHz power gain and noise figure test circuit for 2N4936.

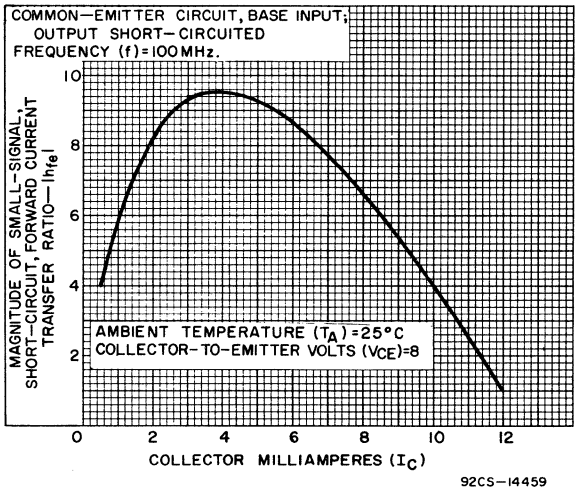
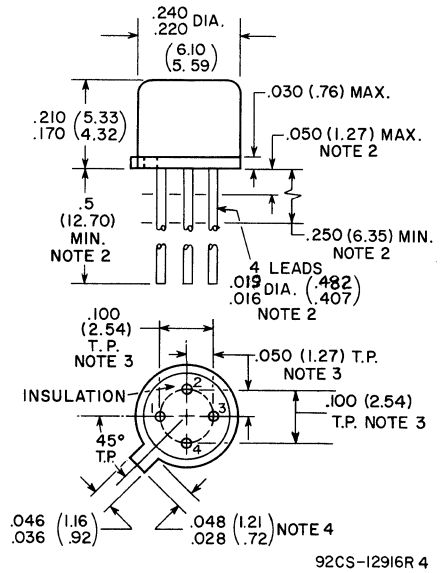


Fig. 17 - Typical small-signal beta characteristic for 2N4934, 2N4935 and 2N4935.

DIMENSIONAL OUTLINE
TO-104



Dimensions in Inches and Millimeters

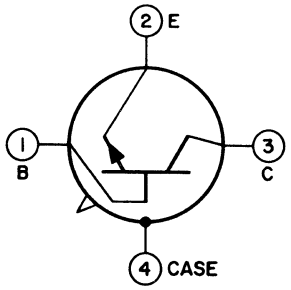
Note 1: *Dimensions in paranthesis are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) -0.000" (0.000 mm) below seating plane shall be within 0.007" (0.117 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

ATTENTION!
NEW TERMINAL ARRANGEMENT
Bottom View



1 - Base
2 - Emitter
3 - Collector
4 - Case

OPERATING CONSIDERATIONS

The flexible leads of the 2N4934, 2N4935 and 2N4936 are usually soldered to the circuit elements. As in the case of any high-frequency semiconductor device, the tips of soldering irons should be grounded, and appropriate precautions should be taken to protect the device against high electric fields.

This device should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the device.

SILICON N-P-N "overlay" TRANSISTOR

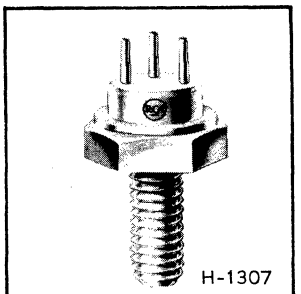
2N5016

File No. 255

RCA-2N5016* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended for large-signal, high-power, class -B and -C rf amplifiers for military and industrial communications service (200 to 700 MHz).

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.

*Formerly RCA-Dev. No.TA2675.



JEDEC TO-60

- For Class B or C VHF – UHF Military and Industrial Communications
- 15 Watts Output Min. at 400 MHz
- 23 Watts Output Typ. at 225 MHz
- Grounded Emitter
- Dynamic Input Impedance: 2.5 + j5 Ω (Typ.)

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = −1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance	V_{CER}	40	V
R_{BE} = 30 Ω			
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	4.5	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 50°C		30	W
At case temperatures above 50°C		*See Fig.5.*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY

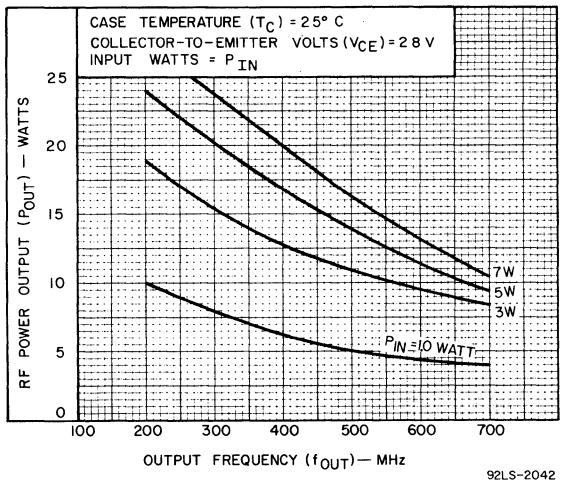


Fig. 1

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Marca(s) Registrada(s)

Printed in U.S.A.
2N5016 3/67

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

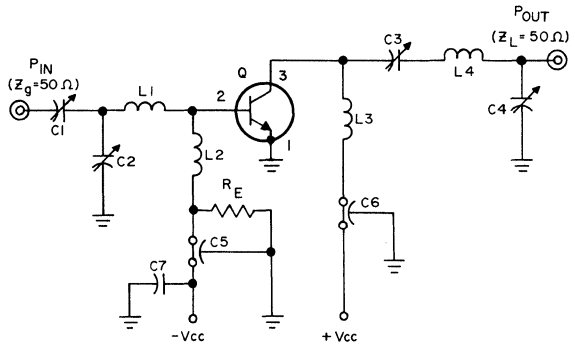
Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current mA					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	10	mA
Collector-to-Emitter Breakdown Voltage	V_{CER} R_{BE}=30 Ω					0	200[a]	40	–	V
	V_{CEV} (sus)			−1.5			200[a]	65	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				5		0	4	–	V
Collector-to-Emitter Saturation Voltage	V_{CE} (sat)					400	2000	–	1	V
Collector-to-Base Capacitance Measured at 1 MHz	C_{ob}	30			0			–	25	pF
Gain-Bandwidth Product	f_T		15				500	600 (typ.)		MHz
RF Power Output Amplifier, Unneutralized At 225 MHz (See Fig.2) 400 MHz (See Fig.3)	P_{OUT}		 28 28					 23[b] (typ.) 15[c]	 –	W
Dynamic Input Impedance at 400 MHz (See Fig.3)	Z_{IN}		28					2.5 + j5 (typ.)[c]		Ω

[a]Pulsed through an inductor (25 mH); duty factor = 50%.

[b]For P_{IN} = 5.0 W; minimum efficiency = 60%.

[c]For P_{IN} = 5.0 W; minimum efficiency = 50%.

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(225 MHz operation)



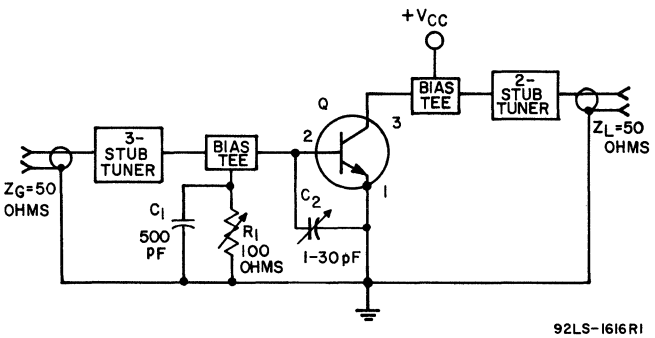
92LS-1352RI

C_1: 4-40 pF
C_2: 7-100 pF
C_3: 3-35 pF
C_4: 8-60 pF
C_5, C_6: 1500 pF feed thru
C_7: 0.01 uF disc, ceramic
R_E: .68 ohms (WW, 1 W)

L_1: 1.5 turns No.16 wire 1/4" ID, 3/16" long
L_2: Ferrite choke, Z=750Ω
L_3: 1.5 turns No.16 wire, 1/4" ID
L_4: 4.5 turns No.16 wire, 1/4" ID, 3" long
Q: 2N5016

Fig. 2

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(400 MHz operation)



92LS-1616RI

Q: 2N5016

Fig. 3

Note 1: For optimum performance, C_2 in Fig.3 should be mounted between emitter and base with minimum lead lengths.

Note 2: The emitter resistor, R_E, in Fig.2 provides self bias and is recommended for improved stability and collector efficiency.

SAFE OPERATION WITH DC FORWARD BIAS

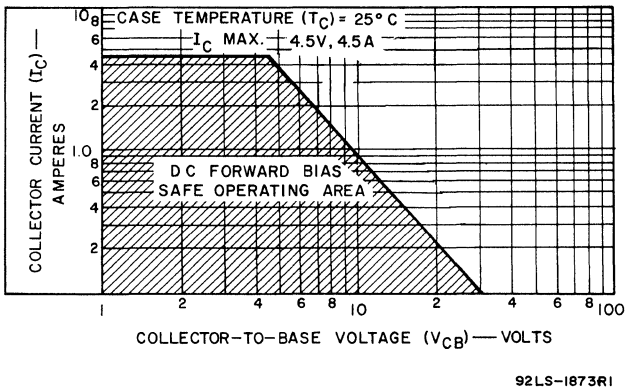


Fig. 4

DISSIPATION DERATING CURVE

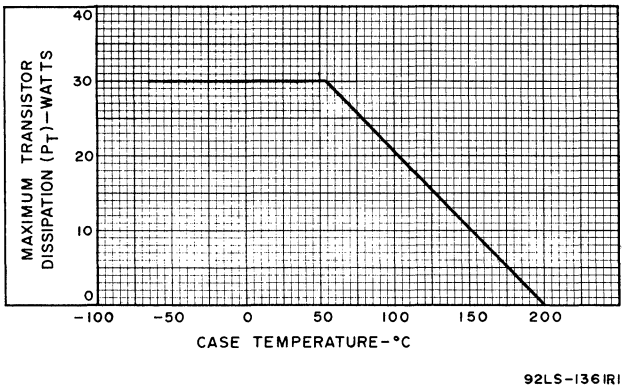


Fig. 5

TYPICAL
POWER OUTPUT and COLLECTOR EFFICIENCY
vs. COLLECTOR SUPPLY VOLTAGE

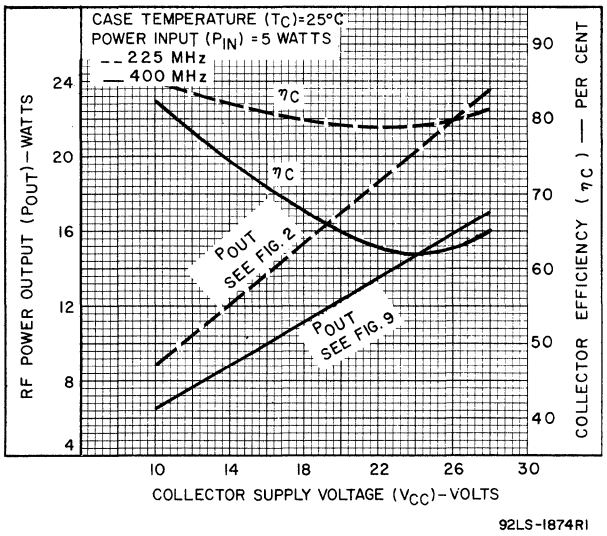


Fig. 6

TYPICAL
COLLECTOR EFFICIENCY vs. POWER INPUT

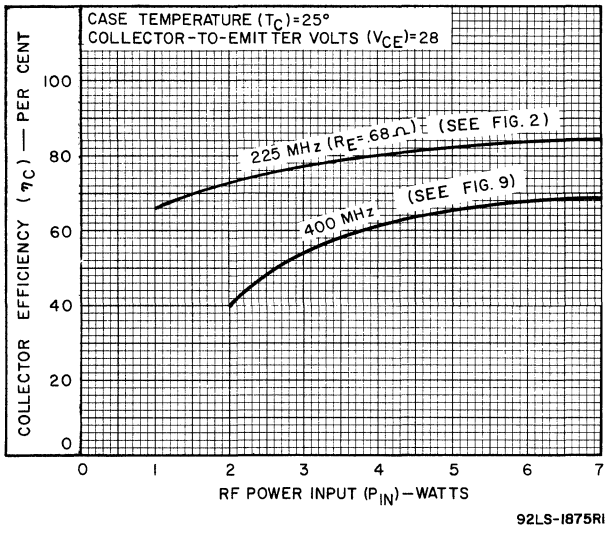


Fig. 7

TYPICAL VARIATION OF
COLLECTOR-TO-BASE CAPACITANCE

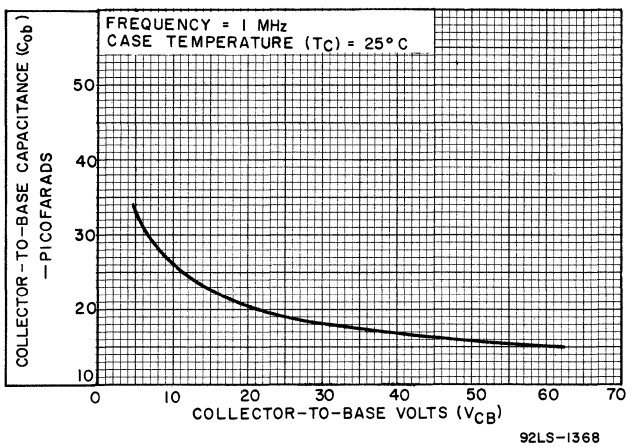
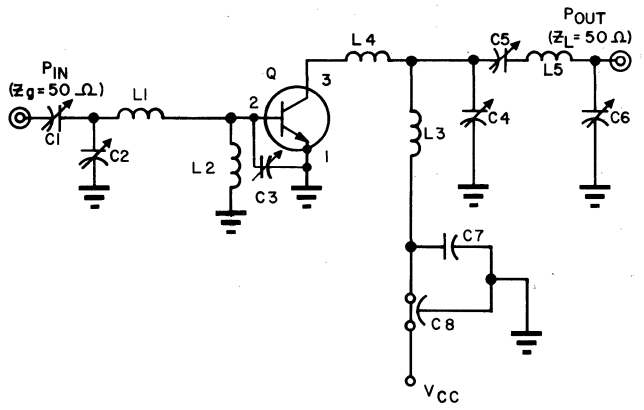


Fig. 8

TYPICAL RF AMPLIFIER CIRCUIT
(400 MHz-operation)



C_1: .1-10 pF piston capacitor
C_2, C_3, C_4, C_5, C_6: 1.0-30 pF piston capacitor **(Note 2)**
C_7: 0.01 µF disc ceramic
C_8: 1000 pF feed thru
L_1: 1/4" OD Copper tubing; 1-1/4" long **(Note 1)**
L_2: .12 µH choke
L_3: 0.27 ohm, WW
L_4: 1/8" x 1/32" x 5/8" long copper strap
L_5: 1/4" OD Copper tubing, 2-1/4" long **(Note 1)**
Q: 2N5016

Note 1: L_1 and L_5 are mounted co-axially within a 1-5/8" x 1-5/8" x 6" box.

Note 2: For optimum performance, C_3 should be mounted between emitter and base with minimum lead lengths.

Fig. 9

REFERENCES

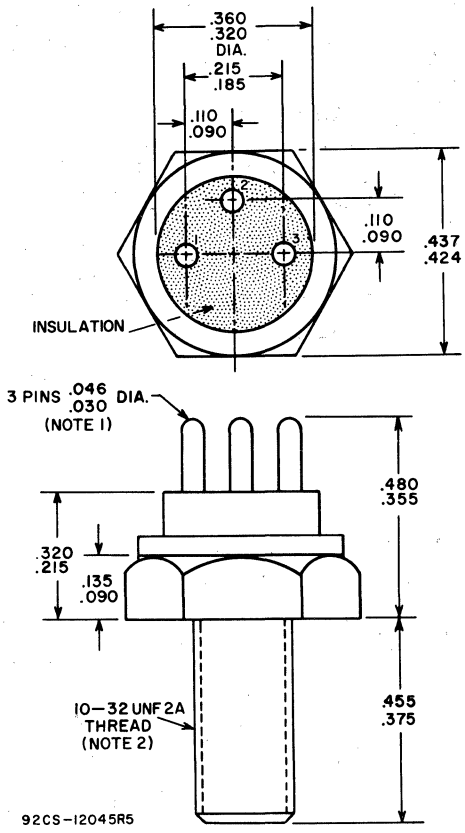
1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

DIMENSIONAL OUTLINE JEDEC TO-60



DIMENSIONS IN INCHES

Note 1: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" and contacts which will accommodate pins having a diameter of 0.035" min., 0.045" max.

Note 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 3: This device may be operated in any position.

TERMINAL CONNECTIONS

Mounting stud, case, Pin No. 1 - Emitter
Pin No. 2 - Base
Pin No. 3 - Collector

SILICON N-P-N "overlay" TRANSISTOR

2N5017

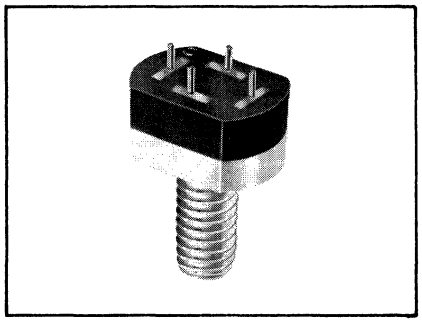
File No. 256

RCA–2N5017* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended for large-signal, high-power, class -B and -C rf amplifiers for military and industrial communications service (200 to 700 MHz).

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.

The 2N5017 features a new molded silicone-plastic case with low-inductance, isolated electrodes. The case provides circuit flexibility: wiring to lumped constant, strip-line, and printed-board circuits.

*Formerly RCA-Dev. No. TA2909.



- For Class B or C VHF – UHF Military and Industrial Communications
- 15 Watts Output Min. at 400 MHz
- 23 Watts Output Typ. at 225 MHz
- Low Inductance, Isolated Electrodes
- Molded Silicone-Plastic Case
- Dynamic Input Impedance: 2 + j2 Ω (Typ.)

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = −1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance	V_{CER}	40	V
R_{BE} = 30 Ω			
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	4.5	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 50° C		30	W
At case temperatures above 50° C		*See Fig. 5.*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
CASE TEMPERATURE (During soldering)			
For 10 s max.		230	°C

TYPICAL POWER OUTPUT vs FREQUENCY

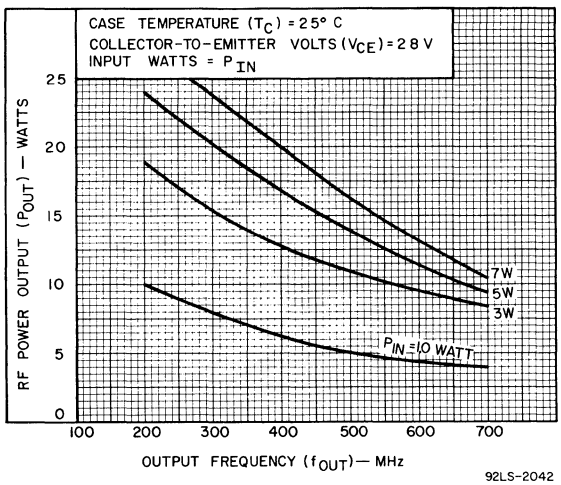


Fig. 1

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Printed in U.S.A.
2N5017 3/67

ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

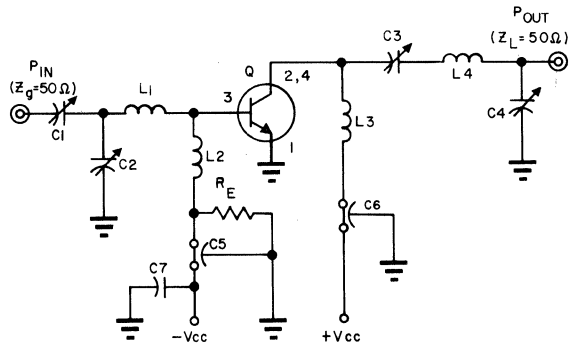
Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current mA					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	10	mA
Collector-to-Emitter Breakdown Voltage	V_{CER} R_{BE} = 30Ω					0	200[a]	40	–	V
	V_{CEV} (sus)			−1.5			200[a]	65	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				5		0	4	–	V
Collector-to-Emitter Saturation Voltage	V_{CE} (sat)					400	2000	–	1	V
Collector-to-Base Capacitance Measured at 1 MHz	C_{ob}	30			0			–	25	pF
Gain-Bandwidth Product	f_T		15				500	600 (typ.)		MHz
RF Power Output Amplifier, Unneutralized At 225 MHz (See Fig.2) 400 MHz (See Fig.3)	P_{OUT}		28 28					23[b] (typ.) 15[c]	– –	W
Dynamic Input Impedance at 400 MHz (See Fig.3)	Z_{IN}		28					2 + j2 (Typ)[c]		Ω

[a]Pulsed through an inductor (25 mH); duty factor = 50%.

[b]For P_{IN} = 5.0 w; minimum efficiency = 60%.

[c]For P_{IN} = 5.0 w; minimum efficiency = 50%.

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(225 MHz operation)

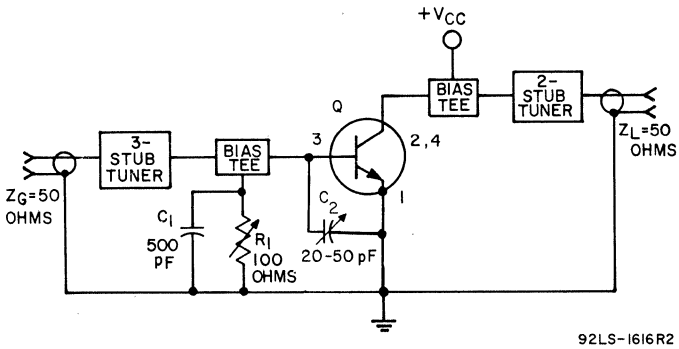


92LS-1863RI

C_1: 4-40 pF
C_2: 7-100 pF
C_3: 3-35 pF
C_4: 8-60 pF
C_5, C_6: 1500 pF feed thru
C_7: 0.01 μF disc, ceramic
R_E: .68 ohms (WW, 1 W)
L_1: 1.5 turns No.16 wire 1/4" ID, 3/16" long
L_2: Ferrite choke, Z = 750 Ω
L_3: 1.5 turns No.16 wire, 1/4" ID
L_4: 4.5 turns No.16 wire, 1/4" ID, 3" long
Q: 2N5017

Fig. 2

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(400 MHz operation)



92LS-1616R2

Fig. 3

Note 1: For optimum performance, C_2 in Fig.3 should be mounted between emitter and base with minimum lead lengths.

Note 2: The emitter resistor, R_E in Fig.2 provides self bias and is recommended for improved stability and collector efficiency.

SAFE OPERATION WITH DC FORWARD BIAS

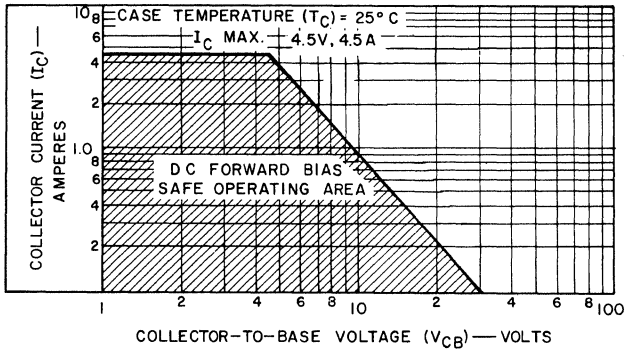


Fig. 4

DISSIPATION DERATING CURVE

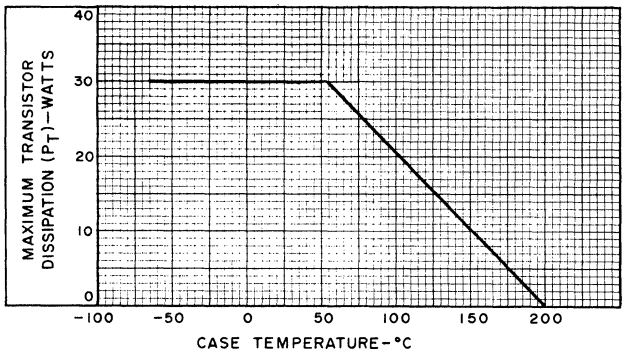


Fig. 5

TYPICAL
POWER OUTPUT and COLLECTOR EFFICIENCY
vs. COLLECTOR SUPPLY VOLTAGE

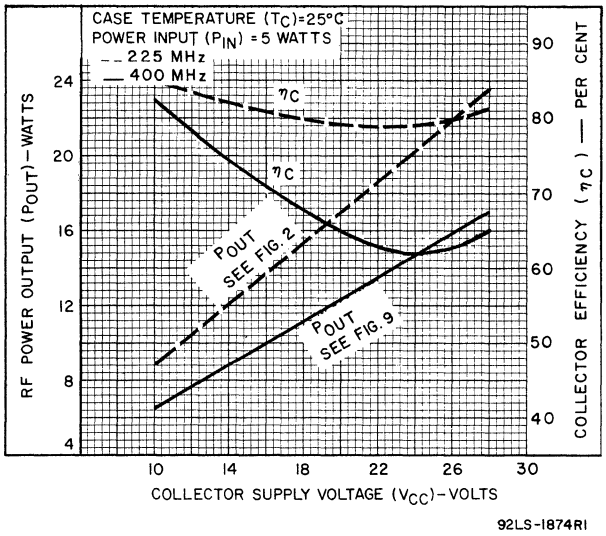


Fig. 6

TYPICAL
COLLECTOR EFFICIENCY vs. POWER INPUT

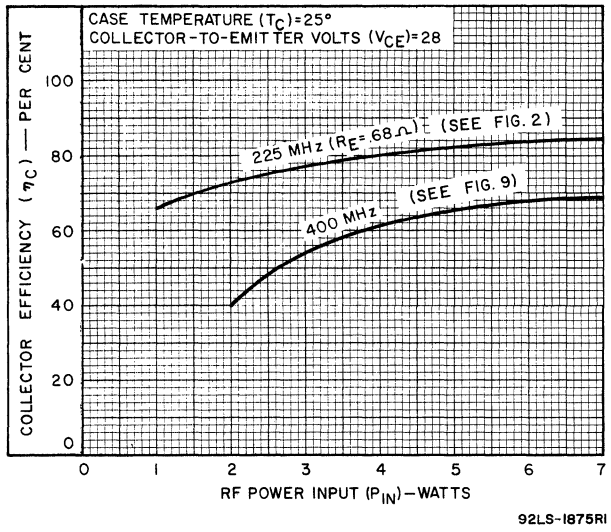


Fig. 7

TYPICAL VARIATION OF
COLLECTOR-TO-BASE CAPACITANCE

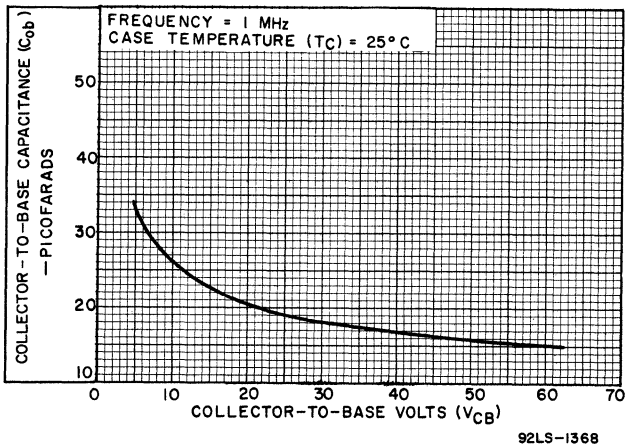
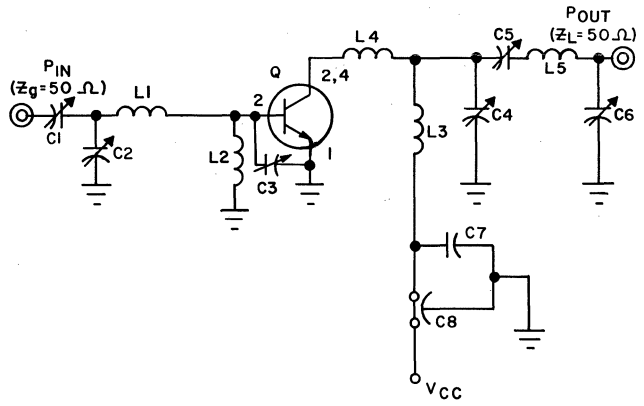


Fig. 8

TYPICAL RF AMPLIFIER CIRCUIT

(400 MHz-operation)



C_1: .1-10 pF piston capacitor
C_2, C_3, C_4, C_5, C_6: 1.0-30 pF piston capacitor **(Note 2)**
C_7: 0.01 µF disc ceramic
C_8: 1000 pF feed thru
L_1: 1/4" OD Copper tubing; 1-1/4" long **(Note 1)**
L_2: .12 µH choke
L_3: 0.27 ohm, WW
L_4: 1/8" x 1/32" x 5/8" long copper strap
L_5: 1/4" OD Copper tubing, 2-1/4" long **(Note 1)**
Q: 2N5017

Note 1: L_1 and L_5 are mounted co-axially within a 1-5/8" x 1-5/8" x 6" box.

Note 2: For optimum performance, C_3 should be mounted between emitter and base with minimum lead lengths.

Fig. 9

REFERENCES

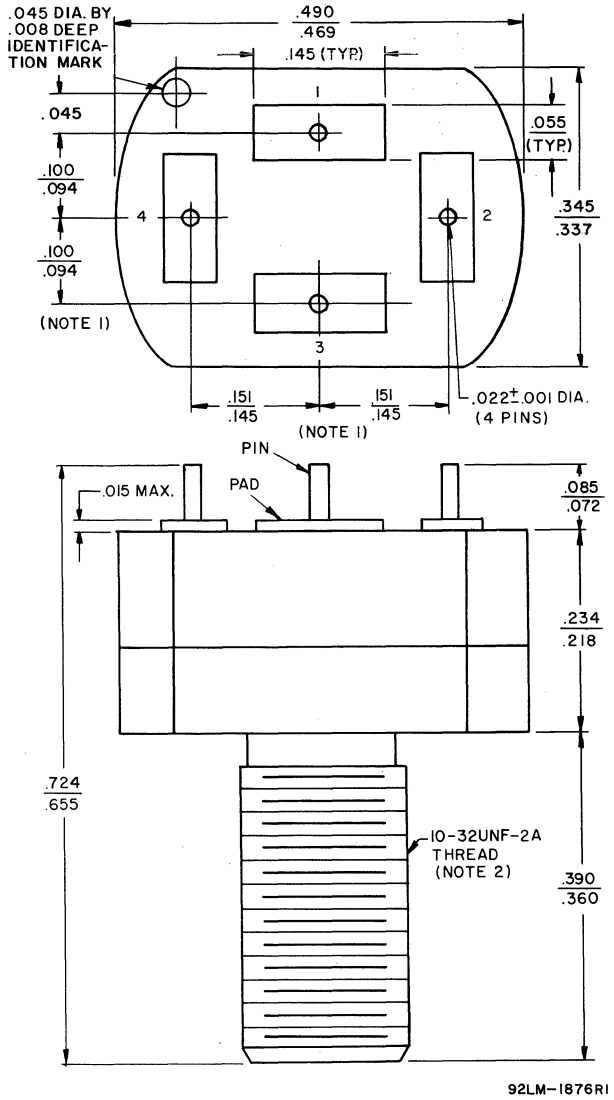
1. *The Overlay Transistor,* Electronics, August 23, 1965.

   Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

   Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note 1: The pin center-to-center dimensions are measured at pad surface only.

Note 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 3: This device may be operated in any position.

Note 4: For best rf performance, electrical connections should be made to the pads.

TERMINAL CONNECTIONS

Pin No.1: Emitter
Pin No.2: Collector
Pin No.3: Base
Pin No.4: Collector

RCA POWER TRANSISTORS

2N5034 2N5035 2N5036 2N5037 40514 40513

File No. 244

SILICON N-P-N MOLDED SILICONE-PLASTIC HOMETAXIAL-BASE TRANSISTORS

RCA-2N5034, 2N5035, 2N5036, 2N5037*, 40513, and 40514 are hometaxial**-base silicon n-p-n power transistors employing two versions of a unique plastic package. This new plastic package is available with two different lead configurations: a "vertical-lead" version which will fit a TO-3 socket; a "horizontal-lead" type for mounting on a printed-circuit board.

Types 2N5034, 2N5036, and 40514 are the "TO-3" versions. The 2N5034, 2N5036, and 40514 differ in breakdown-voltage, collector-current ratings, and leakage-current limits. These devices may be plugged into a TO-3 socket and secured by means of an over-clamp whose mounting holes are identical to those in a TO-3 socket.

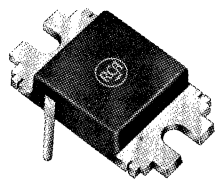
Types 2N5035, 2N5037, and 40513 are electrically identical to the 2N5034, 2N5036, and 40514, respectively, but employ the horizontal-lead package.

These plastic transistors are intended for a wide variety of high-power switching and amplifier applications such as series and shunt regulator driver and output stages and for high-fidelity amplifiers.

*Formerly Dev. Type Nos. TA7201, TA7202, TA7199, and TA7200, respectively.

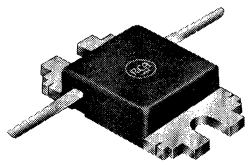
**"Hometaxial" was coined by RCA from "homogeneous" and "axial" to describe a single-diffused transistor with a base region of homogeneous-resistivity silicon in the axial direction (emitter-to-collector).

GENERAL-PURPOSE TYPES FOR INDUSTRIAL AND COMMERCIAL APPLICATIONS



H-1532

2N5034 2N5036 40514
"Plastic TO-3"



H-1533

2N5035 2N5037 40513
For Printed-Circuit Boards

- **Low thermal resistance:** θ_{J-C} = 1.5 °C/W max.
- **Low saturation voltage:** $V_{CE}(sat)$ = 1 V max. at I_C = 2.5 A (2N5034, 2N5035, 40513, & 40514) = 1 V max. at I_C = 3 A (2N5036 & 2N5037)
- **High second breakdown ratings for both forward- and reverse-bias operation**
- **High peak collector current ratings**
- **Maximum-area-of-operation curves for DC and pulse operation**

MAXIMUM RATINGS

Absolute-Maximum Values:

		40514 40513	2N5034 2N5035	2N5036 2N5037	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	–	55	70	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With −1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	–	55	70	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	45	45	60	V
With base open	$V_{CEO}(sus)$	–	40	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	6	6	8	A
PEAK COLLECTOR CURRENT		12	12	12	A
CONTINUOUS BASE CURRENT	I_B	6	6	6	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25° C		83	83	83	W
At temperatures above 25° C		See Figs. 1 & 2.			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		−65 to 150			°C
LEAD TEMPERATURE (During Soldering)					
2N5304, 2N5306, & 40514: At distances ≧ 1/16 in. from seating plane for 10 s max.			235		°C
2N5035, 2N5037, & 40513: At distances ≧ 1/8 in. from case for 10 s max.			235		°C

ELECTRICAL CHARACTERISTICS

Case Temperature (T_C) = 25° C Unless Othersiwe Specified

Characteristic	Symbol	TEST CONDITIONS							LIMITS						Units
		DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)			Types 40514 40513		Types 2N5034 2N5035		Types 2N5036 2N5037		
			V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}		20						–	2.5	–	–	–	–	mA
			35						–	–	–	1.0	–	–	
			50						–	–	–	–	–	1.0	
	I_{CER} (T_C = 150° C)		20						–	5.0	–	–	–	–	mA
			35						–	–	–	5.0	–	–	
			50						–	–	–	–	–	5.0	
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}		50		-1.5				–	–	–	1.0	–	–	mA
			65		-1.5				–	–	–	–	–	1.0	
	I_{CEV} (T_C = 150° C)		50		-1.5				–	–	–	5.0	–	–	mA
			65		-1.5				–	–	–	–	–	5.0	
Emitter-Cutoff Current	I_{EBO}			5		0			–	5.0	–	5.0	–	5.0	mA
DC Forward-Current Transfer Ratio	h_{FE}		4			2.5[a]			20	70	20	70	–	–	
			4			3[a]			–	–	–	–	20	70	
Emitter-to-Base Breakdown Voltage	BV_{EBO}						5 mA		5	–	5	–	5	–	V
Collector-to-Emitter Sustaining Voltage With base open	V_{CEO}(sus)					0.2[a]		0	–	–	40	–	50	–	V
With base-emitter junction reverse biased	V_{CEV}(sus)				-1.5	0.1[a]			–	–	55	–	70	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)					0.2[a]			45	–	45	–	60	–	V
Base-to-Emitter Voltage	V_{BE}		4			2.5[a]			–	1.7	–	1.7	–	–	V
			4			3[a]			–	–	–	–	–	1.7	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)					2.5[a]		0.25	–	1.0	–	1.0	–	–	V
						3[a]		0.3	–	–	–	–	–	1.0	V
Gain-Bandwidth Product	f_T		4			0.5			0.8	2.8	0.8	2.8	0.8	2.8	MHz
Thermal Resistnace (Junction-to-Case)	θ_{J-C}								–	1.5	–	1.5	–	1.5	°C/W

[a]Pulsed; pulse duration = 300 μs, duty factor = 1.8 %.

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DISSIPATION DERATING CURVE FOR TYPES
2N5034, 2N5035, 2N5036, 2N5037, 40513, & 40514

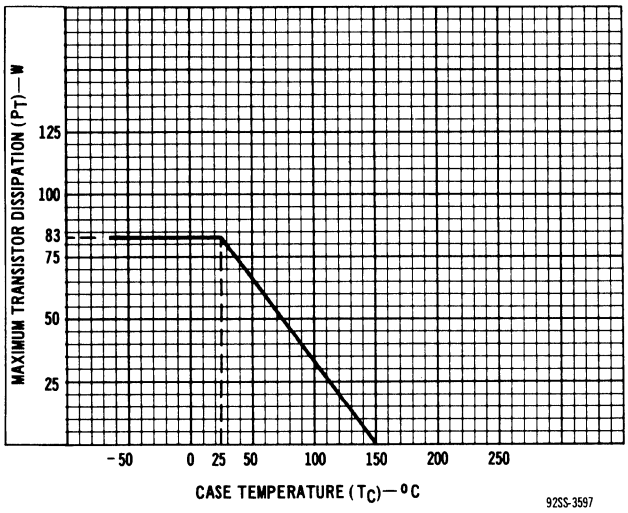


Fig. 1

DISSIPATION DERATING CURVE FOR TYPES
2N5034, 2N5035, 2N5036, 2N5037, 40513, & 40514

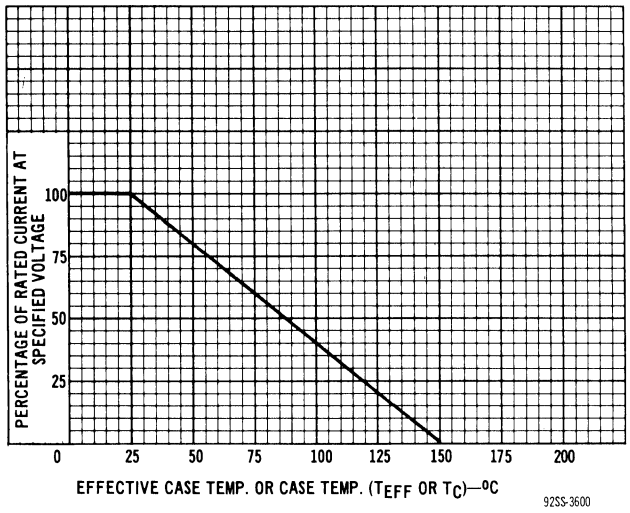


Fig. 2

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPES 2N5034 AND 2N5035

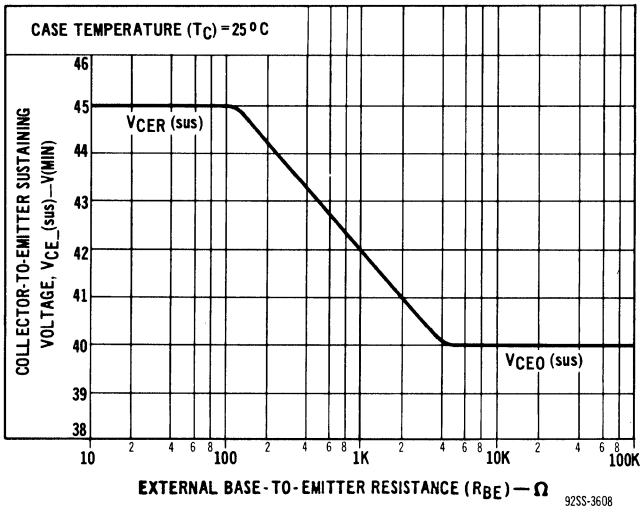


Fig. 3

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPES 2N5036 AND 2N5037

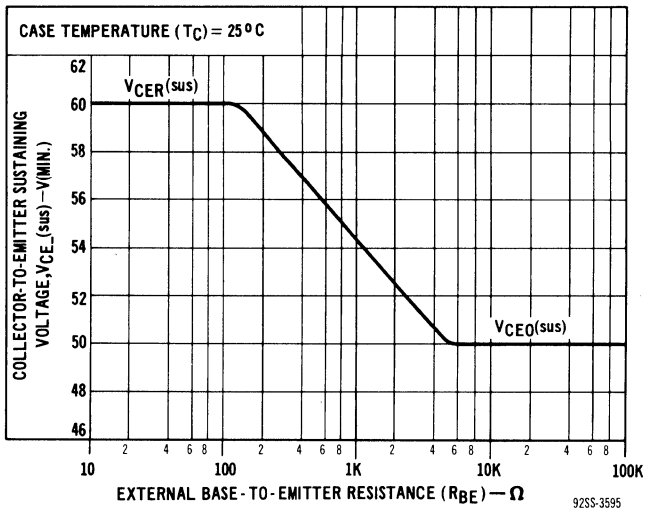


Fig. 4

MAXIMUM OPERATING AREAS FOR TYPES
2N5034, 2N5035, 40513, AND 40514

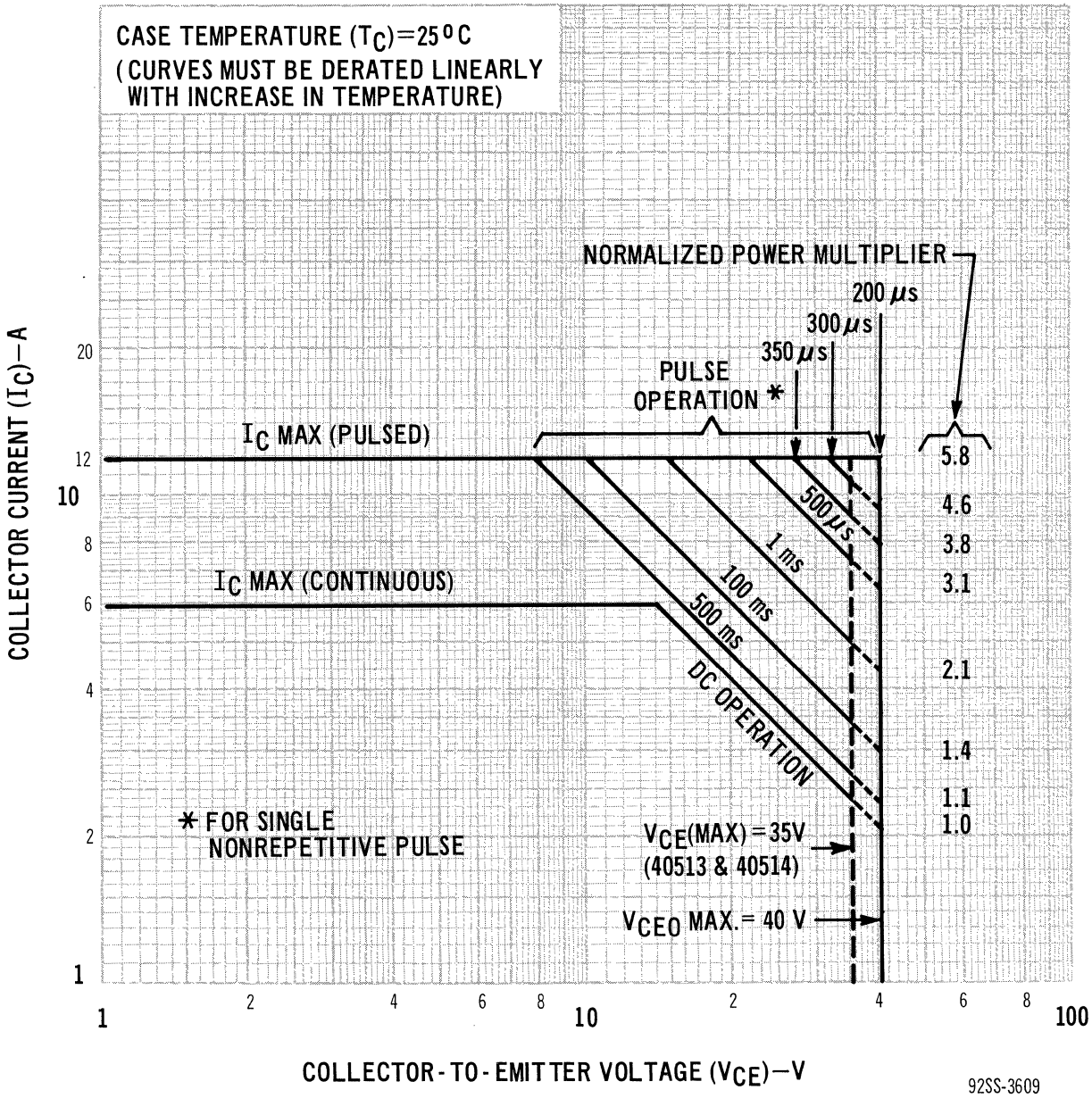


Fig. 5

MAXIMUM OPERATING AREAS
FOR TYPES 2N5036 AND 2N5037

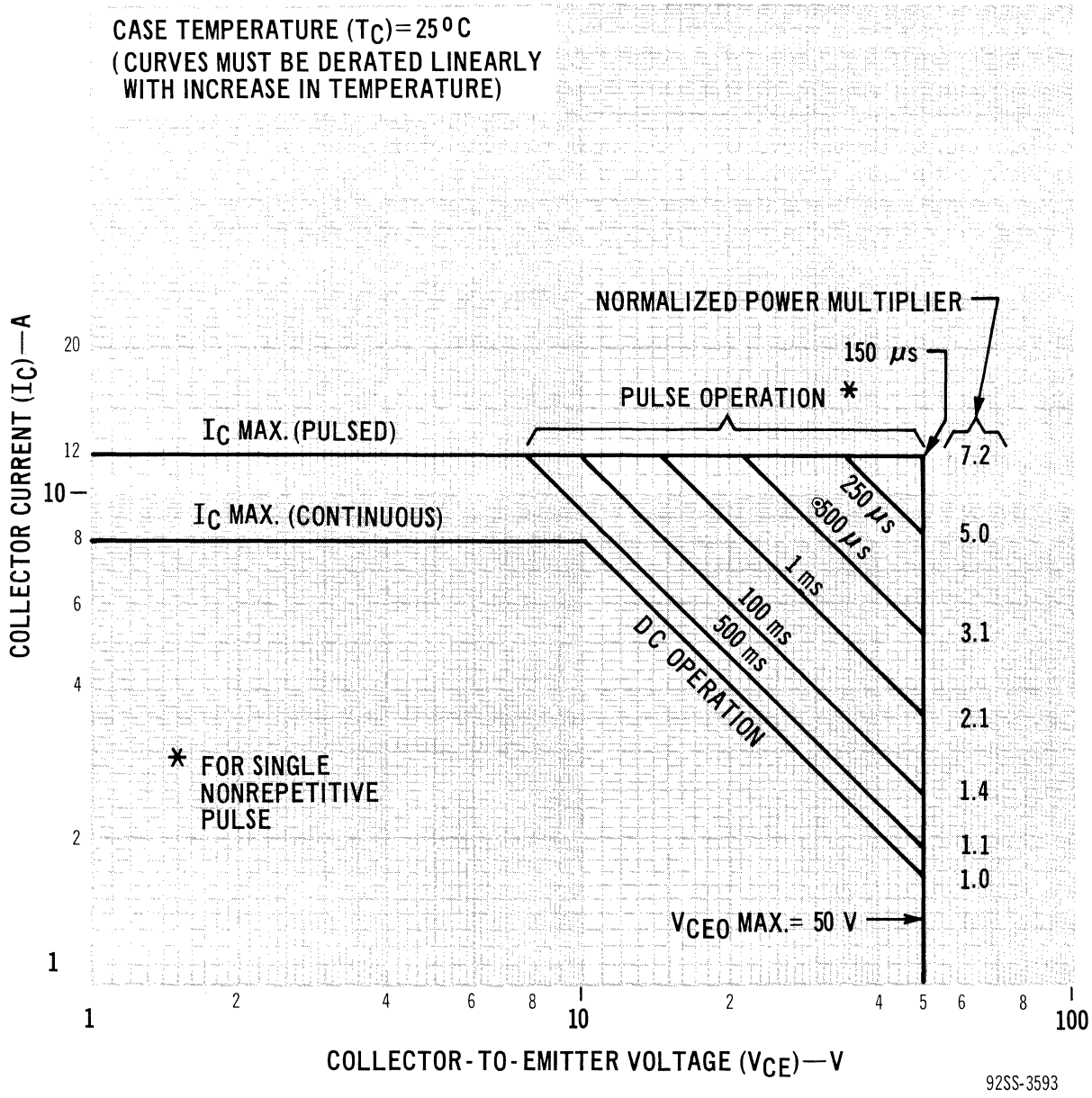


Fig. 6

SECOND BREAKDOWN

Second breakdown (S/b) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE}, with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown ratings are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

Forward-Bias Operation

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature.

The maximum-area-of-operation curves, Figs. 5 and 6 show the DC and pulse current derating curves applicable to these transistors at a case temperature of 25° C. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the devices are thermally limited (i.e., maximum allowable power dissipation does not vary with voltage). The curves shown in Figs. 5 and 6 must be derated linearly with increasing case temperature as shown in Fig. 2.

Steady State. The maximum steady-state dissipation capability is dependent upon the total thermal resistance from the transistor junction to the thermal ambient $\theta_{J\text{-}A}$, the maximum junction temperature $T_J(max)$, and upon the ambient temperature T_A. These factors may be combined in the equation

$$P_{SS} = \frac{T_J(max) - T_A}{\theta_{J\text{-}A}} \quad (1)$$

where $\theta_{J\text{-}A}$, the thermal resistance from junction to ambient, is the sum of $\theta_{J\text{-}C}$ (junction-to-case), $\theta_{C\text{-}S}$ (case-to-heat sink), and $\theta_{S\text{-}A}$ (heat sink-to-ambient). When the case temperature, T_C, is known, equation (1) may be written in the form

$$P_{SS} = \frac{T_J(max) - T_C}{\theta_{J\text{-}C}} \quad (2)$$

The maximum specified junction temperature for these transistors is 150° C, and the maximum specified thermal resistance $\theta_{J\text{-}C}$ is 1.5°C/W. For these conditions, the maximum steady-state dissipation is 83 watts at a case temperature of 25° C. This value must be derated linearly with increasing case temperature as shown in Fig. 1.

Non-Repetitive Pulse. Reference to Figs. 2, 5, and 6 can facilitate direct calculation of the maximum dissipation limits when only a single non-repetitive pulse condition occurs. The recommended procedure for establishing the maximum dissipation is as follows: Using the case temperature, enter the dissipation derating curve Fig. 2 and find the temperature derating factor (TDF). For the pulse width employed, enter the maximum-operating-area curve Fig. 5 or 6 and obtain the normalized power multiplier (M). The maximum power for single-pulse operation (P_{SP}) may be calculated by using the following equation:

$$P_{SP} = M(TDF)\, P_T \quad (3)$$

where P_T is the maximum power dissipation capability at 25° C case temperature. This equation may also be written in the form

$$P_{SP} = M \left[\frac{T_J(max) - T_C}{\theta_{J\text{-}C}}\right] \quad (4)$$

Repetitive-Pulse Operation. The collector current limits shown in the maximum-operating-area curves Figs. 5 and 6 must be reduced when repetitive pulses are applied because of the rise in case temperature (due to average power dissipation) and the heat energy stored in the thermal capacitance of the transistor pellet and header. The amount of current derating is determined by the slope of the dissipation derating curve, Fig. 2, where T_{EFF} is the effective case temperature produced by the pulses.

For repetitive-pulse operation, the average power dissipation (P_{AVG}) in the transistor may be determined from the relationship

$$P_{AVG} = P_{PK}(d) \quad (5)$$

where P_{PK} is the peak power
and d is the duty factor.

The recommended procedure for establishing the maximum dissipation for repetitive-pulse operation is as follows: For the pulse width employed, enter the maximum-operating-area curve, Fig. 5 or 6, and find the normalized power multiplier (M). The peak power for repetitive pulses may be calculated from the equation

$$(P_{RP})_{PK} = \frac{M\left[T_J(max) - T_A\right]}{\theta_{J\text{-}C} + M(d)\,\theta_{J\text{-}A}}. \quad (6)$$

In many applications, the heat sink may be held at a fixed temperature independent of the power dissipated in the device under consideration. In this instance, the effective case temperature may be calculated from the equation

$$T_{EFF} = T_C + P_{PK}(d)\,\theta_{J\text{-}C}. \quad (7)$$

The recommended procedure to establish the maximum dissipation for repetitive-pulse operation under these conditions is as follows: Using the effective case temperature, enter the dissipation derating curve, Fig. 2, and find the temperature derating factor (TDF). For the pulse width employed, enter the maximum-operating-area curve, Fig. 5 or 6, and determine the normalized power multiplier (M). The peak power may be calculated by using the equation

$$(P_{RP})_{PK} = M(TDF)\ P_T \qquad (8)$$

where P_T is the maximum power dissipation capability at 25° C case temperature.

REVERSE-BIAS OPERATION

The energy required to induce second breakdown when the transistor is turned off depends on the current during the "on" condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. The curves shown in Fig. 7 should prove useful in the design of circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. Also, these curves can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers.)

The curves shown in Figs. 5 and 6 are based on the premise that the junction temperature must not exceed the maximum allowable junction temperature. Also, this limit must not be exceeded in the reverse-bias mode. After checking to insure that the operation of the unit lies within the capability shown in Fig. 7, a computation is required to insure that the reverse bias energy will not exceed the derated power time as shown in Fig. 5 or 6. Derating is accomplished exactly as described in the preceding discussion of forward-bias operation.

In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore, the allowable energy shown in the above-mentioned curves (calculated from $E_{S/b} = \frac{1}{2}LI^2$, where L is a series load or leakage inductance and I is the peak collector current from the curves) will be conservative for smaller inductive loads. For further information on second breakdown, consult RCA Application Notes SMA-21, "Characterization of Second Breakdown in Silicon Power Transistors," and SMA-30, "Second Breakdown in Transistors Under Conditions of Cutoff."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPES 2N5034, 2N5035, 2N5036, 2N5037, 40513, & 40514

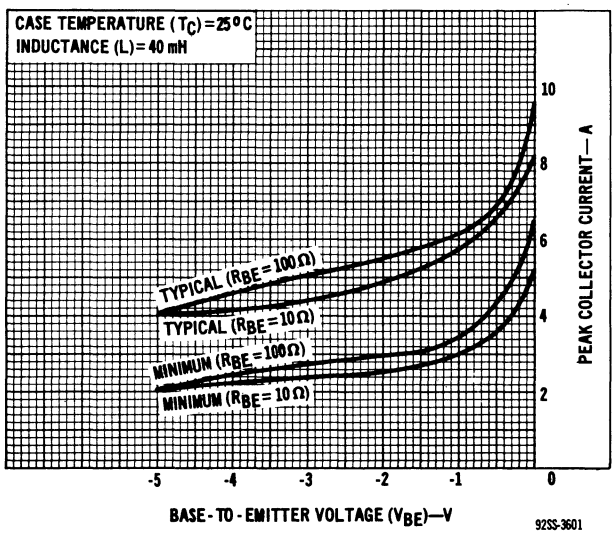


Fig. 7

TYPICAL DC BETA CHARACTERISTICS
FOR TYPES 2N5034, 2N5035, 40513, & 40514

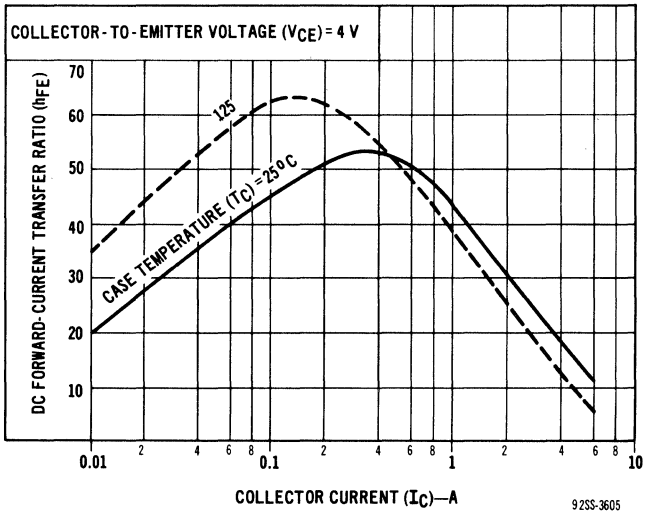


Fig. 8

TYPICAL INPUT CHARACTERISTICS
FOR TYPES 2N5034, 2N5035, 40513, & 40514

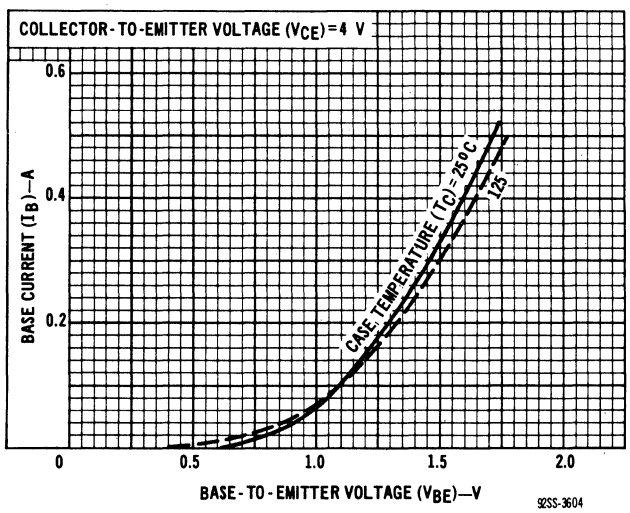


Fig. 9

TYPICAL COLLECTOR CHARACTERISTICS
FOR TYPES 2N5034, 2N5035, 40513, & 40514

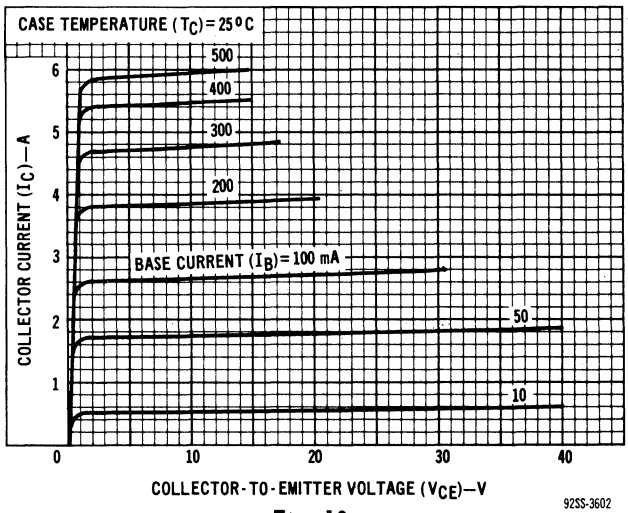


Fig. 10

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPES 2N5034, 2N5035, 40513, & 40514

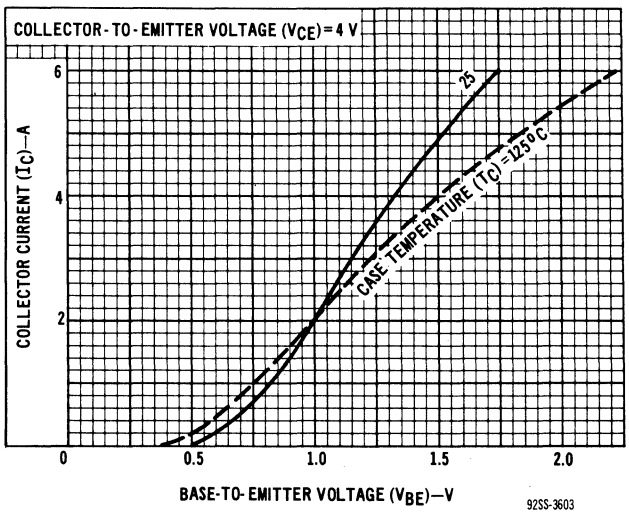


Fig. 11

TYPICAL GAIN-BANDWIDTH PRODUCT
FOR TYPES 2N5034, 2N5035, 40513, & 40514

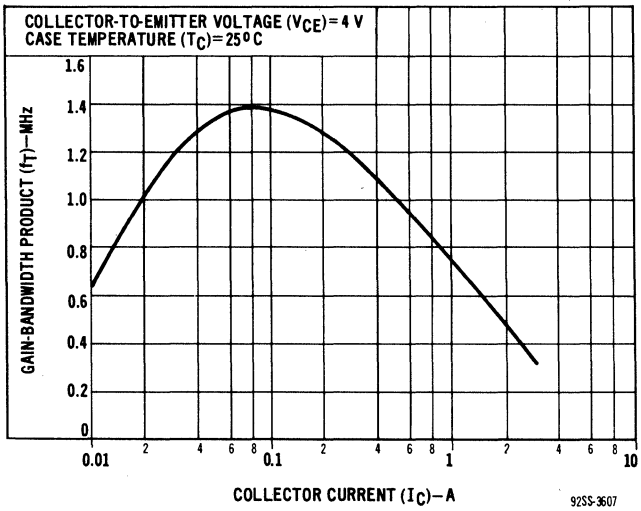


Fig. 12

TYPICAL DC BETA CHARACTERISTICS
FOR TYPES 2N5036 AND 2N5037

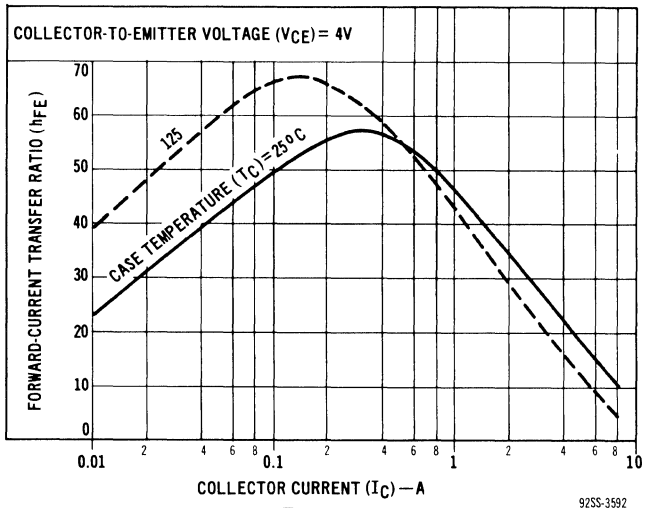


Fig. 13

TYPICAL INPUT CHARACTERISTICS
FOR TYPES 2N5036 AND 2N5037

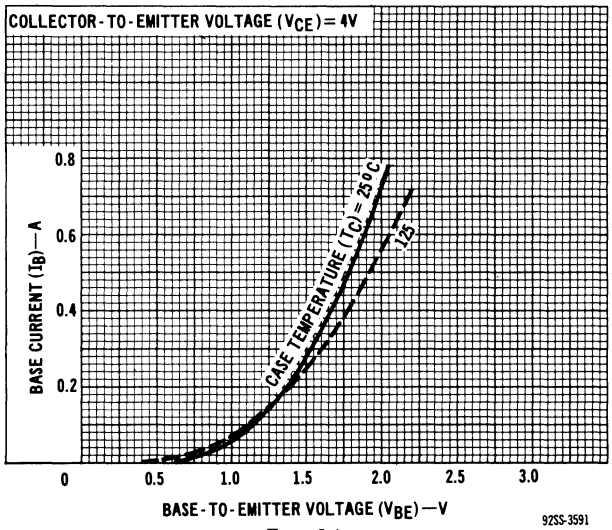


Fig. 14

TYPICAL COLLECTOR CHARACTERISTICS
FOR TYPES 2N5036 AND 2N5037

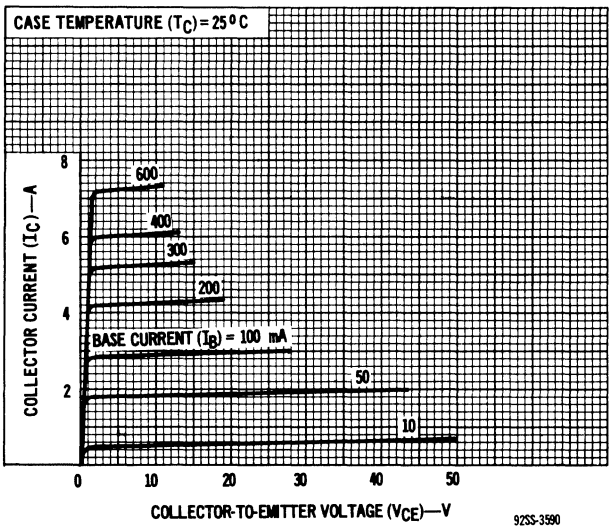


Fig. 15

TYPICAL TRANSFER CHARACTERISTICS
FOR TYPES 2N5036 AND 2N5037

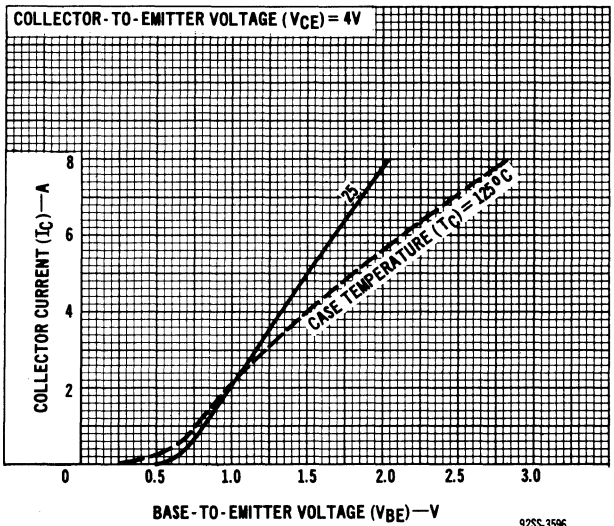


Fig. 16

TYPICAL GAIN-BANDWIDTH PRODUCT
FOR TYPES 2N5036 AND 2N5037

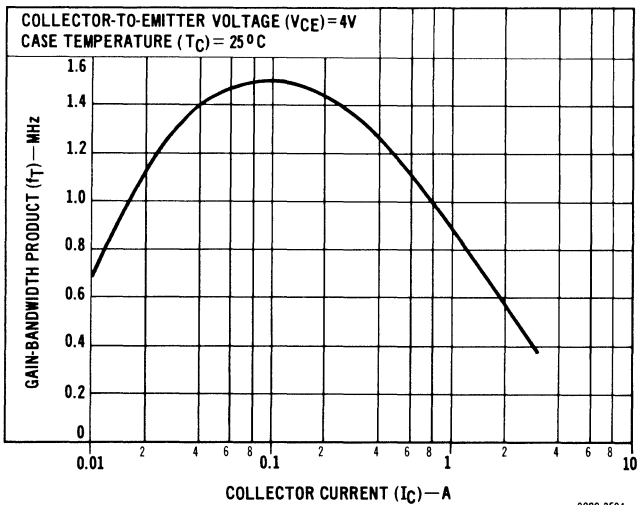
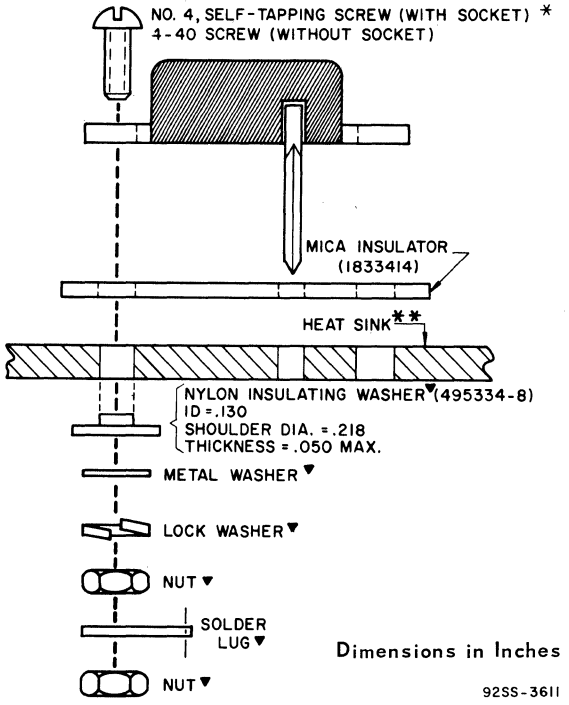


Fig. 17

SUGGESTED HARDWARE FOR MOUNTING TYPES 2N5034, 2N5036, AND 40514



* SOCKET NO. XA1521
(INDUSTRIAL ELECTRONICS HARDWARE CORP.
109 PRINCE STREET., NEW YORK, N.Y.) OR EQUIV.

** .130 MAX. THICKNESS

▼ NOT REQUIRED WITH SOCKET
(USE SELF-TAPPING SCREW)

Fig. 18

SUGGESTED HARDWARE FOR MOUNTING TYPES 2N5035, 2N5037, AND 40513

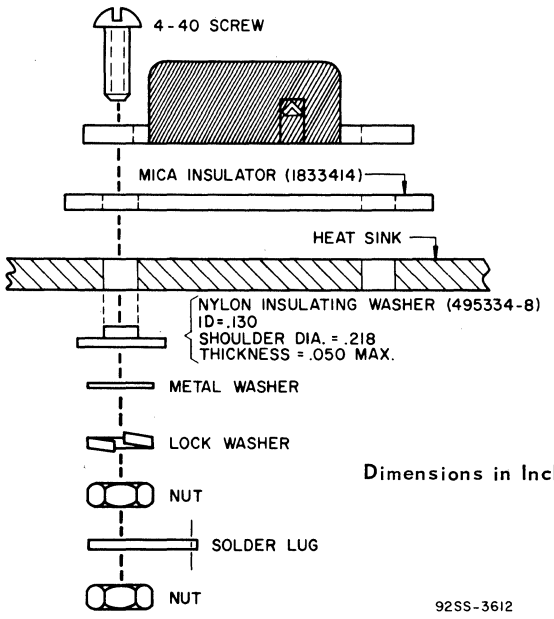
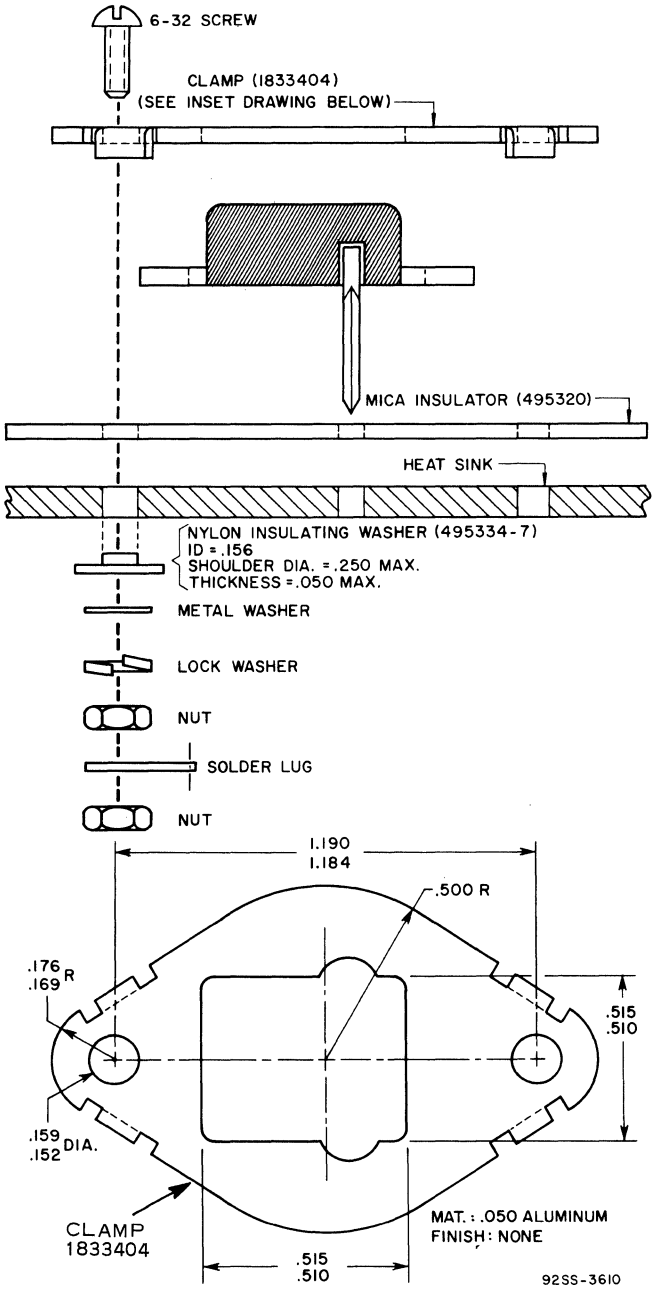


Fig. 19

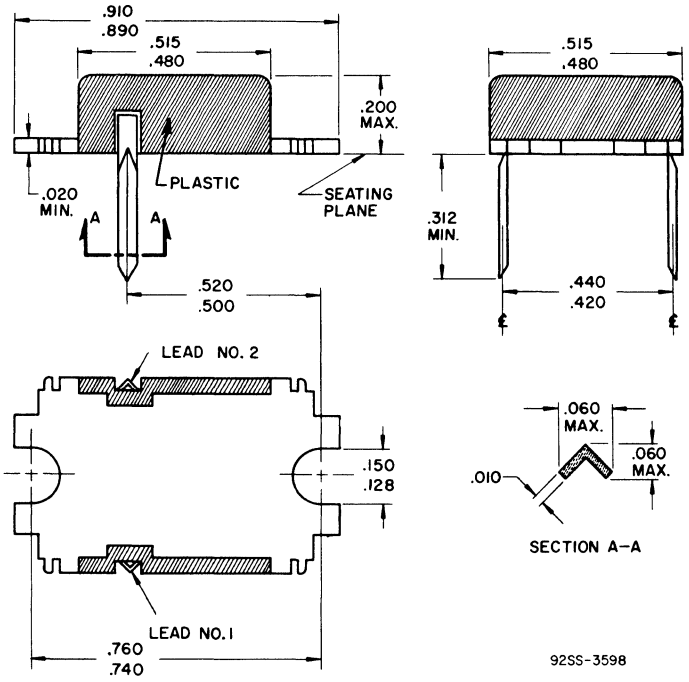
SUGGESTED HARDWARE FOR MOUNTING TYPES 2N5034, 2N5036, AND 40514 IN PLACE OF TO-3 TYPES



Dimensions in Inches

Fig. 20

DIMENSIONAL OUTLINE FOR TYPES 2N5034, 2N5036, & 40514

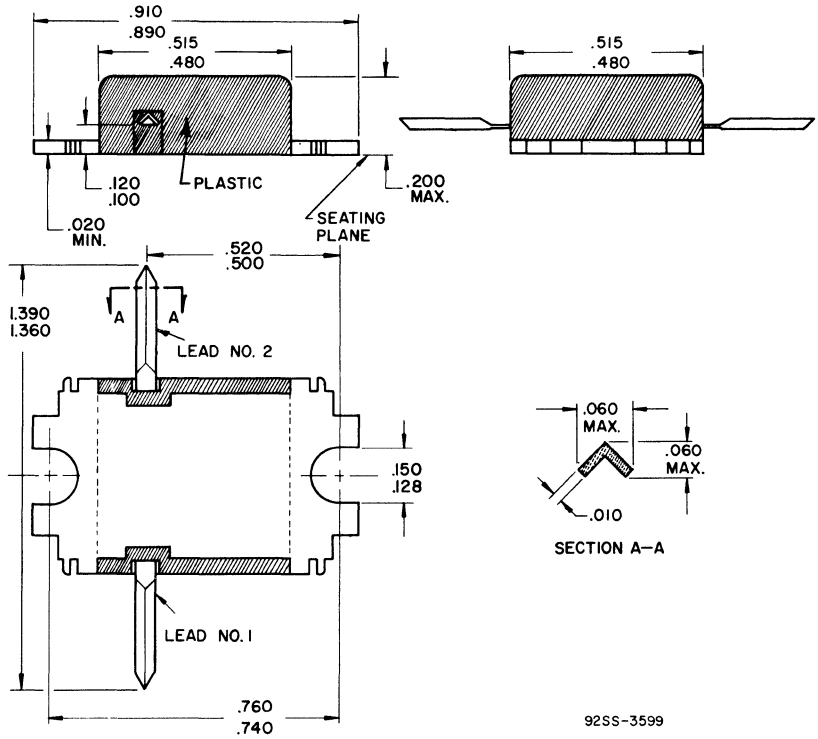


Dimensions in Inches

TERMINAL CONNECTIONS FOR TYPES 2N5034, 2N5035, 2N5036, 2N5037, 40513 & 40514

Lead No. 1 – Base
Lead No. 2 – Emitter
Mounting Flange – Collector

DIMENSIONAL OUTLINE FOR TYPES 2N5035, 2N5037, & 40513



Dimensions in Inches


RCA

SILICON N-P-N "overlay" TRANSISTOR

2N5070

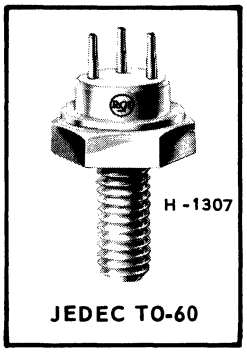
File No. 268

RCA-2N5070* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is especially designed for linear applications to provide high power in Class A or Class B service. This device is intended for 2-to-30 MHz single-sideband power amplifier operating from a 28-volt power supply.

The inherent high frequency capability of the "overlay" structure together with individually ballasted emitter sites makes it possible to forward bias the device into the active region without incurring thermal instability.

The emitter pin is common to case to minimize lead inductance.

Formerly RCA-Dev. No.TA2793



JEDEC TO-60

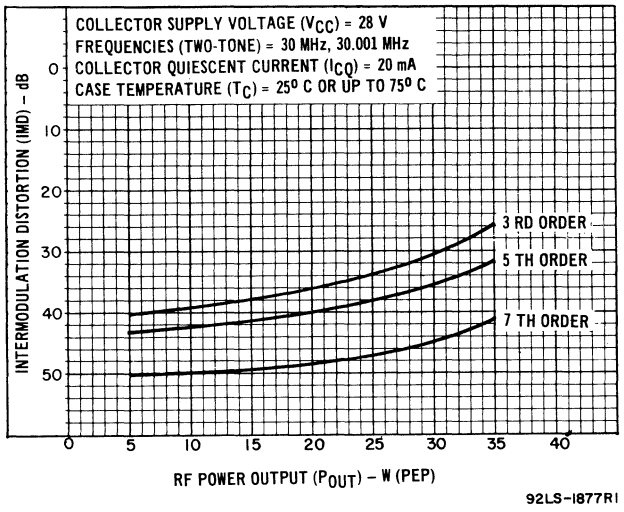
- **For Class-A or Class-B Amplifiers**
- **For HF Single Sideband Communications**
- **25 Watts PEP Output (min.) at 30 MHz**
  with Gain: 13 dB (min.)
  η: 40% (min.)
  IMD: 30 dB (max.)
- **Low Thermal Resistance**

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = -1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance, R_{BE} = 5 Ω	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		70	W
At case temperatures above 25° C		See *Fig.3*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

TYPICAL INTERMODULATION DISTORTION vs. RF POWER OUTPUT



92LS-1877RI

Fig. 1

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ELECTRICAL CHARACTERISTICS
Case Temperature = 25° C

Characteristics	Symbol	TEST CONDITIONS					Limits		Units
		DC Collector Volts		DC Base Volts	DC Current mA				
		V_{CB}	V_{CE}	V_{BE}	I_E	I_C	Min.	Max.	
Collector-to-emitter Sustaining Voltage	$V_{CEV}(sus)$			−1.5		200[a]	65	–	V
	$V_{CER}(sus)$ R_{BE}= 5 Ω					200[a]	40	–	V
Emitter-to-base Breakdown Voltage	BV_{EBO}				10		4	–	V
Collector-to-emitter Cutoff Current	I_{CEO}		30				–	5.0	mA
Collector-to-base Cutoff Current	I_{CBO}	60					–	10	mA
Collector-to-base Capacitance f = 1 MHz	C_{ob}	30					–	85	pF
Junction-to-case Thermal Resistance	θ_{J-C}						–	2.5	°C/W

[a]Pulsed through an inductor (25 mH); duty factor = 50%.

LINEAR RF POWER AMPLIFIER

Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2.

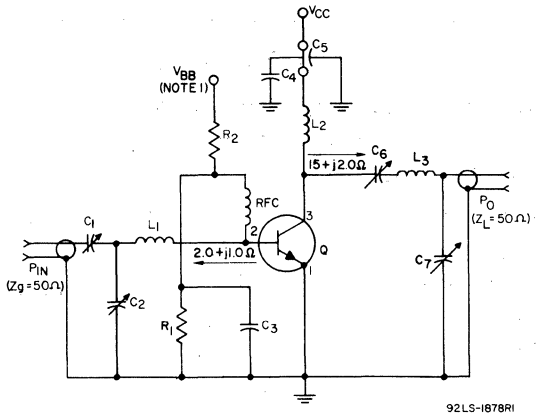
Test Operation

In test circuit shown in Fig.2, with "Two-Tone" Modulation, at T_C = 30° C, and at 30 MHz.

Collector Supply Voltage	28 V
Collector Bias Current	20 mA
RF Power Output:	
Average	12.5 min. W
Peak Envelope	25 min. W
Intermodulation Distortion[a]	30 max. dB
Collector Efficiency	40 min. %

[a]Referenced to either of the two tones and without the use of feedback to enhance linearity.

LINEAR RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST (30 MHz Operation)



L_1: 3T No.12 Wire, 1/4" I.D., 1/2" long
L_2: 6T No.14 Wire, 3/8" I.D., 3/4" long
L_3: 5T No.10 Wire, 3/4" I.D., 3/4" long

C_1: 140-680 pF, Arco 468 or equivalent
C_2: 170-780 pF, Arco 469 or equivalent
C_3: 0.05 μF, Ceramic capacitor
C_4: 0.1 μF, Ceramic capacitor
C_5: 1000 pF feedthrough capacitor
C_6: 24-200 pF Arco 425, or equivalent
C_7: 32-250 pF Arco 426, or equivalent
Q: 2N5070
R_1: 1 Ω, 5 W
R_2: 50 Ω, 25 W
RFC: 350 Ferrite choke, Ferroxcube* #VK200 01-03B, or equivalent

*Ferroxcube Corp. of America, Saugerties, N.Y.

Fig. 2

Note 1: Adjust V_{BB} for a collector quiescent current of 20 mA with no RF input signal.

Note 2: Impedance measurements are made at transistor socket pins.

DISSIPATION DERATING CURVE

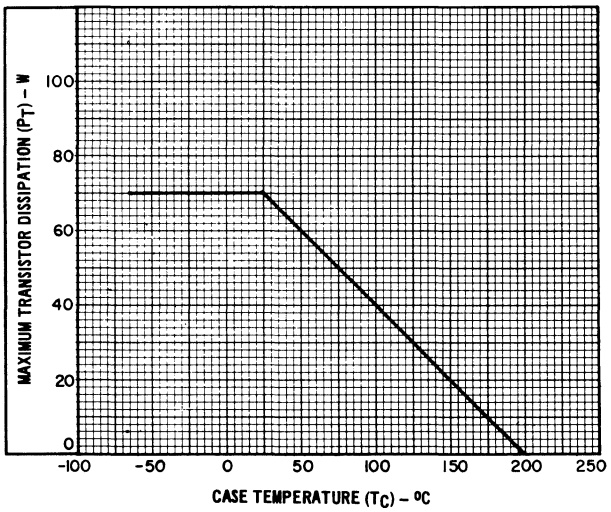


Fig. 3

SAFE OPERATION WITH DC FORWARD BIAS

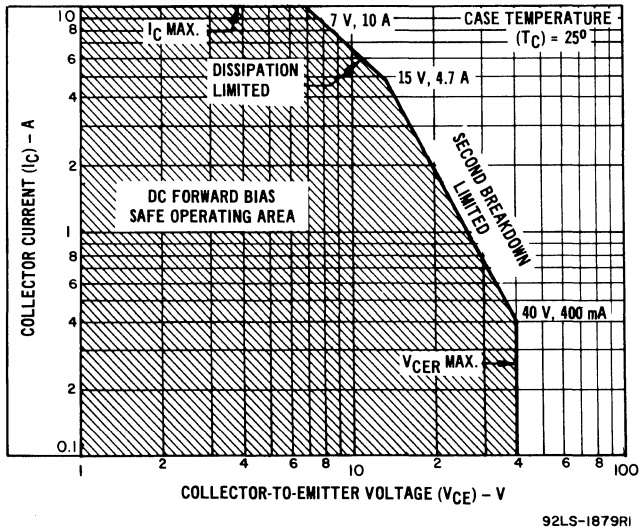


Fig. 4

TYPICAL COLLECTOR EFFICIENCY vs. RF POWER OUTPUT

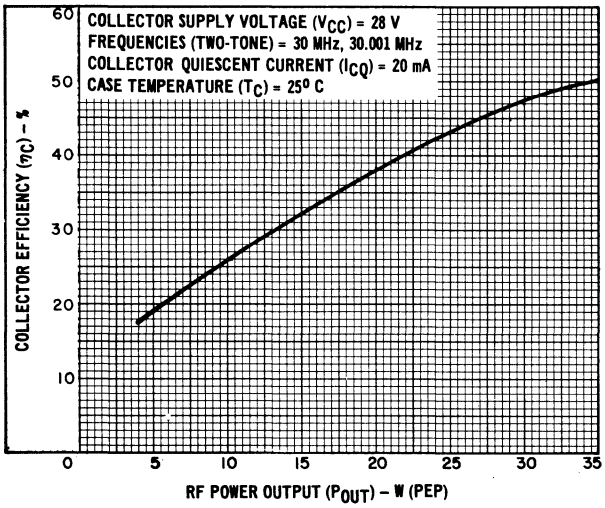


Fig. 5

TYPICAL RF POWER OUTPUT AND INTERMODULATION DISTORTION vs. CASE TEMPERATURE

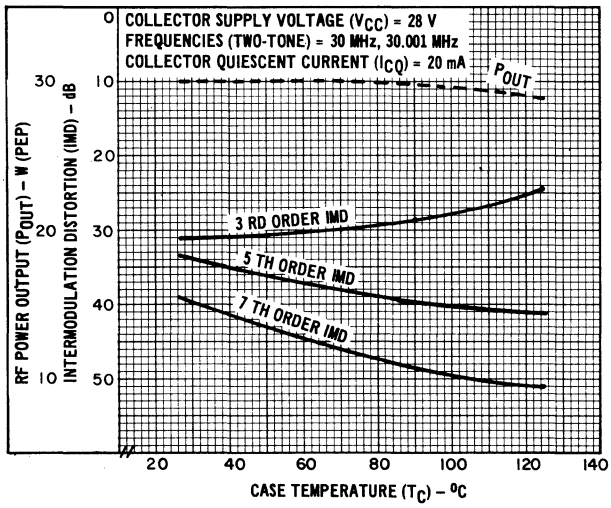


Fig. 6

TYPICAL RF POWER OUTPUT vs. COLLECTOR SUPPLY VOLTAGE

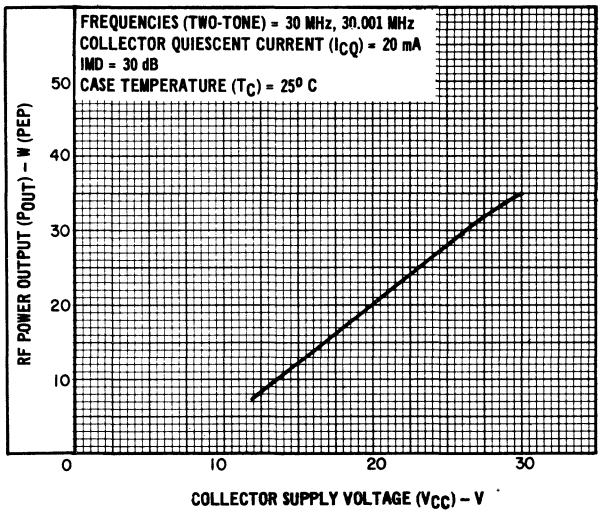


Fig. 7

TYPICAL TRANSFER CHARACTERISTICS

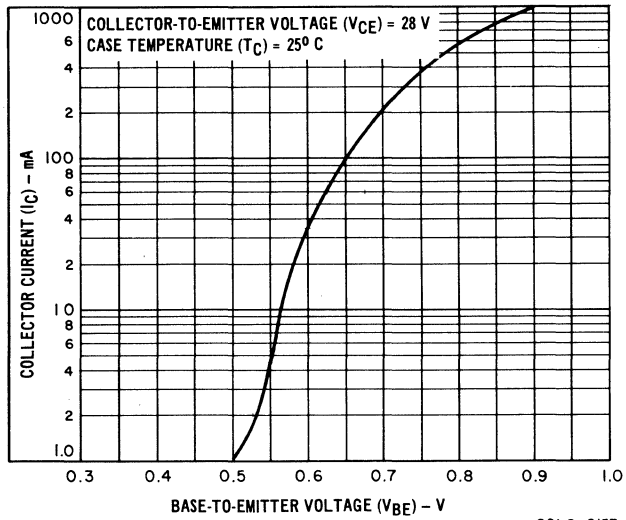
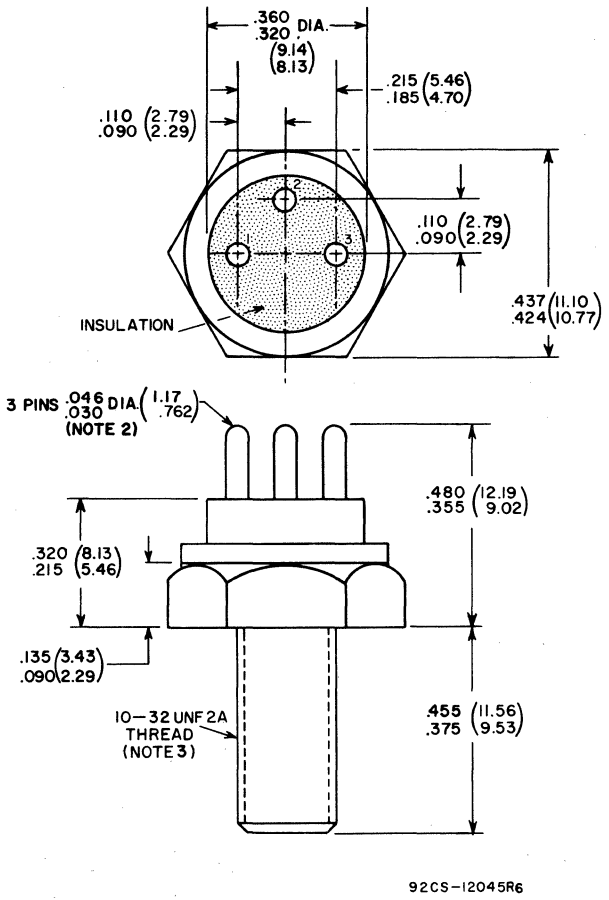


Fig. 8

DIMENSIONAL OUTLINE
JEDEC TO-60



DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" (5.08) and contacts which will accommodate pins having a diameter of 0.035" (0.889) min., 0.045" (1.143) max.

Note 3: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 4: This device may be operated in any position.

TERMINAL CONNECTIONS

Case, Mounting Stud, Pin No.1 - Emitter
Pin No.2 - Base
Pin No.3 - Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. *Design of Large-Signal VHF Transistor Power Amplifiers,* R. Minton, RCA Application Note SMA-36.

SILICON N-P-N "overlay" TRANSISTOR

2N5071

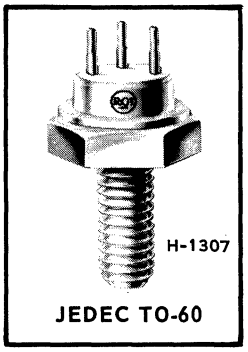
File No. 269

RCA-2N5071* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended as a high-power, class B and C rf amplifier for FM communications with a 24-volt power supply. It is useful for both narrowband and wideband applications in the 30 to 76 MHz frequency range.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.

The transistor can be operated under a wide range of mismatched load conditions. All transistors are tested for a load mismatch having a VSWR of 3:1 which is varied through all phases. The test is performed at 30 MHz and 30 watts output.

Formerly RCA-Dev. No.TA2827



JEDEC TO-60

- For Class-B or Class-C Amplifiers
- For 24 V FM (30 to 70 MHz) Communications
- 24 Watts Output at 76 MHz with 9 dB Gain (Min.)
- Low Thermal Resistance

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = −1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance (R_{BE} = 5 Ω)	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		70	W
At case temperatures above 25° C		See *Fig.4*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY

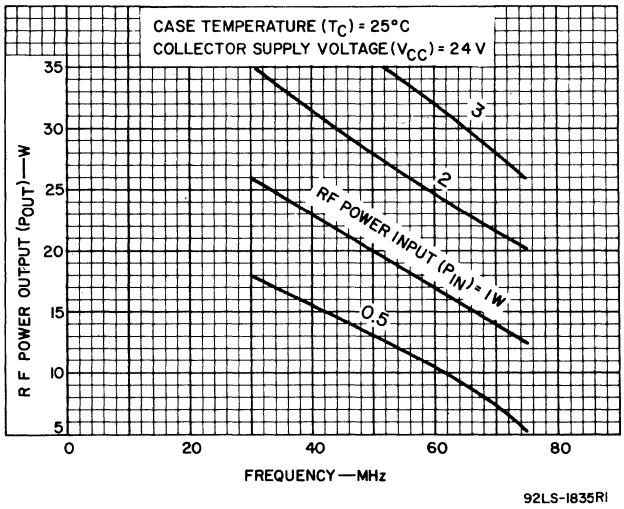


Fig. 1

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ELECTRICAL CHARACTERISTICS

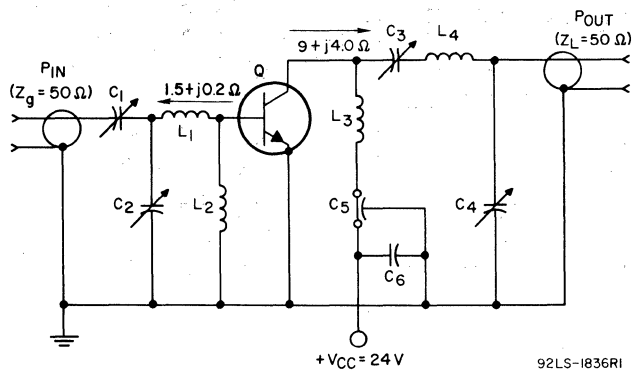
Case Temperature = 25° C

Characteristics	Symbol	TEST CONDITIONS					Limits		Units
		DC Collector Volts		DC Base Volts	DC Current mA				
		V_{CB}	V_{CE}	V_{BE}	I_E	I_C	Min.	Max.	
Collector-to-emitter Sustaining Voltage	$V_{CEV}(sus)$			−1.5		200[a]	65	–	V
	$V_{CER}(sus)$ R_{BE} = 5 Ω					200[a]	40	–	V
Emitter-to-base Breakdown Voltage	BV_{EBO}				10		4	–	V
Collector-to-emitter Cutoff Current	I_{CEO}		30				–	5.0	mA
Collector-to-base Cutoff Current	I_{CBO}	60						10	mA
Collector-to-base Capacitance Measured at 1 MHz	C_{ob}	30					–	85	pF
RF Power Output, Narrowband Amplifier, At 76 MHz (See *Fig.2*)	P_{OUT}		24				24[b]		W
RF Power Output, Wideband Amplifier, At 30 to 76 MHz (See *Fig.3*)	P_{OUT}		24				15[c]		W
Junction-to-case Thermal Resistance	θ_{J-C}							2.5	°C/W

[a]Pulsed through an inductor (25 mH); duty factor = 50%. [b]For P_{in} = 3 W; minimum efficiency = 60%.

[c]For P_{in} = 3 W; minimum efficiency = 35%.

NARROWBAND RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST (76-MHz Operation)

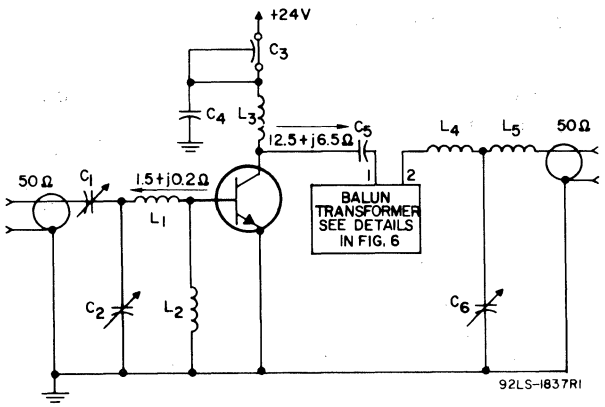


C_1, C_2: 55-300 pF, ARCO 427, or equivalent
C_3, C_4: 32-250 pF, ARCO 426, or equivalent
C_5: 1000 pF
C_6: 0.1 µF (50 V)
L_1: 1 turn, No.16 wire, 5/16" I.D.
L_2: Ferroxcube No.VK200 01-3B, or equivalent
L_3, L_4: 3 turns, No.10 wire, 5/16" I.D., 1/2" long
Q: 2N5071

Fig. 2

Note: Impedance measurements are made at transistor socket pins.

WIDEBAND RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST (30 to 76 MHz Operation)



C_1, C_2: 55-300 pF, ARCO 427, or equivalent
C_3: 100 pF
C_4: 0.1 µF (50 V).
C_5: 0.1 µF (5 in parallel), 200 V, Hi Q or equivalent
C_6: 14-150 pF, ARCO 424, or equivalent
L_1: 1 turn, No.16 wire, 5/16" I.D.
L_2: Ferroxcube No.VK200 01-3B, or equivalent
L_3: G.I. CF106 Q1, 10 turns, No.22 wire
L_4, L_5: 5 turns, No.12 wire, 1/2" I.D.
Q: 2N5071

Fig. 3

DISSIPATION DERATING CURVE

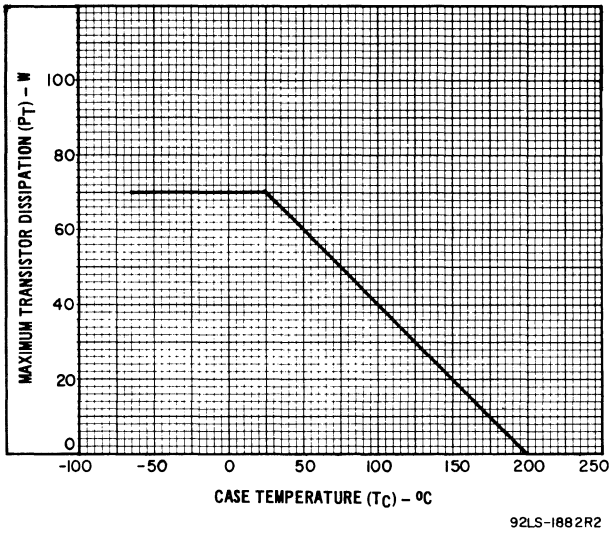


Fig. 4

SAFE OPERATION WITH DC FORWARD BIAS

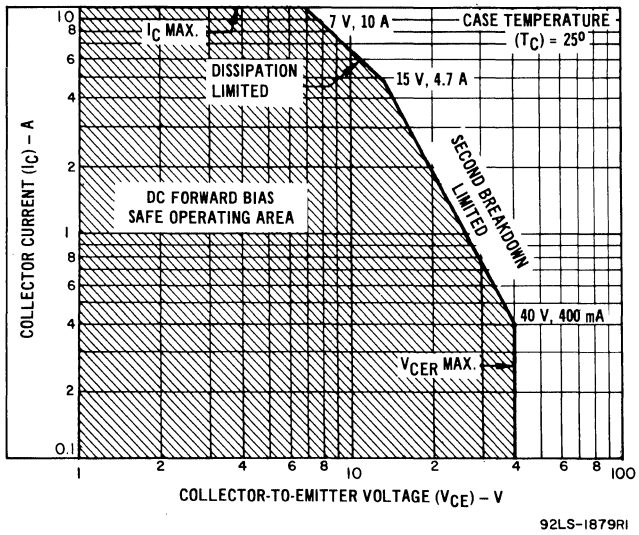
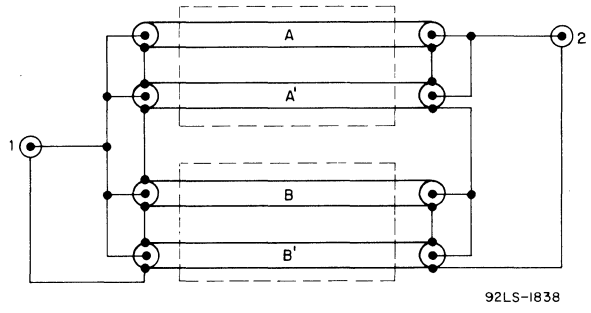


Fig. 5

DETAIL OF BALUN TRANSFORMER CONSTRUCTION



1. Wind A and A' on a G.I. No.CF111, Q1 core, 7 turns. (Use RG196 A/U 50-ohm wire)
2. Wind B and B' on another G.I. No.CF111, Q1 core, 7 turns. (Use RG196 A/U 50-ohm wire)
3. Stack two cores together and connect as shown above.

Fig. 6

TYPICAL RF POWER OUTPUT vs. COLLECTOR SUPPLY VOLTAGE

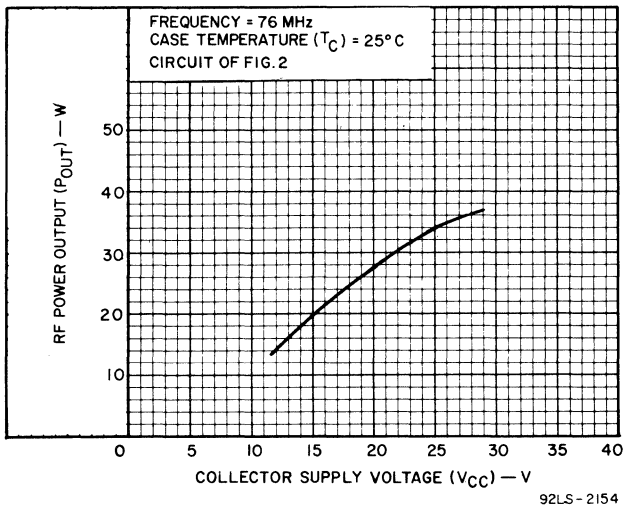
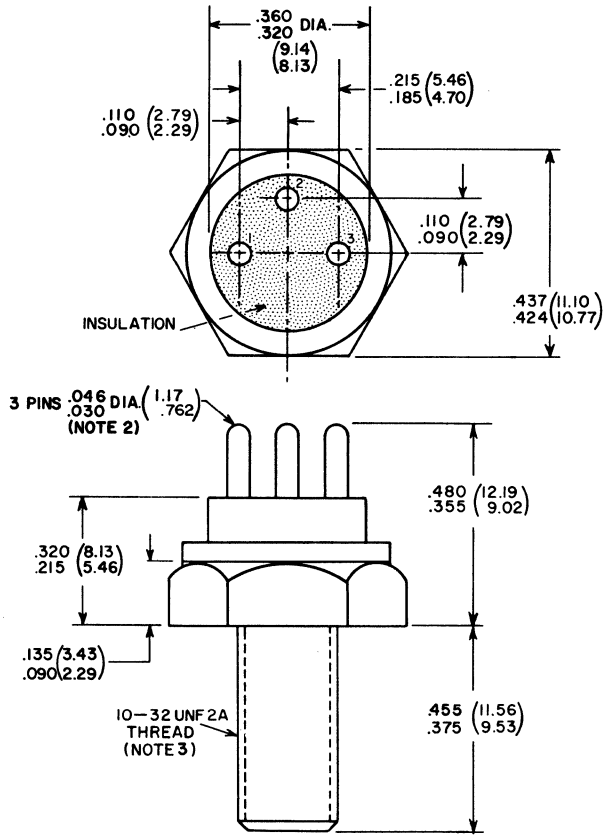


Fig. 7

DIMENSIONAL OUTLINE
JEDEC TO-60



92CS-12045R6

DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" (5.08) and contacts which will accommodate pins having a diameter of 0.035" (0.889) min., 0.045" (1.143) max.

Note 3: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 4: This device may be operated in any position.

TERMINAL CONNECTIONS

Mounting stud, case, Pin No. 1 – Emitter
Pin No. 2 – Base
Pin No. 3 – Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II – *Putting the Overlay to Work at Hi-Frequency.* Dr. D.J. Donahue and B.A. Jacoby.

2. *Design of Large-Signal VHF Transistor Power Amplifiers,* R. Minton, RCA Application Note SMA-36.

SILICON N-P-N "overlay" TRANSISTOR

2N5090

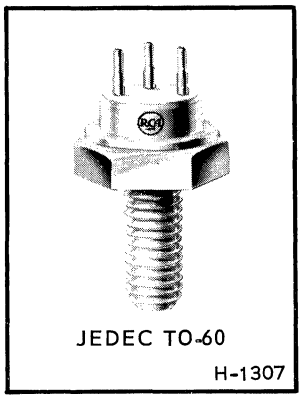
File No. 270

RCA-2N5090* is an epitaxial silicon n-p-n planar transistor employing an advanced version of the RCA-developed "overlay" emitter-electrode design. This electrode consists of many isolated emitter sites connected together through the use of a diffused-grid structure and a metal overlay which is deposited on a silicon oxide insulating layer by means of a photo-etching technique. This overlay design provides a very high emitter periphery-to-emitter area ratio resulting in low output capacitance, higher RF current handling capability, and substantially higher power gain.

The 2N5090 is intended for class-A, -B, or -C amplifier, frequency-multiplier, or oscillator circuits; it may be used in output, driver, or pre-driver stages in VHF and UHF equipment.

*Formerly RCA-Dev. No. TA7146

High-Gain Device for Class-A, B, or C Operation in VHF-UHF Circuits



JEDEC TO-60

H-1307

- 1.2 Watts Output Min. at 400 MHz (7.8 dB Gain)
- 1.6 Watts Output Typ. at 175 MHz (1.2 dB Gain)
- Isolated Electrodes

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	55	V
With base open	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 75° C		5	W
At case temperatures above 75° C		*See Fig. 4.*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY

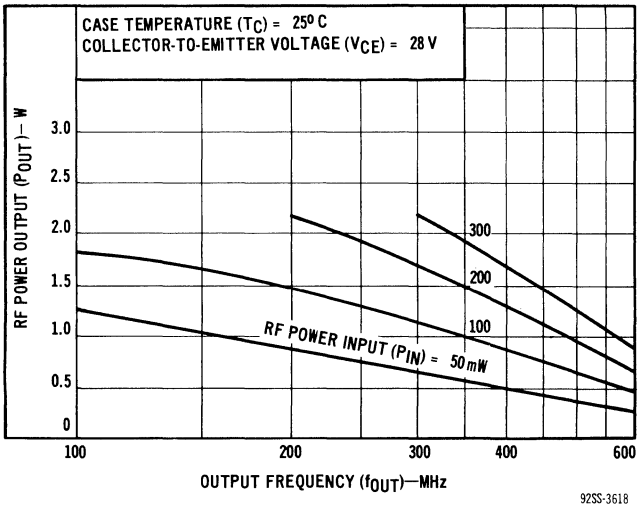


Fig. 1

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ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS					LIMITS		Units
		DC Collector Volts		DC Current (mA)					
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		28		0		-	20	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}			0		0.1	55	-	V
Collector-to-Emitter Sustaining Voltage With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER} (sus)					5	55[a]		V
With base open	V_{CEO} (sus)				0	5	30	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0.1		0	3.5	-	V
Collector-to-Emitter Saturation Voltage	V_{CE} (sat)				20	100	-	1.0	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	30		0			-	3.5	pF
RF Power Output: As Class-C Amplifier, Unneutralized At 400 MHz *(See Fig. 3.)*	P_{OUT}		28				1.2[b]		W
Gain-Bandwidth Product	f_T		15			50	500		MHz

[a] Pulsed through an inductor (25 mH); duty factor = 50%.

[b] For P_{IN} = 0.2 W; minimum efficiency = 45%.

TYPICAL POWER OUTPUT vs. COLLECTOR SUPPLY VOLTAGE

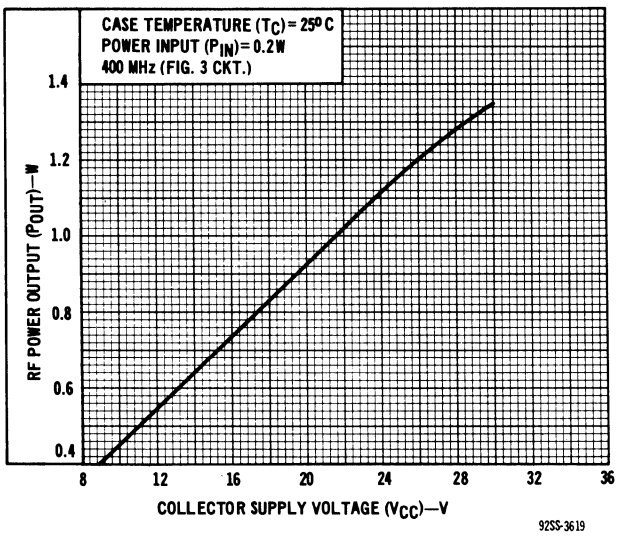
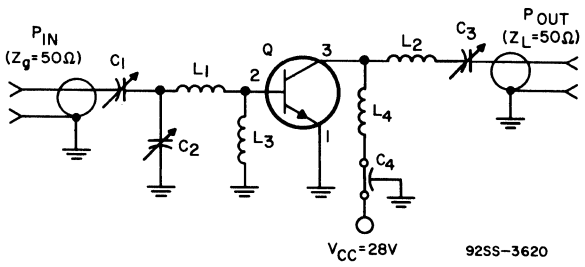


Fig. 2

RF AMPLIFIER CIRCUIT FOR 2N5090 POWER-OUTPUT TEST (400-MHz Operation)



C_1: 0.9-7 pF (ARCO 400 or equivalent)
C_2, C_3: 1.5-20 pF (ARCO 402 or equivalent)
C_4: 1,000 pF feed through

L_1: 2 turns No. 18 wire, 1/4" ID, 1/8" long
L_2: 3 turns No. 16 wire, 1/4" ID, 3/8" long
L_3: RF choke, 0.1 μH
L_4: 2 turns No. 18 wire, 1/8" ID, 2/16" long
Q: 2N5090

Fig. 3

DISSIPATION DERATING CURVE

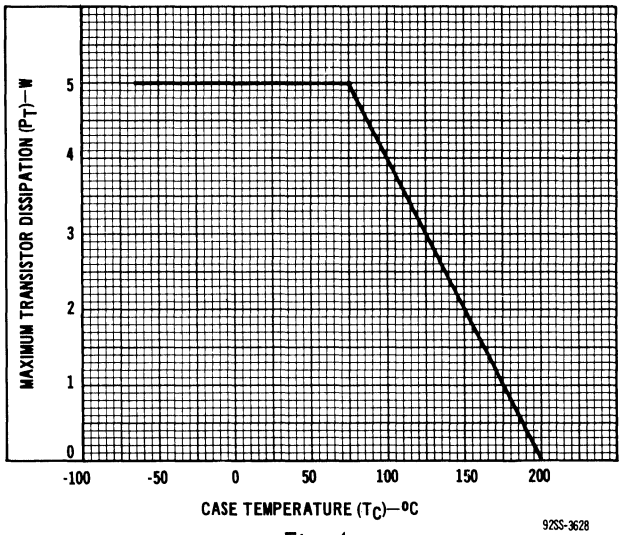


Fig. 4

TYPICAL GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

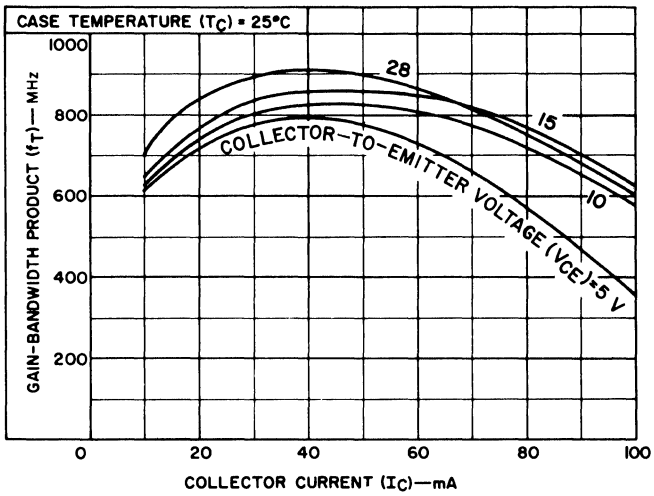


Fig. 5

TYPICAL SERIES INPUT RESISTANCE vs. FREQUENCY

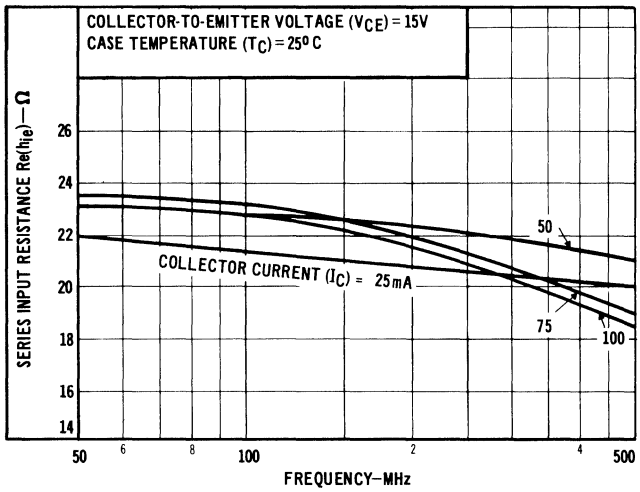


Fig. 6

TYPICAL SERIES INPUT REACTANCE vs. FREQUENCY

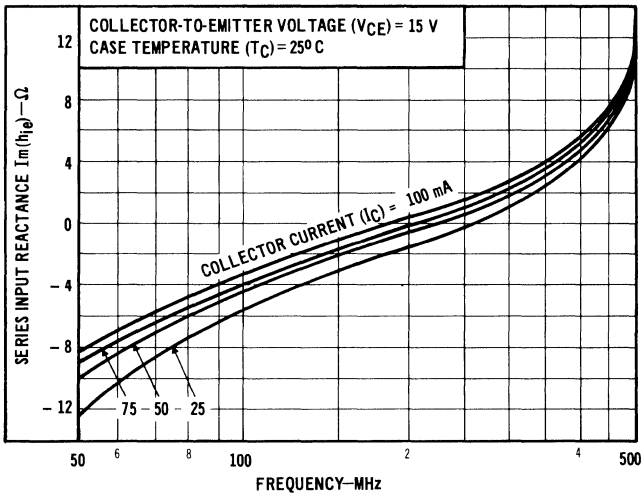


Fig. 7

TYPICAL SERIES INPUT RESISTANCE AND REACTANCE vs. FREQUENCY

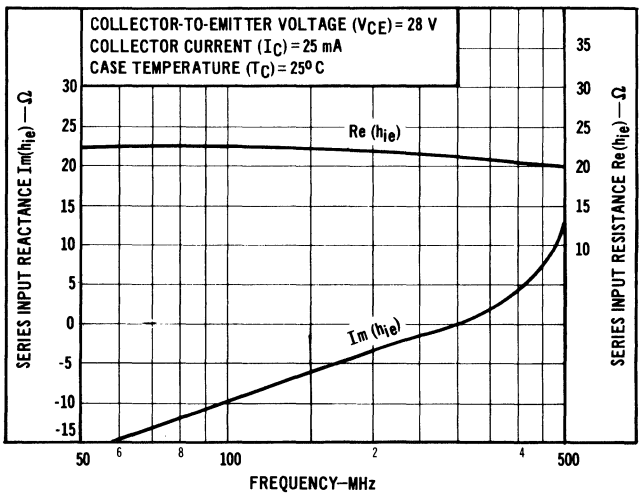


Fig. 8

TYPICAL PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

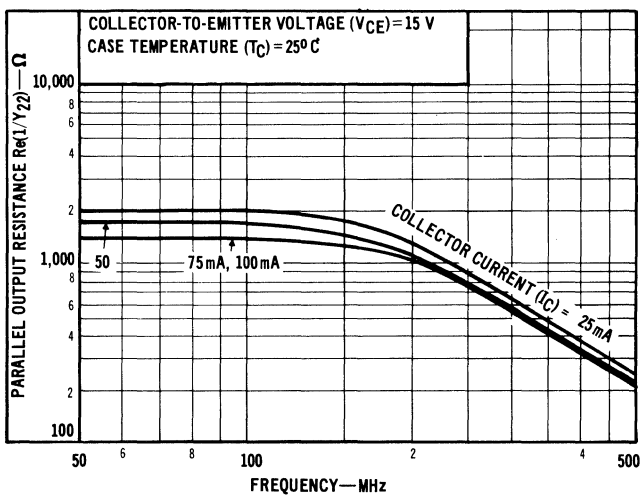


Fig. 9

TYPICAL PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

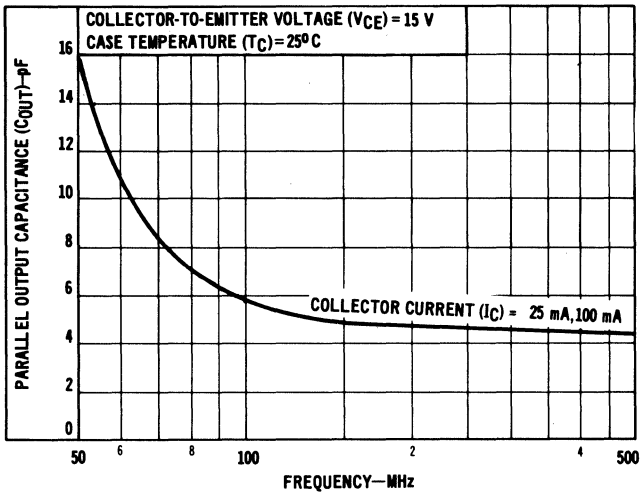


Fig. 10

TYPICAL PARALLEL OUTPUT RESISTANCE AND CAPACITANCE vs. FREQUENCY

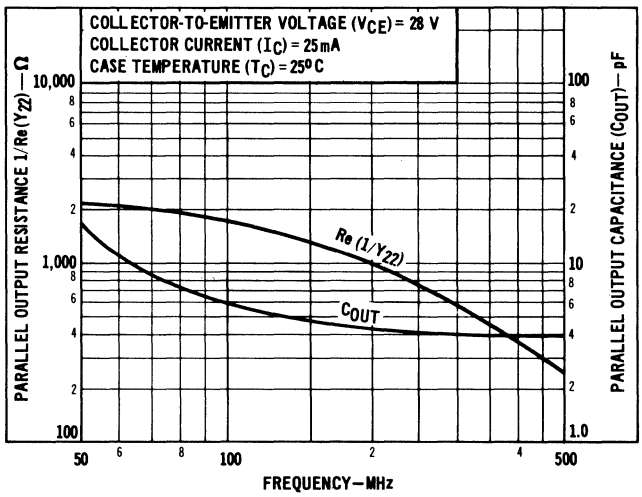


Fig. 11

TYPICAL VARIATION OF COLLECTOR-TO-BASE CAPACITANCE

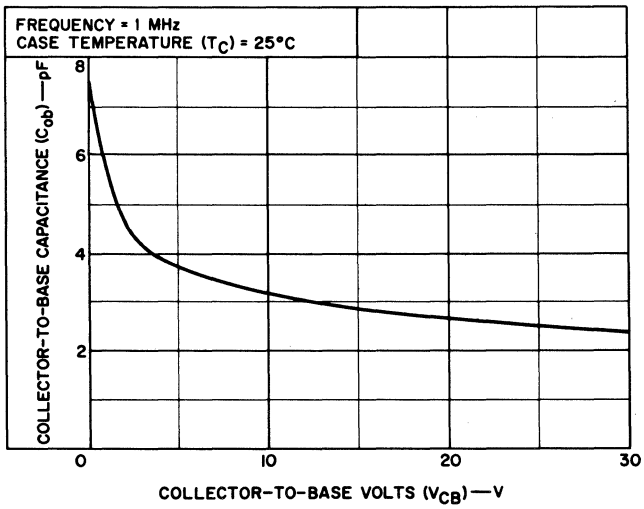
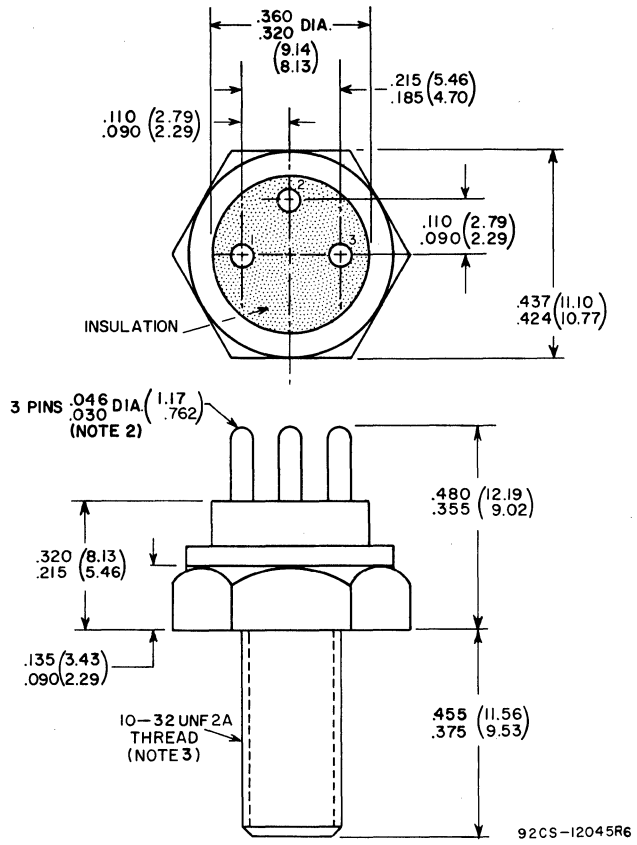


Fig. 12

DIMENSIONAL OUTLINE JEDEC TO-60



DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" (5.08) and contacts which will accommodate pins having a diameter of 0.035" (0.889) min., 0.045" (1.143) max.

Note 3: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 4: This device may be operated in any position.

TERMINAL CONNECTIONS

Pin No. 1 - Emitter
Pin No. 2 - Base
Pin No. 3 - Collector

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.
   Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.
   Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.
2. Frequency Multiplication Using Transistors, H.C. Lee and R. Minton, RCA Application Note SMA-40.

SILICON N-P-N "overlay" TRANSISTOR

2N5102

File No. 279

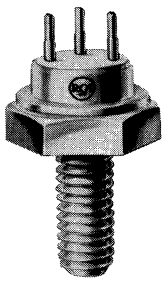
RCA-2N5102* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is especially designed with integral ballast resistors in each emitter site to provide high power as a class-C rf amplifier for VHF Aircraft Communications service (108 to 150 MHz) with amplitude modulation and 24-volt power supply.

The transistor features complete protection against any load mismatch. Each unit is tested at 118 MHz with full modulation and no current limiting for all load mismatch conditions from short-circuit to open-circuit.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain efficiency, frequency capability, and linearity.

Formerly RCA-Dev. No. TA2791.

High-Power Device for Class-C, AM Operation in VHF Circuits



JEDEC TO-60

H-1307

- 15 Watts Output Min. at 136 MHz
- For 24-Volt Aircraft Communication
- Complete Load Mismatch Protection
- High Voltage Ratings
- Case Connected to Emitter

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = − 1.5 volts	V_{CEV}	100	V
With external base-to-emitter resistance R_{BE} = 5 Ω	V_{CER}	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		70	W
At case temperatures above 25° C		See Fig. 8.	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY

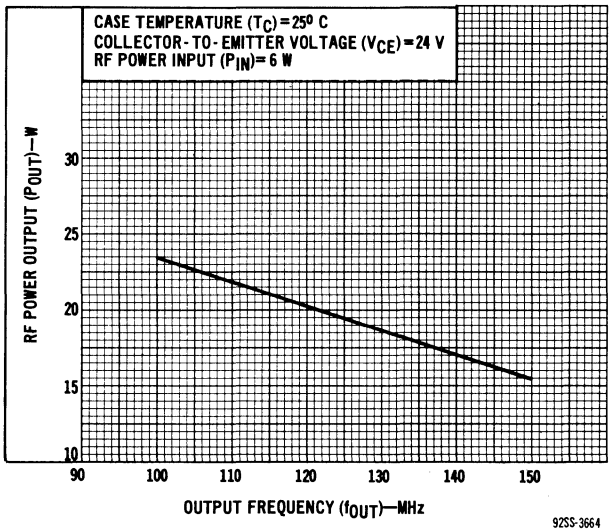


Fig. 1

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ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS							LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)		RF Power Watts	Frequency MHz			
		V_{CB}	V_{CE}	V_{BE}	I_E	I_C	P_{IN}	f	Min.	Max.	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 5 Ω	I_{CER}		50							10	mA
Collector-to-Emitter Sustaining Voltage With base-to-emitter junction reverse biased	$V_{CEV}(sus)$			- 1.5		600[a]			100		V
With external base-to-emitter resistance (R_{BE}) = 5 Ω	$V_{CER}(sus)$					200[a]			50		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10	0			4		V
Collector-to-Base Capacitance	C_{ob}	30				0				85	pF
RF Power Output *(See Fig. 2.)*	P_{OUT}		24 (V_{CC})				6	136	15[b]		W
Modulation[c]	M		24					118	80		%
Load Mismatch[d]	LP		24					118	Will not be[d] damaged		—
Dynamic Input Impedance *(See Fig. 2.)*	Z_{IN}		24			1,100	6	150	1.7 + j 2.6 (typ.)		Ω

[a] Pulsed through an inductor (9 MH); duty factor = 50%.

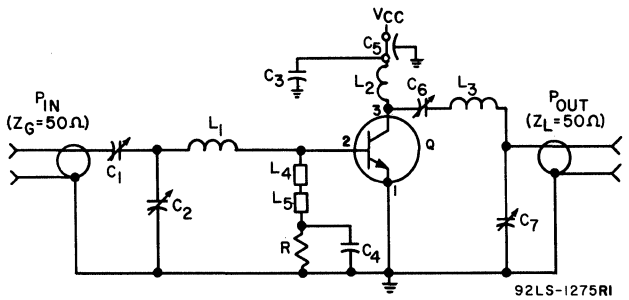
[b] Unmodulated carrier.

[c] See Fig. 2 & 3. Carrier Power, P_{CAR}, = 15 W;

V_{CC} modulation = 100%; $M = \sqrt{\frac{2\,(P_{AM} - P_{CAR})}{P_{CAR}}} \times 100\%$.

[d] Under conditions of *footnote* c, the transistor is subjected to all conditions of load mismatch from short-circuit to open-circuit.

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST



C_1, C_6: 3-35 pF

C_2, C_7: 7-100 pF

C_3: 0.1 μF

C_4: 0.05 μF

C_5: 1,000 pF

R: 1 Ω wire wound

L_1: 3 1/4 turns, 1/8" diameter, No. 14 wire

L_2: 2 turn, 3/8" diameter, No. 14 wire

L_3: 4 turns, 3/8" diameter, No. 14 wire

L_4, L_5: 350 Ω Ferrite choke, Ferroxcube # VK200 01-3B*

Q: 2N5102

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 2

BLOCK DIAGRAM FOR MODULATION TEST

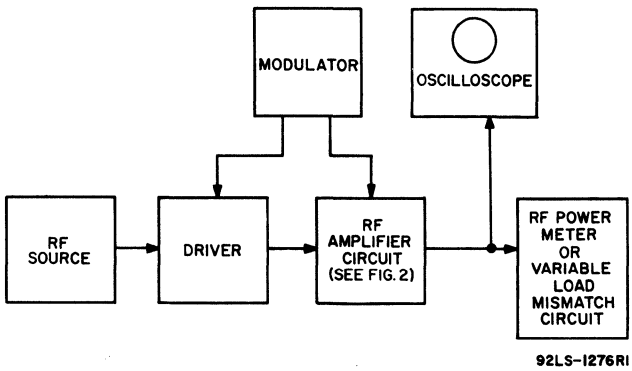
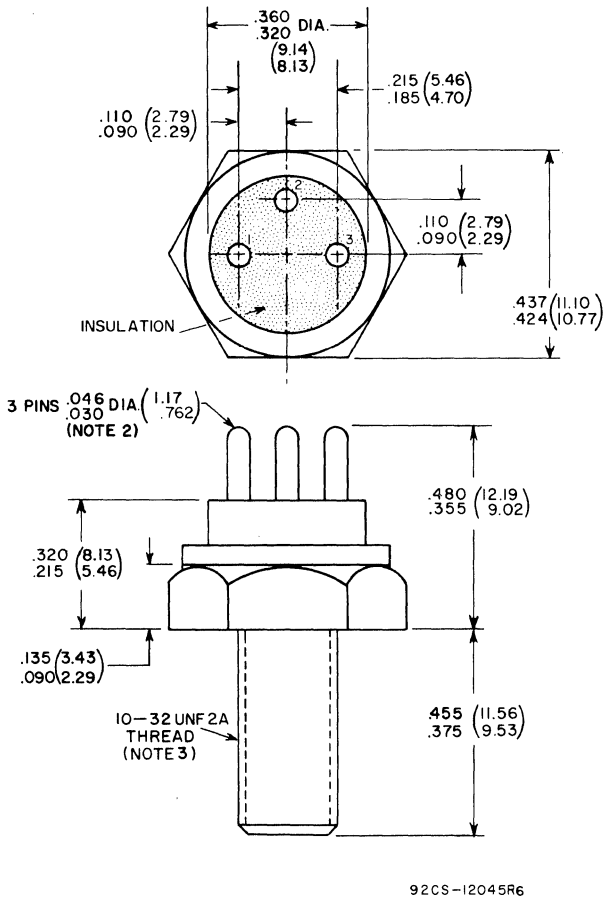


Fig. 3

DIMENSIONAL OUTLINE

JEDEC TO-60



DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" (5.08) and contacts which will accommodate pins having a diameter of 0.030" (.762) min., .046" (1.17) max.

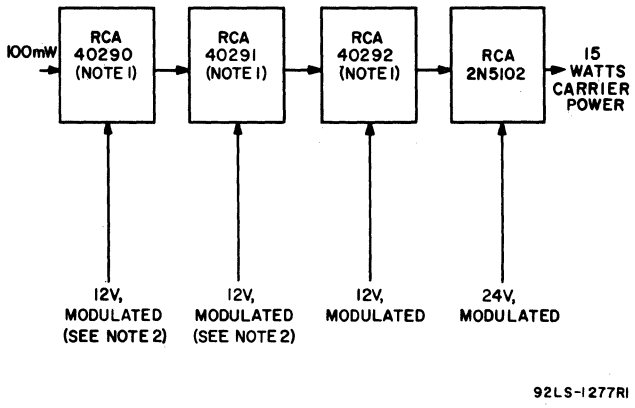
Note 3: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 4: This device may be operated in any position.

TERMINAL CONNECTIONS

Mounting stud, case, Pin No. 1 - Emitter
Pin No. 2 - Base
Pin No. 3 - Collector

BLOCK DIAGRAM OF A TYPICAL NARROWBAND AIRCRAFT RADIO TRANSMITTER CHAIN

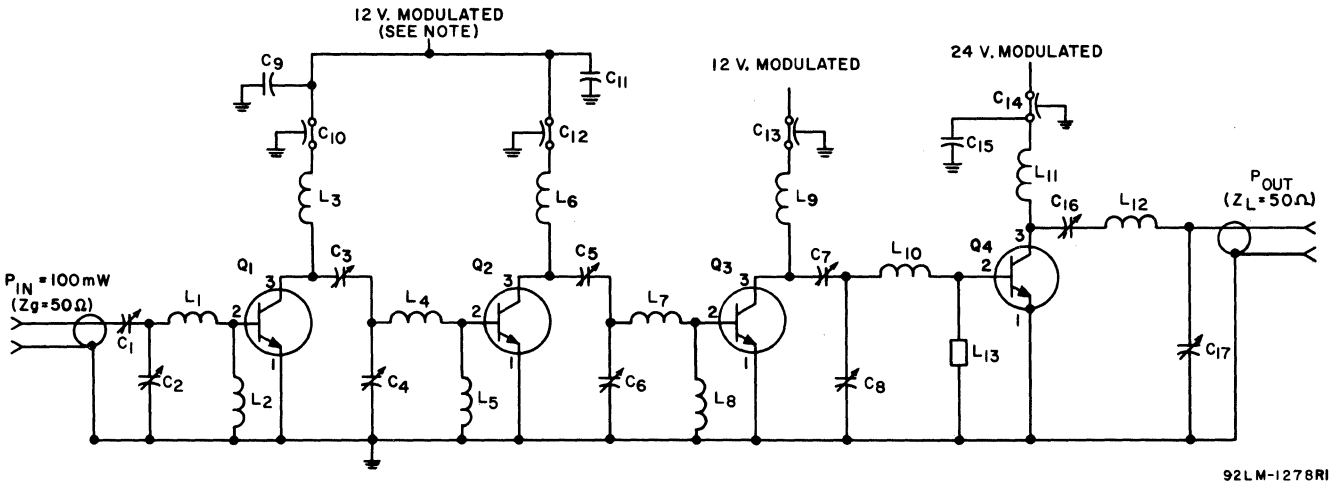


Note 1: For technical bulletin write RCA Commercial Eng., Harrison, N.J.

Note 2: Upward Modulation only.

Fig. 10

CIRCUIT DIAGRAM OF A TYPICAL NARROWBAND AIRCRAFT RADIO TRANSMITTER CHAIN



C_1, C_3, C_5, C_7, C_{16}: 3-35 pF

C_2, C_4, C_6, C_8, C_{17}: 8-60 pF

C_9, C_{11}, C_{13}: 0.03 μF

C_{10}, C_{12}, C_{14}: 1,000 pF

C_{15}: 0.1 μF

L_1, L_9: 3 turns, 1/4" diameter, No. 16 wire

L_2, L_5: Ferrite choke, Z = 450 ohms, Ferroxcube # VK200 01-4B*

L_3: RF choke, 1.5 μH

L_4, L_7: 4 turns, 1/4" diameter, No. 16 wire

L_6: RF choke, 1.0 μH

L_8: wire wound resistor, R = 2.4 ohms

L_{10}: 3 turns, 1/8" diameter, No. 14 wire

L_{11}: 2 turns, 1/2" diameter, No. 16 wire

L_{12}: 4 turns, 1/2" diameter, No. 16 wire

L_{13}: 350 Ω ferrite choke, Ferroxcube # VK200 01-3B*

Q_1: RCA-40290

Q_2: RCA-40290 or 40291

Q_3: RCA-40292

Q_4: 2N5102

Note: Upward modulation only.

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 11

TYPICAL RF POWER OUTPUT vs. COLLECTOR-TO-EMITTER VOLTAGE

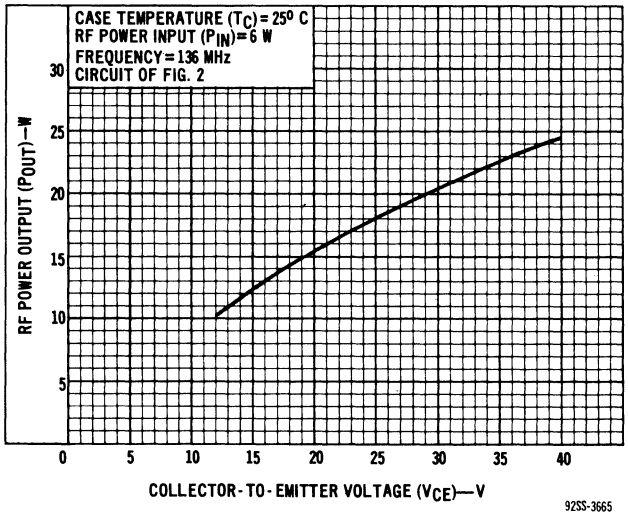


Fig. 4

TYPICAL COLLECTOR EFFICIENCY vs. FREQUENCY

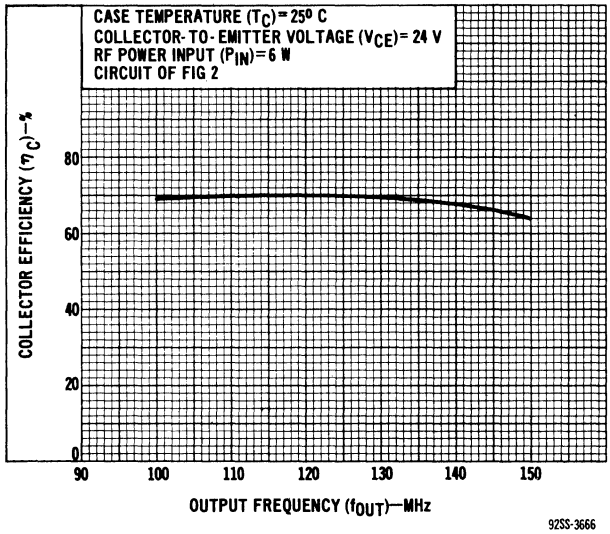


Fig. 5

TYPICAL POWER OUTPUT vs. POWER INPUT

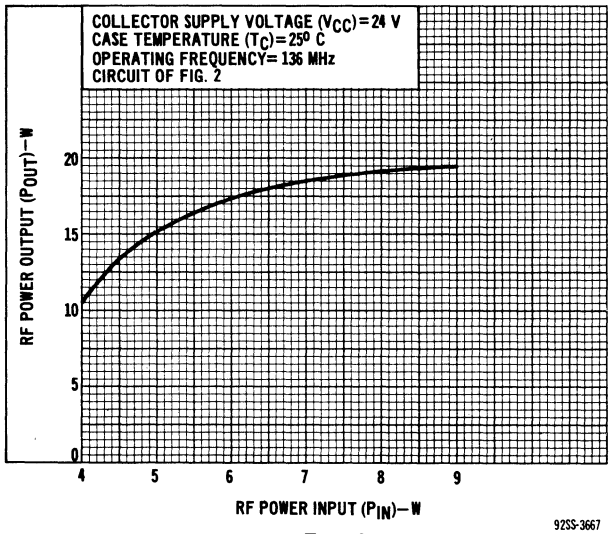


Fig. 6

TYPICAL VARIATION OF COLLECTOR-TO-BASE CAPACITANCE

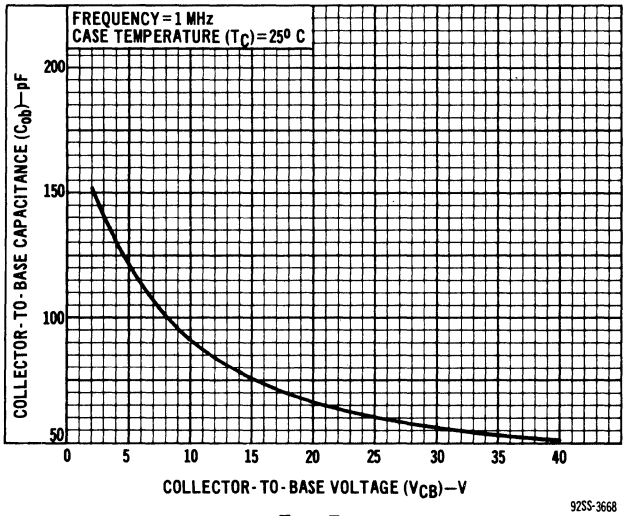


Fig. 7

DISSIPATION DERATING CURVE

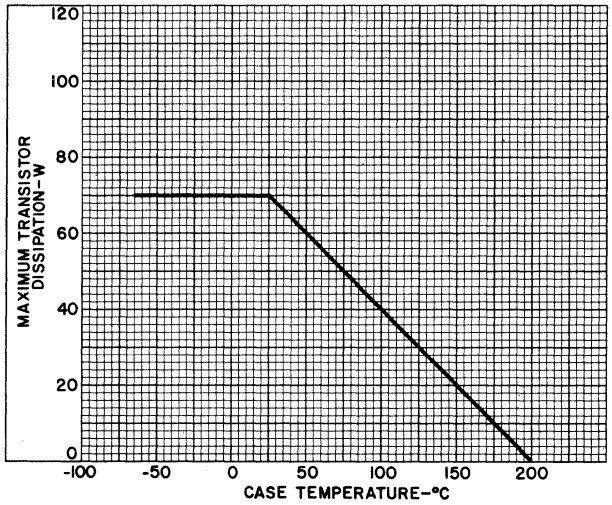


Fig. 8

SAFE OPERATION WITH DC FORWARD BIAS

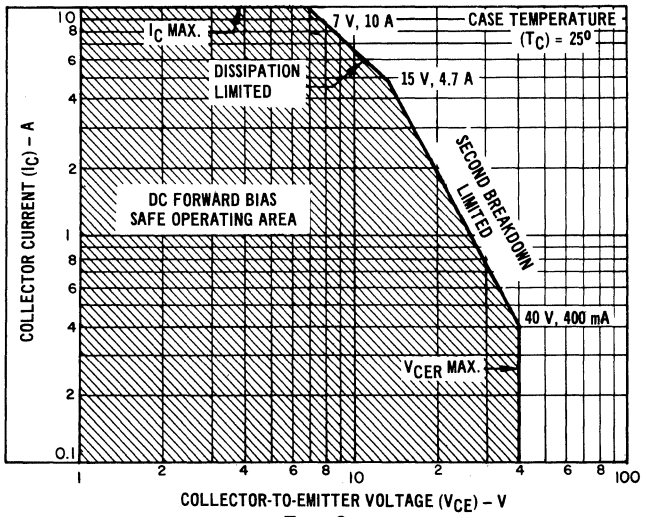


Fig. 9

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. *Design of Large-Signal VHF Transistor Power Amplifier,* R. Minton, RCA Application Note SMA-36.

SILICON N-P-N "overlay" TRANSISTOR

2N5108

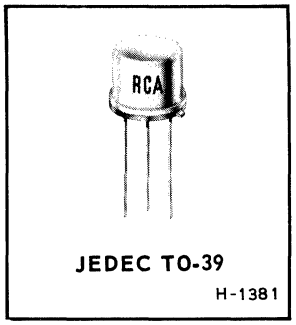
File No. 280

RCA-2N5108* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is intended as a high power amplifier, fundamental frequency oscillator and frequency multiplier. It may be used in final, driver, and pre-driver amplifier stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus provides greater power output, gain, efficiency, frequency capability, and linearity.

*Formerly RCA-Dev. No.TA2710

High-Gain Device for Class-B or C Operation in UHF Circuits



JEDEC TO-39

H-1381

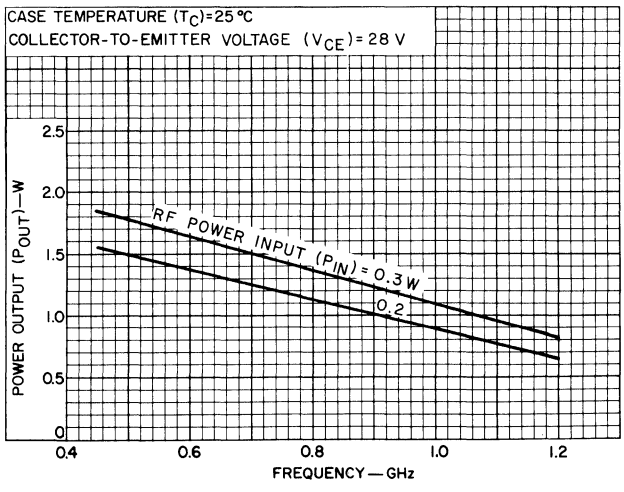
- 1 Watt Output Min. at 1 GHz (5 dB Gain)
- For Sonde Applications
  0.3 Watt Output Typ. at 1.68 GHz

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE . . .	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	55	V
With base open	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3	V
COLLECTOR CURRENT.	I_C	0.4	A
TRANSISTOR DISSIPATION.	P_T		
At case temperatures up to 25° C . . .		3.5	W
At case temperatures above 25° C . . .		See *Fig.7.*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distance ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY



92LS-1841RI

Fig. 1

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

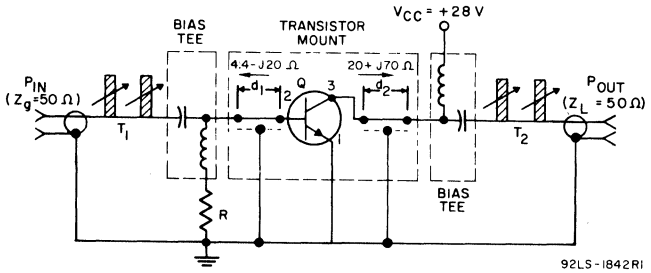
Characteristic	Symbol	Test Conditions					Limits		Units
		DC Collector Volts		DC Current (mA)					
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		15		0		-	20	μA
	I_{CES}		50					1	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}			0		0.1	55	-	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$					5	55[a]	—	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0.1		0	3	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	-	0.5	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	30		0			-	3.0	pF
Small Signal (Common Emitter) Forward Current Transfer Ratio (Measured at 200 MHz)	$\|h_{fe}\|$		15			50	6.0	-	
RF Power Output Common Emitter Amplifier at 1 GHz (See *Fig.2.*)	P_{OUT}		28				1[b]	-	W
RF Power Output Fundamental Frequency Oscillator at 1.68 GHz (See *Fig.4.*)	P_{OUT}		20				0.3[c] (typ.)		W

[a] Pulsed through an inductor (2.5 mH), duty factor = 50%.

[b] For P_{in} = 0.316 W, minimum efficiency = 35%.

[c] Minimum efficiency = 15%. (V_{EB} = 1.5 V)

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST
(1-GHz Operation)



d_1: 1" Input line, center conductor width = .280"
d_2: 1" Output line, center conductor width = .125"
Q: 2N5108
R: 3.9 ohms
T_1, T_2: Microlab Double Stub Tuner
Bias Tee: Microlab 08N, or equivalent
Transistor Mount: 1/32" Microstrip board

Note: Imdepance measurements are made of transistor socket pins.

Fig. 2

TYPICAL RF POWER OUTPUT vs. COLLECTOR-TO-EMITTER VOLTAGE

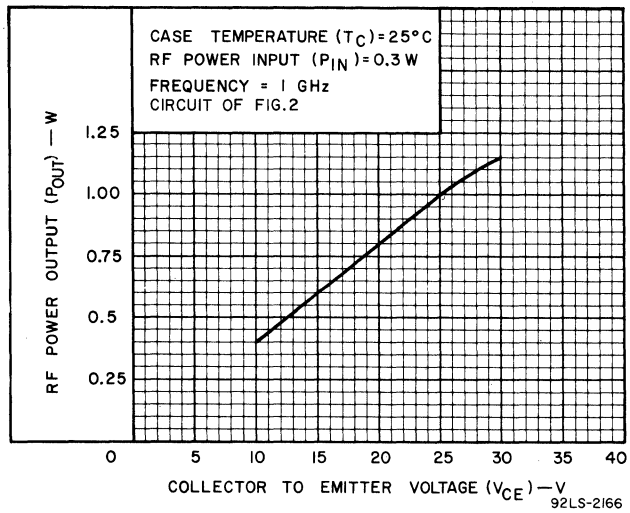
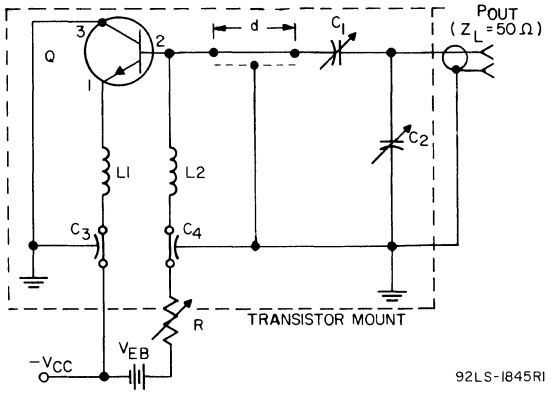


Fig. 3

RF FUNDAMENTAL-FREQUENCY OSCILLATOR CIRCUIT for POWER OUTPUT TEST (1.68-GHz Operation)



C_1, C_2: 0.35-3.5 pF
C_3, C_4: 500 pF feed through 3/4" output line, center
d: 3/4" output line, center conductor width = 0.160"
L_1, L_2: RF choke – 5 turns, No.28 wire, 1/8" dia. x 1/2" long
Q: 2N5108
R: 0-50 ohms
Transistor Mount: 1/16" microstrip board

Fig. 4

TYPICAL OSCILLATOR POWER OUTPUT vs. COLLECTOR SUPPLY VOLTAGE

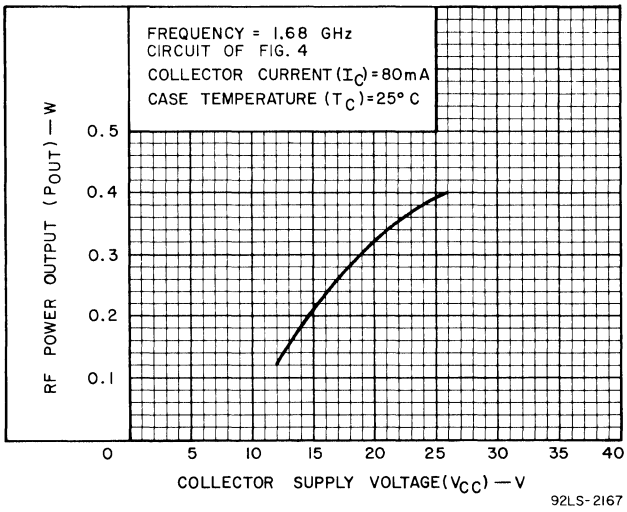


Fig. 5

TYPICAL RF AMPLIFIER CIRCUIT (1-GHz Operation)

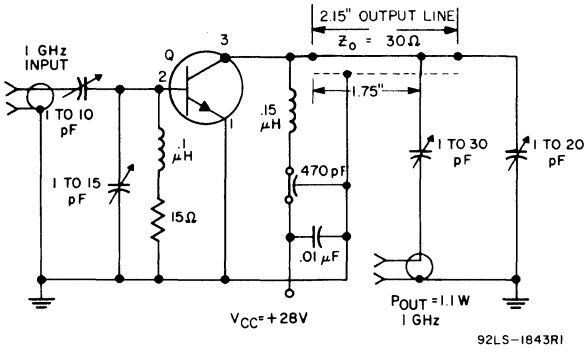


Fig. 6

DISSIPATION DERATING CURVE

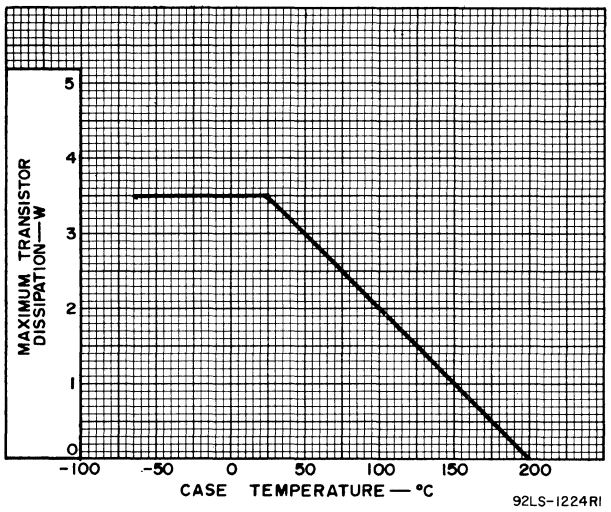
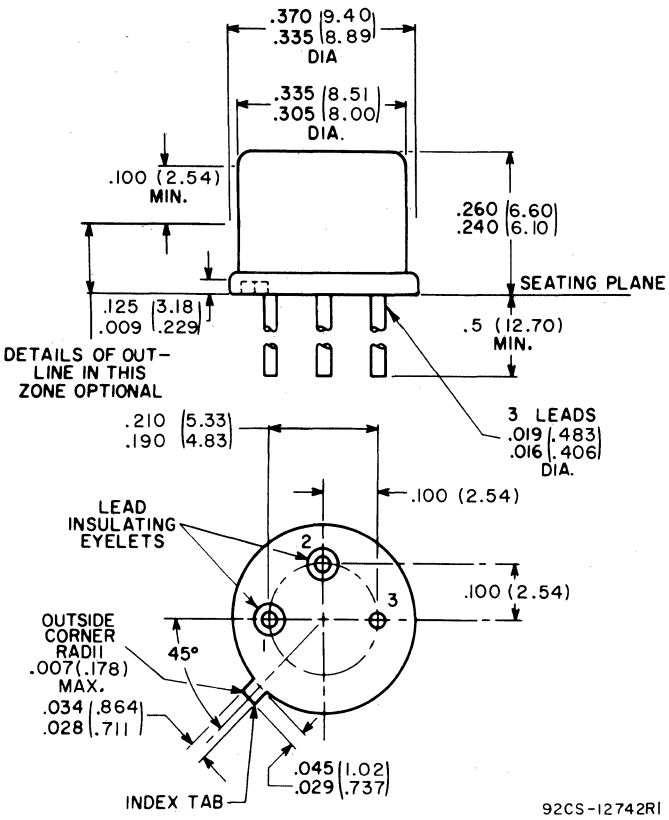


Fig. 7

DIMENSIONAL OUTLINE
JEDEC TO-39



DIMENSIONS IN INCHES AND MILLIMETERS

TERMINAL CONNECTIONS

Lead No.1 - Emitter
Lead No.2 - Base
Case, Lead No.3 - Collector

Note: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

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RCA RF POWER TRANSISTORS

2N5109

File No. 281

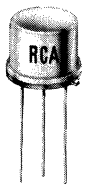
RCA-2N5109* is an epitaxial silicon n-p-n planar transistor employing "overlay" emitter electrode construction. It is especially designed to provide large dynamic range, low distortion, and low noise as a wide-band amplifier into the VHF range.

A high gain-bandwidth product over a wide range of collector current makes the 2N5109 ideally suited for such applications as CATV and MATV line amplifiers and low-noise linear amplifiers.

*Formerly RCA-Dev. No. TA2800.

SILICON N-P-N "overlay" TRANSISTOR

High-Gain for Line Amplifiers in CATV and MATV Equipment



JEDEC TO-39

H-1381

- High gain-bandwidth product
- Large dynamic range
- Low distortion
- Low noise

MAXIMUM RATINGS, *Absolute Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3	V
COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		3.5	W
At case temperatures above 25° C		*See Fig. 12*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from the seating plane for 10 s max.		230	°C

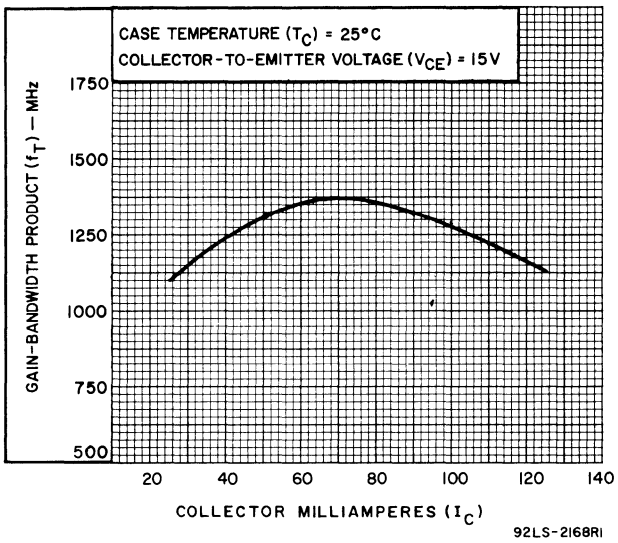


Fig. 1 - Gain-bandwidth vs. collector current for type 2N5109.

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RCA Electronic Components

Printed in U.S.A. 12-69

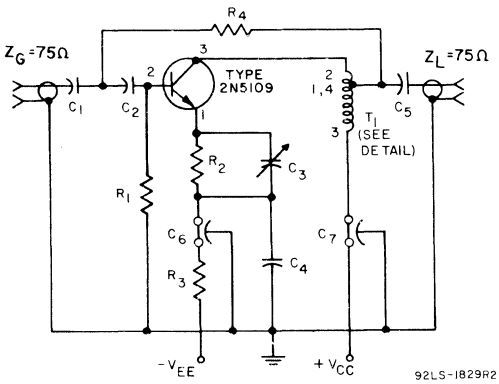
Supersedes Issue Dated 6-67

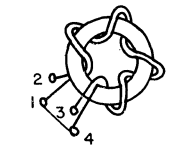
ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25° C

Characteristic	Symbol	Test Conditions					Limits		Units
		DC Collector Volts		DC Current (mA)					
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		15		0			20	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	40		V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER(sus)}$[a]					5	40		V
With base open	$V_{CEO(sus)}$				0	5	20		V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3		V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				10	100		0.5	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{obo}	15		0				3.5	pF
DC Forward-Current Transfer Ratio	h_{FE}		15			50	40	120	
Small Signal Common Emitter Forward Current Transfer Ratio (Measured at 200 MHz)	h_{fe}		15			25	4.8		
			15			50	6		
			15			100	4.8		
Voltage Gain, Wideband, 50 to 216 MHz (See *Fig.2.*)	G_{VE}		15			50	11		dB
Cross Modulation @ 54 dBmV[b] Output (See *Fig.11.*)	CM		15			50	−57 (typ.)		dB
Power Gain, Narrowband, at 200 MHz P_{IN} = −10 dB	G_{PE}		15			10	11		dB
Noise Figure, At 200 MHz, (See *Fig.3.*)	NF		15			10	3 (typ.)		dB

[a]Pulsed through a 25 mH inductor; duty factor = 50%

[b]O dBmV = 1 millivolt

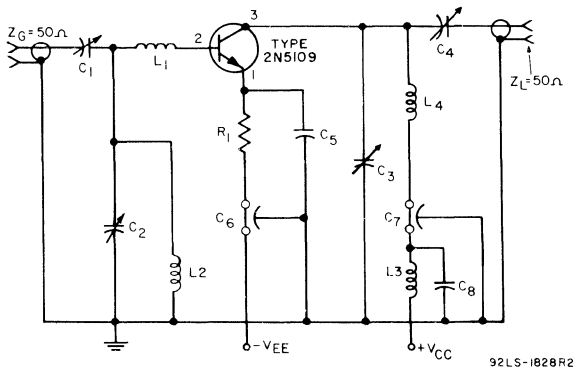




DETAIL OF TRANSFORMER T_1

C_1, C_2, C_5: 0.002 μF
C_3: 8 – 60 pF, ARCO 404, or equivalent
C_4: .03 μF
C_6, C_7: 1,500 pF
R_1: 390 Ω, 1/2 W
R_2: 6.8 Ω, 1/2 W
R_3: 330Ω, 1 W
R_4: 270Ω, ½ W
T_1 – 4 turns No. 30 wire bifilar wound on "Indiana General" Core No. CF-102-Q1, or equivalent

Fig. 2 - RF amplifier for voltage-gain testing of type 2N5109.



C_1, C_2, C_3: 1.0 – 30 pF
C_4: 1.0 – 20 pF
C_5: 10,000 pF
C_6, C_7: 1,000 pF
C_8: .01 μF
L_1: 4-1/2 turns, No.22 wire, 3/16 in. I.D.
L_4: 3-1/2 turns, No.22 wire, 3/16 in. I.D.
L_2, L_3: 0.82 μH RFC
R_1: 240 ohms, 2 watts

Fig. 3 - 200-MHz amplifier for power-gain and noise-figure testing of type 2N5109.

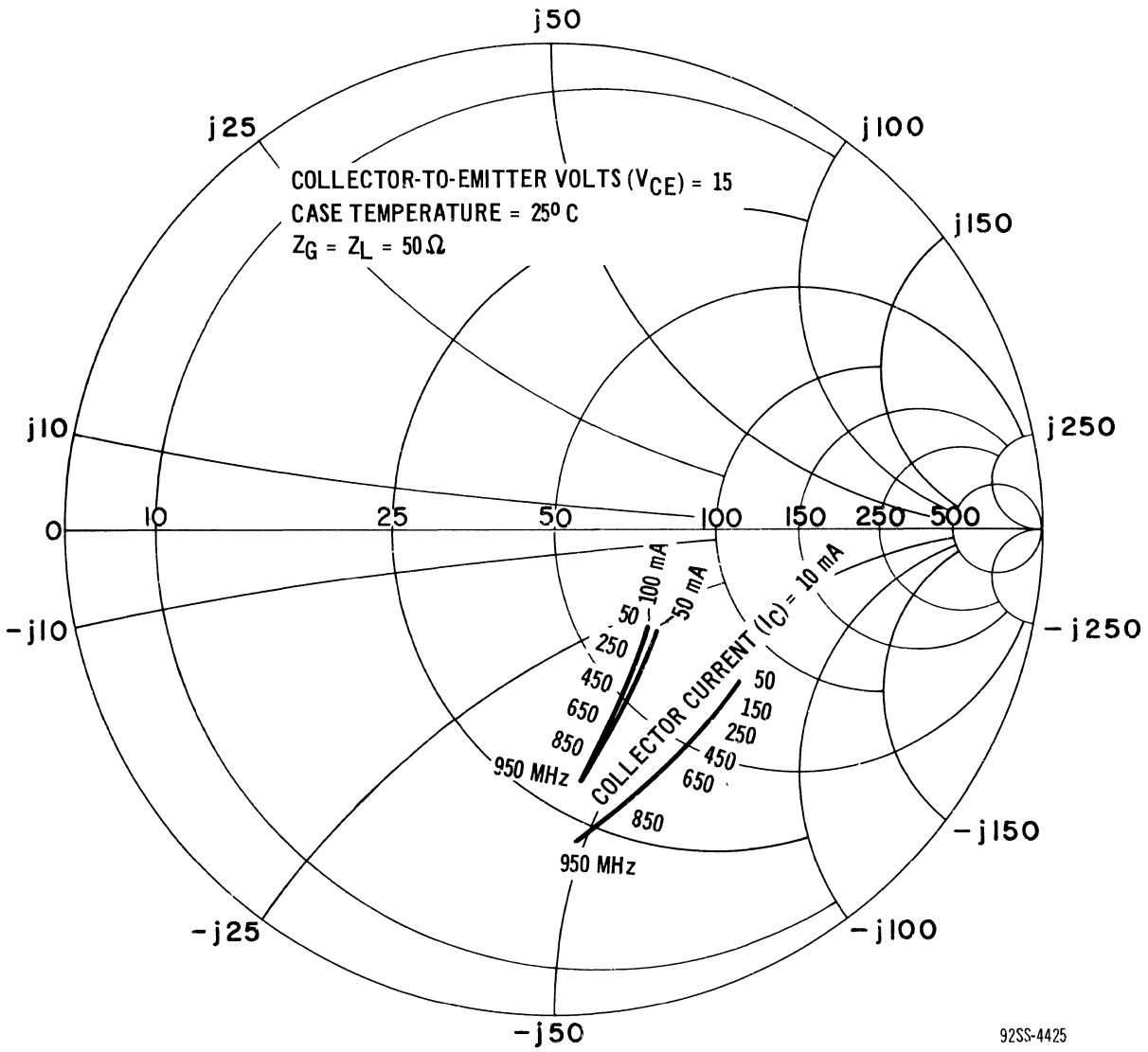


Fig. 7 - Output reflection coefficient (S_{22e}) vs. frequency for type 2N5109.

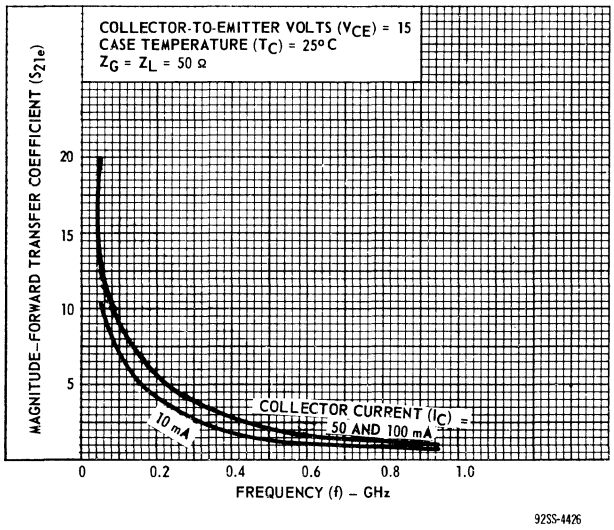


Fig. 8 - Magnitude–common-emitter forward transfer coefficient (S_{21e}) vs. frequency for type 2N5109.

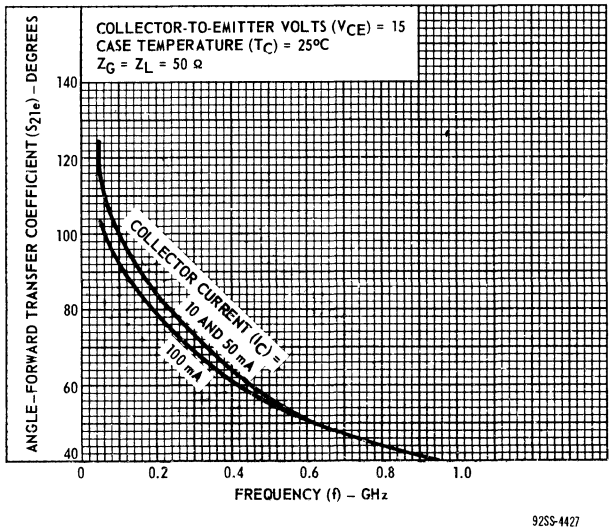


Fig. 9 - Angle–common-emitter forward transfer coefficient (S_{21e}) vs. frequency for type 2N5109.

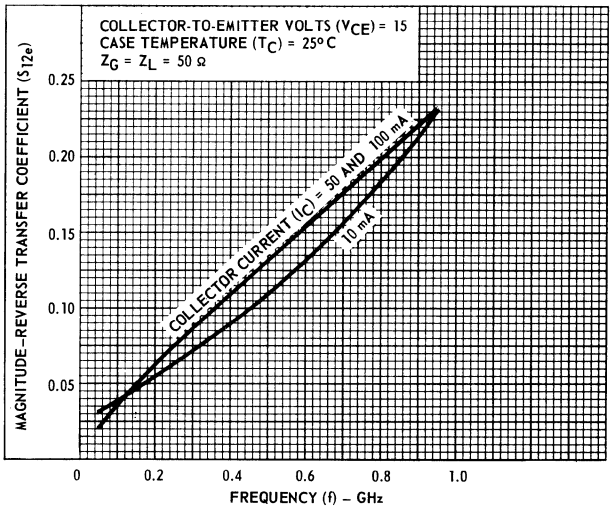


Fig. 10 - Magnitude–common-emitter, reverse transfer coefficient (S_{12e}) for type 2N5109.

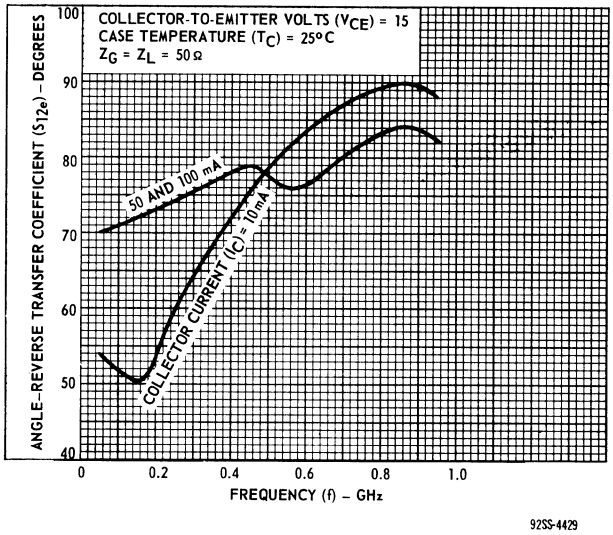


Fig. 11 - Angle–common-emitter reverse transfer coefficient (S_{12e}) vs. frequency for type 2N5109.

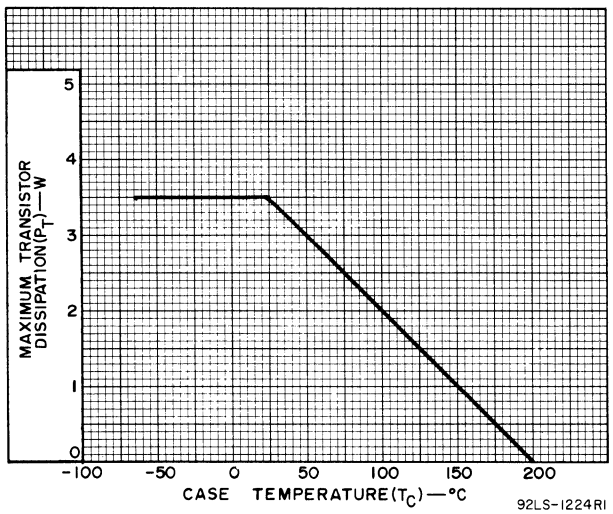
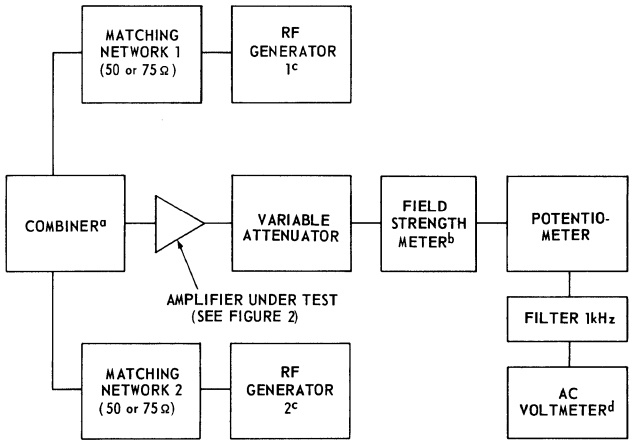


Fig. 12 - Dissipation derating curve for type 2N5109.



[a] Provides 20 db isolation between generators

[b] 50–220 MHz with detector output

[c] Hewlett-Packard HP 608 D or equivalent

[d] Ballantine 861 or equivalent

Fig. 13 - Test set-up for measuring cross modulation in type 2N5109.

CROSS-MODULATION TEST PROCEDURE:

1. Set up equipment as shown in *Fig. 13*.
2. Set generator 1 to 150 MHz modulated 30% by 1,000 Hertz, and tune field strength meter to 150 MHz.
3. Adjust output level of generator 1 to give rated output from the amplifier under test.
4. Adjust potentiometer and AC voltmeter for a convenient level. This level then corresponds to 100% cross modulation.
5. Remove modulation. Readjust output level of generator 1, if necessary, to obtain the AC voltmeter "100% level". Do not readjust generator 1 during the following steps.
6. Set generator 2 to 210 MHz modulated 30% by 1,000 Hertz and tune field strength meter to 210 MHz.
7. Adjust output level of generator 2 to give rated output of the amplifier; i.e., the AC voltmeter indicates the "100% level".
8. Tune field strength meter to 150 MHz CW and read the AC voltmeter (a change of the AC voltmeter scale may be necessary).
9. Calculate percentage of cross modulation by comparing the reading of step 8 to the "100% level".

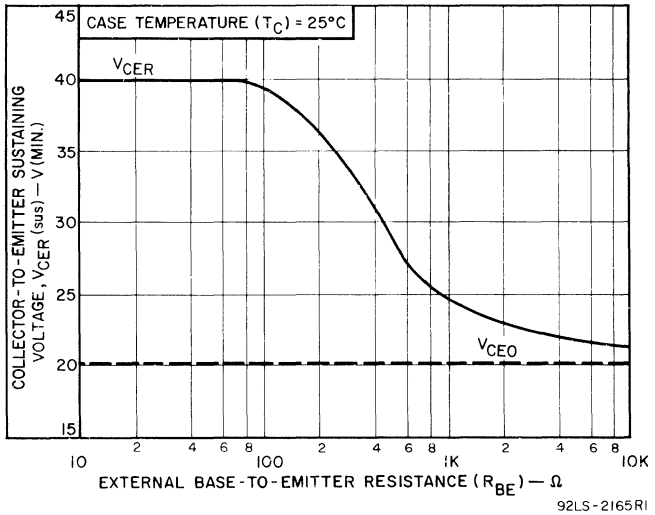


Fig. 4 - Sustaining voltage vs. base-to-emitter resistance for type 2N5109.

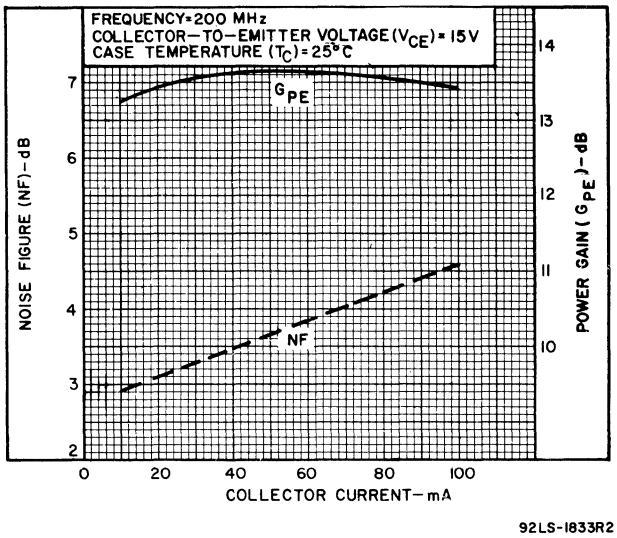


Fig. 5 - Power gain and noise figure vs. collector current for type 2N5109.

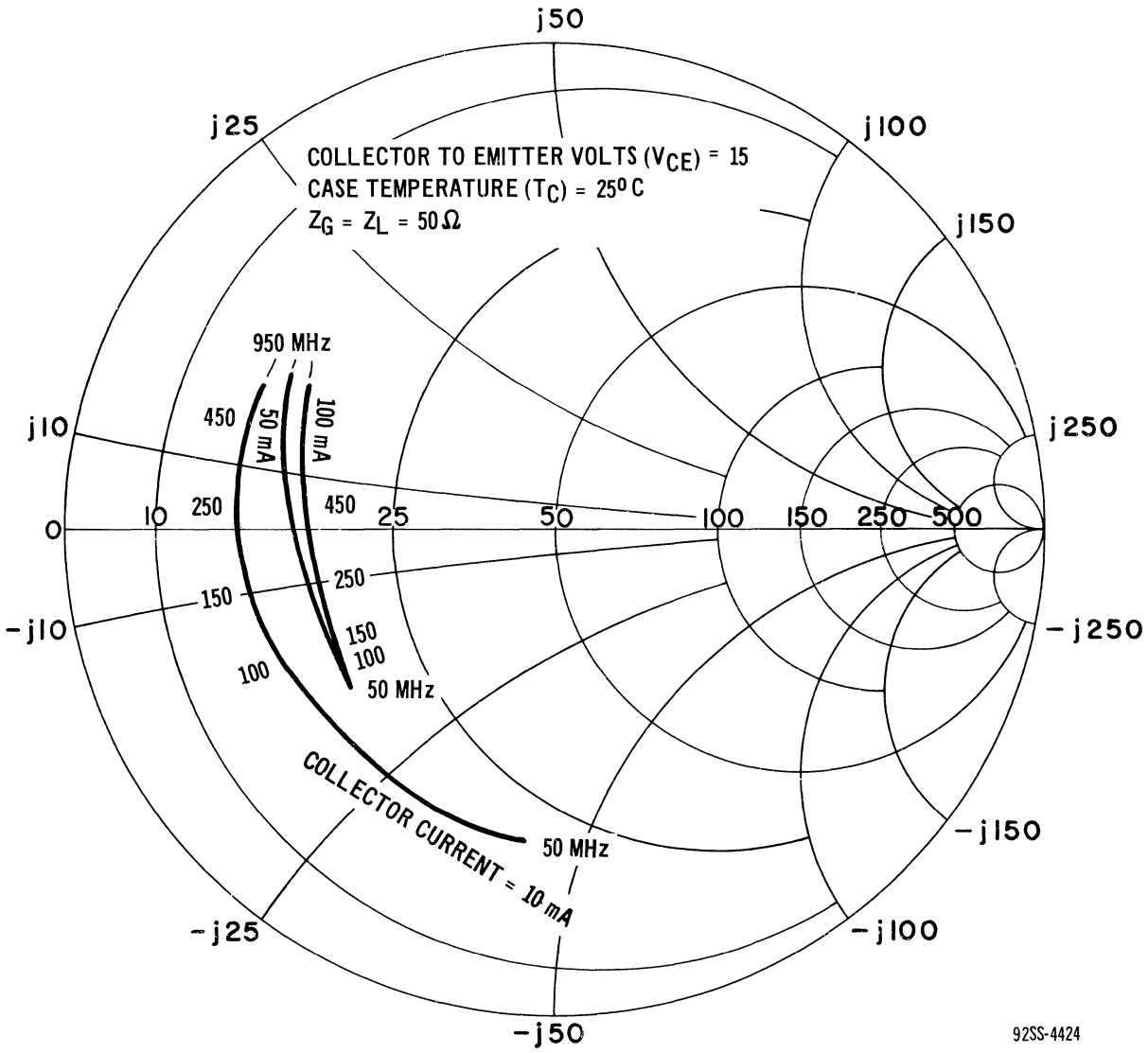
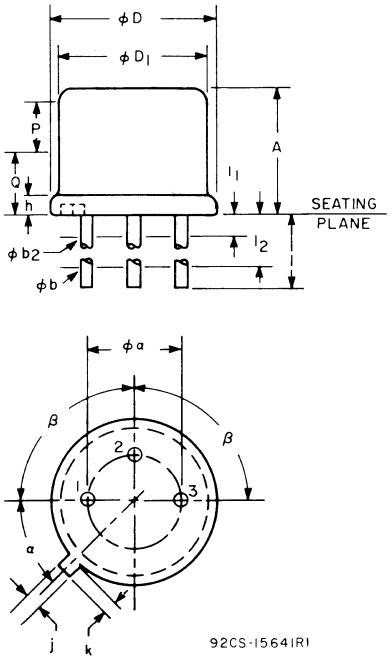


Fig. 6 - Input reflection coefficient (S_{11e}) vs. frequency for type 2N5109.



DIMENSIONAL OUTLINE
JEDEC No. TO-39

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	.190	.210	4.83	5.33	
A	.240	.260	6.10	6.60	
ϕb	.016	.021	.406	.533	2
ϕb_2	.016	.019	.406	.483	2
ϕD	.350	.370	8.89	9.40	
ϕD_1	.315	.335	8.00	8.51	
h	.009	.125	.229	3.18	
j	.028	.034	.711	.864	
k	.029	.040	.737	1.02	3
l	.500		12.70		2
l_1		.050		1.27	2
l_2	.250		6.35		2
P	.100		2.54		1
Q					4
α	45^0 NOMINAL				
β	90^0 NOMINAL				

Note 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010 in (.254 mm).

Note 2: (Three leads) ϕb_2 applies between l_1 and l_2. ϕb applies between l_2 and .5 in (12.70 mm) from seating plane. Diameter is uncontrolled in l_1 and beyond .5 in (12.70 mm) from seating plane.

Note 3: Measured from maximum diameter of the actual device.

Note 4: Details of outline in this zone optional.

TERMINAL CONNECTIONS

Lead No.1 - Emitter

Lead No.2 - Base

Lead No.3 - Collector

Case - Collector

RCA RF TRANSISTOR

General-Purpose Type for UHF Applications

2N5179

File No. 288

RCA-2N5179* is a double-diffused epitaxial planar transistor of the silicon n-p-n type. It is extremely useful in low-noise tuned-amplifier and converter applications at UHF frequencies, and as an oscillator up to 500 MHz.

The 2N5179 utilizes a hermetically sealed four-lead JEDEC TO-72 package. All active elements of the transistor are insulated from the case, which may be grounded by means of the fourth lead in applications requiring minimum feedback capacitance, shielding of the device, or both.

* Formerly Dev. No. TA7319.

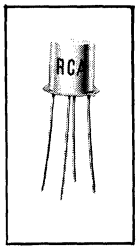
Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	20 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	12 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max.	V
COLLECTOR CURRENT, I_C	50 max.	mA
TRANSISTOR DISSIPATION, P_T:		
For operation with heat sink:		
At case temperatures** { up to 25°C	300 max.	mW
At case temperatures** { above 25°C	Derate at 1.71mW/°C	
For operation at ambient temperatures:		
At ambient temperatures { up to 25°C	200 max.	mW
At ambient temperatures { above 25°C	Derate at 1.14mW/°C	
TEMPERATURE RANGE:		
Storage and Operating (Junction)	−65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

** Measured at center of seating surface.

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SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-72

For UHF Applications in Military, Communications, and Industrial Equipment

- **high gain-bandwidth product — 1000MHz min.**
- **hermetically sealed TO-72 four-lead metal package**
- **low leakage current**
- **high power gain as neutralized amplifier — G_{pe} = 15dB min. at 200MHz**
- **high power output as UHF oscillator — 20mW typ. at 500MHz**
- **low noise figure — NF = 4.5dB max. at 200MHz**
- **low collector-to-base time constant — $r_b'C_c$ = 14ps max.**
- **high reliability — production lots of RCA-2N5179 are subjected to and meet the minimum mechanical, environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See page 5 for a description of the Group A and Group B Tests.**

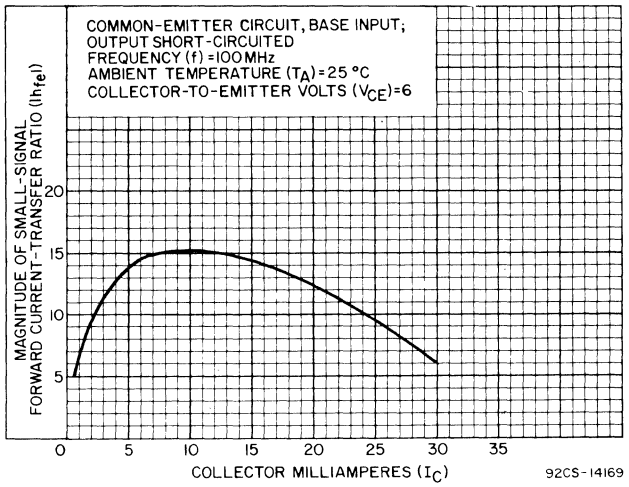


Fig. 1 – Small-Signal Beta Characteristic for Type 2N5179

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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2N5179 8-67

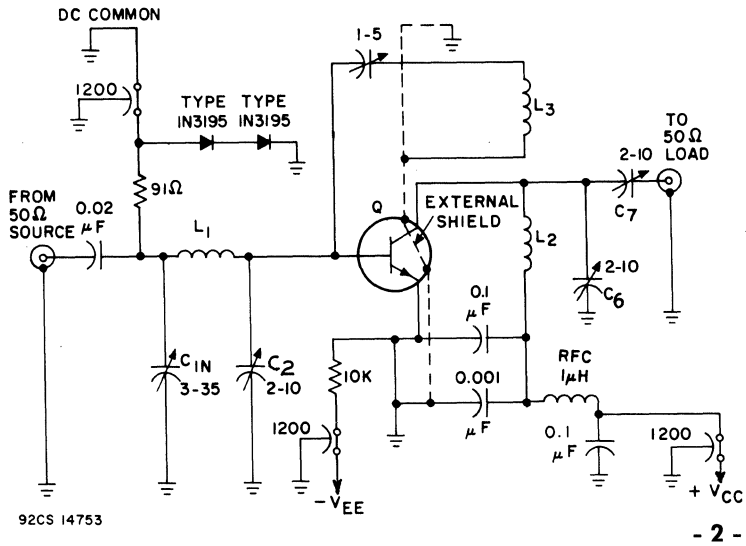
ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS			Units
		Ambient Temp. T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N5179			
		°C	MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25 150		15 15			0 0			- -	- -	0.02 1	μA μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	25					0	0.001		20	-	-	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$	25						3	0	12	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	25					−0.01	0		2.5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25						10	1	-	-	0.4	V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25						10	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}	25			1			3		25	70	250	
Magnitude of Small-Signal Forward Current-Transfer Ratio[a]	$\lvert h_{fe} \rvert$	25	100 1 kHz		6 6			5 2		9 25	14 90	20 300	
Collector-to-Base Feedback Capacitance[b]	C_{cb}	25	0.1 to 1	10			0			-	0.7	1	pF
Common-Base Input Capacitance[c]	C_{ib}	25	0.1 to 1			0.5		0		-	-	2	pF
Collector-to-Base Time Constant[a]	$r_b'C_c$	25	31.9	6				2		3	7	14	ps
Small-Signal Power Gain in Neutralized Common-Emitter Amplifier Circuit[a] (See Fig. 2)	G_{pe}	25	200		12			5		15	21	-	dB
Power Output in Common-Emitter Oscilator Circuit[c] (See Fig. 3)	P_o	25	>500	10			−12			20	-	-	mW
Noise Figure[a]	NF	25	200		6			1.5		-	3	4.5	dB

[a] Lead No.4(case) grounded; Rg = 125Ω

[b] Three-terminal measurement of the collector-to-base capacitance with the case and emitter leads connected to the guard terminal.

[c] Lead No. 4 (case) floating.



NOTE: (Neutralization Procedure): (a) Connect a 50-Ω rf voltmeter to the output of a 200-MHz signal generator (R_g = 50Ω), and adjust the generator output to 5mV. (b) Connect the generator to the input and the rf voltmeter to the output of the amplifier, as shown above. (c) Apply V_{EE} and V_{CC}, and adjust the generator output to provide an amplifier output of 5mV. (d) Tune C_2, C_6, and C_7 for maximum amplifier output, readjusting the generator output, as required, to maintain an output of 5mV from the amplifier. (e) Interchange the connections to the signal generator and the rf voltmeter. (f) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the amplifier input. (g) Repeat steps (a), (b), (c), and (d) to determine if retuning is necessary.

Q = Type 2N5179

Fig. 2 – Neutralized Amplifier Circuit Used to Measure Power Gain and Noise Figure at 200MHz for Type 2N5179

TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF FREQUENCY (f) FOR RCA TYPE 2N5179

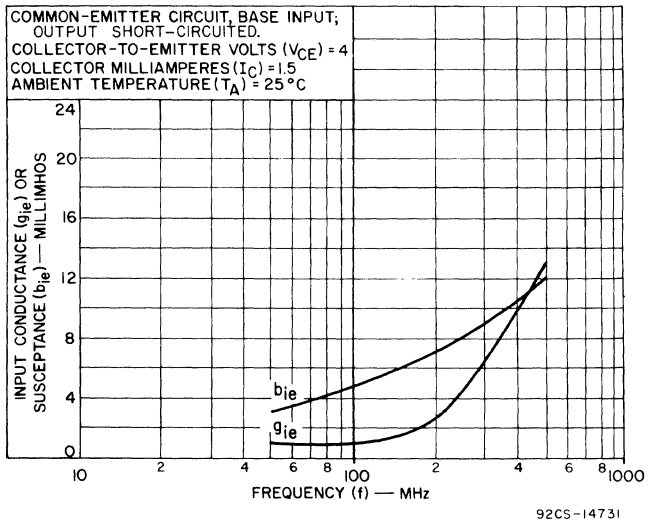


Fig. 8 – Input Admittance (y_{ie})

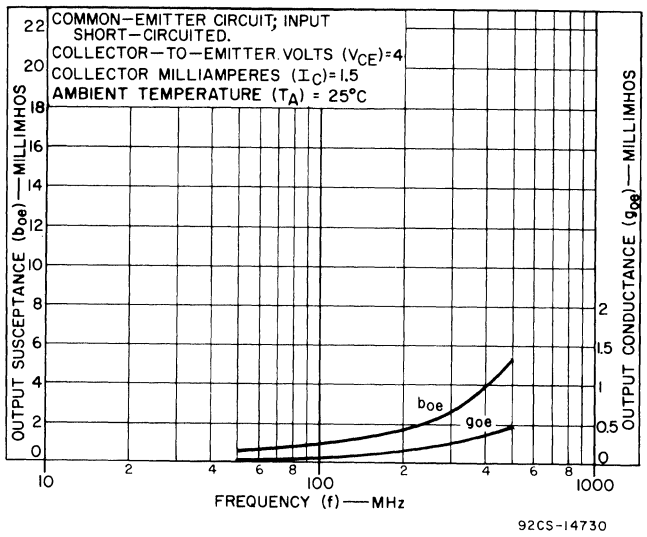


Fig. 9 – Output Admittance (y_{oe})

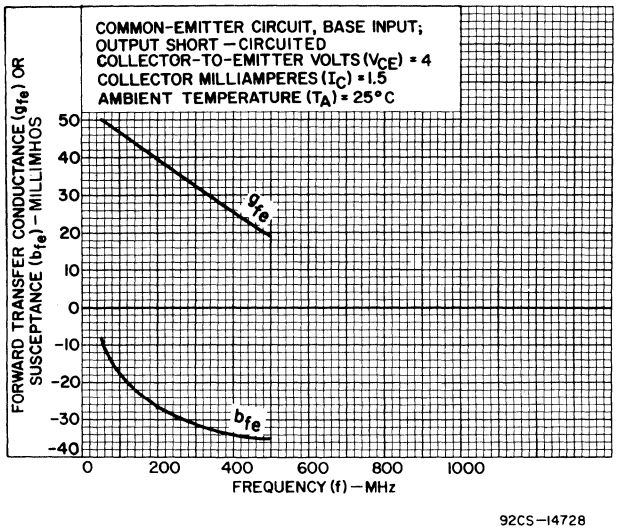


Fig. 10 – Forward Transadmittance (y_{fe})

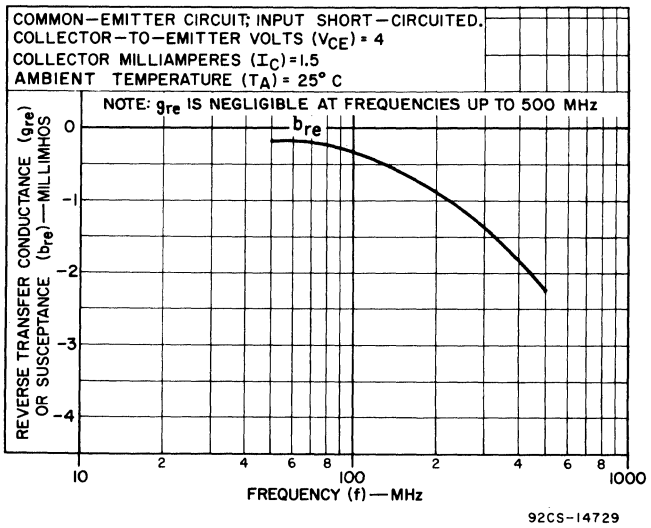
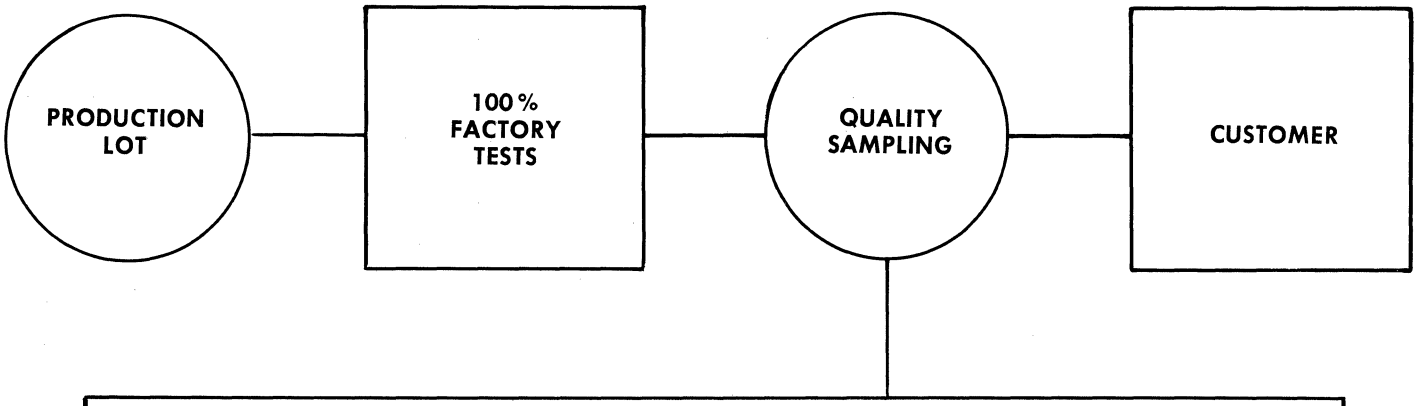
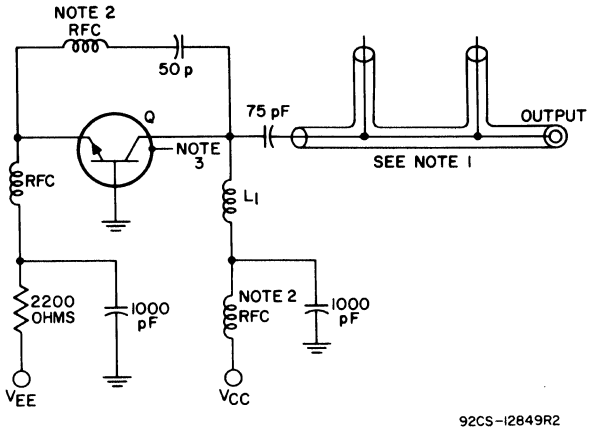


Fig. 11 – Reverse Transadmittance (y_{re})

GROUP A AND GROUP B QUALITY SAMPLING TESTS



ITEM	TEST DESCRIPTION	LTPD
GROUP A TESTS		
Subgroup 1.	Visual and Mechanical Examination	5%
Subgroup 2.	Electrical	10%
GROUP B TESTS		
Subgroup 1.	Physical Dimensions	20%
Subgroup 2.	Solderability, Temperature Cycling, Thermal Shock, Moisture Resistance	20%
Subgroup 3.	Shock, Vibration Fatigue, Vibration Variable Frequency, Constant Acceleration	20%
Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 300mW, T_A = 25°C)	λ = 10%



Note 1 — Coaxial-Line output network consisting of:

2 General Radio Type 874 TEE or equivalent

1 General Radio Type 874-D20 Adjustable Stub or equivalent

1 General Radio Type 874-LA Adjustable Line or equivalent

1 General Radio Type 874-WN3 Short-circuit termination or equivalent

Note 2 — RFC = 0.2μH Ohmite #2-460 or equivalent

Note 3 — Lead Number 4 (case) floating

L_1 — 2 turns #16AWG wire, 3/8 inch OD, 1¼ inch long

Q = 2N5179

Fig. 3 – Circuit Used to Measure 500MHz Oscillator Power Output for Type 2N5179

TWO-PORT ADMITTANCE (y) PARAMETERS AS FUNCTIONS OF COLLECTOR CURRENT (I_C) FOR RCA TYPE 2N5179

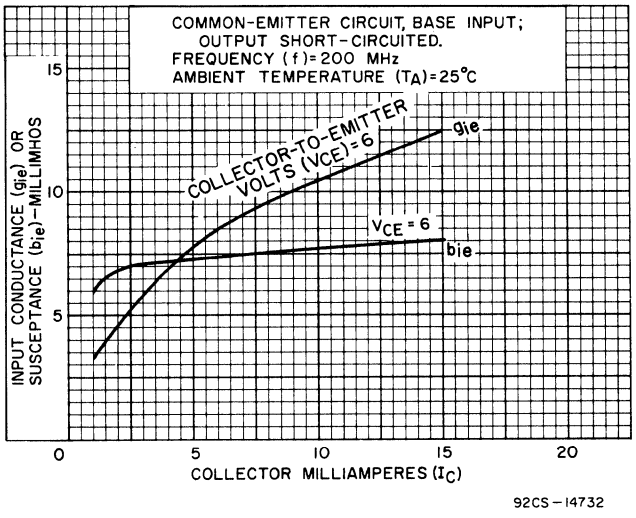


Fig. 4 – Input Admittance (y_{ie})

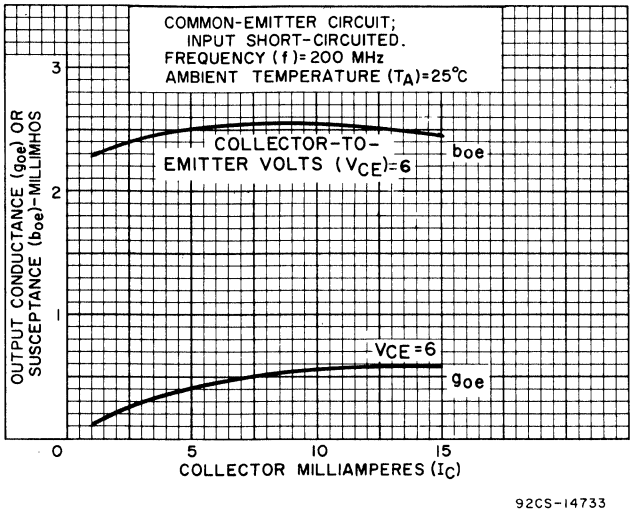


Fig. 5 – Output Admittance (y_{oe})

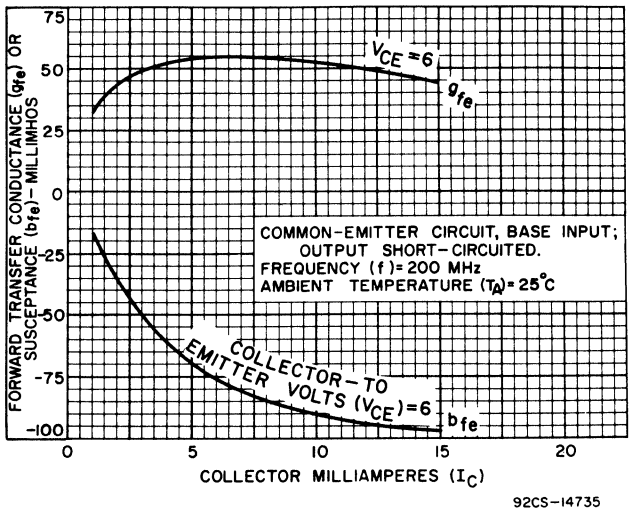


Fig. 6 – Forward Transadmittance (y_{fe})

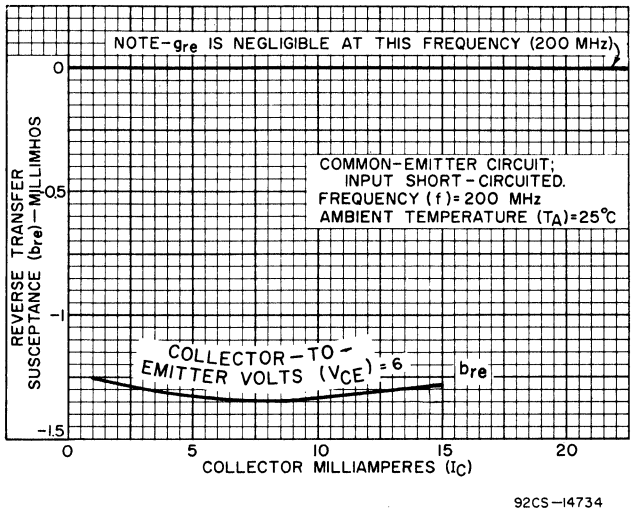
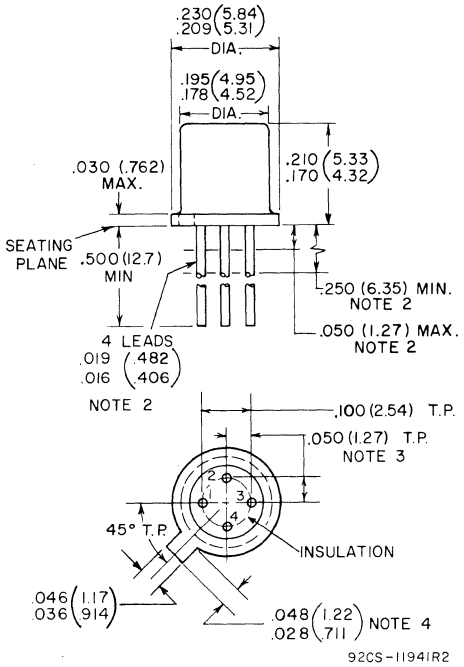


Fig. 7 – Reverse Transadmittance (y_{re})

DIMENSIONAL OUTLINE
JEDEC TO-72



Dimensions in inches and millimeters

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

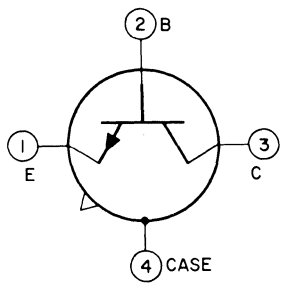
Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) - 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

TERMINAL DIAGRAM
Bottom View

LEAD 1 – EMITTER
LEAD 2 – BASE



LEAD 3 – COLLECTOR
LEAD 4 – CONNECTED TO CASE

RCA RF TRANSISTOR

General-Purpose Type for VHF Applications

2N5180

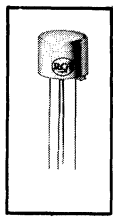
File No. 289

RCA-2N5180* is an epitaxial planar transistor of the silicon n-p-n type with characteristics which make it extremely useful as a general-purpose RF amplifier at vhf frequencies. These characteristics include an exceptionally low noise figure at high frequencies, low leakage current, and a high gain-bandwidth product.

The 2N5180 utilizes a hermetically sealed four-lead metal package in which all active elements of the transistor are insulated from the case. The case may be grounded by means of a fourth lead in applications requiring minimum feedback capacitance, shielding of the device, or both.

* Formerly Dev. No. TA7303.

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR



JEDEC TO-104

For VHF Applications In Industrial and Commercial Equipment

Features

- **high gain-bandwidth product — f_T = 900MHz typ.**
- **low noise figure — NF = 4.5dB max. at 200MHz 2.5dB typ. at 60MHz**
- **high unneutralized power gain MUG= 12dB min. at 200MHz**
- **hermetically sealed four-lead metal package**
- **all active elements insulated from case**
- **low collector-to-base feedback capacitance, C_{cb} = 1pF max.**

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2 max.	V
COLLECTOR CURRENT, I_C	limited by dissipation	
TRANSISTOR DISSIPATION, P_T: At ambient temperatures up to 25°C	180 max.	mW
TRANSISTOR DISSIPATION, P_T: At ambient temperatures above 25°C	See Fig. 1	
TEMPERATURE RANGE: Storage and Operating (Junction)	−65 to +175	°C
LEAD TEMPERATURE (During Soldering): At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

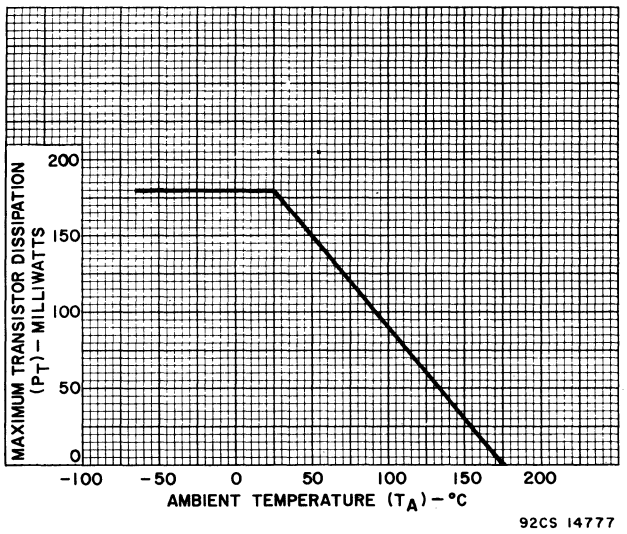


Fig. 1 — Rating chart for type 2N5180

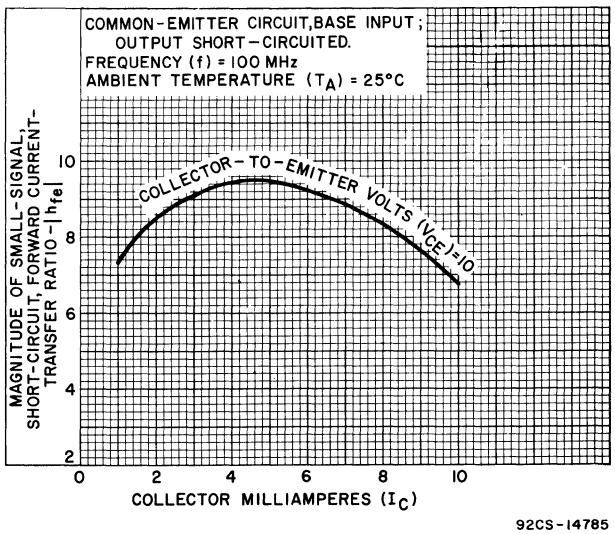


Fig. 2 — Typical small-signal beta characteristics for type 2N5180

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ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
2N5180 8-67

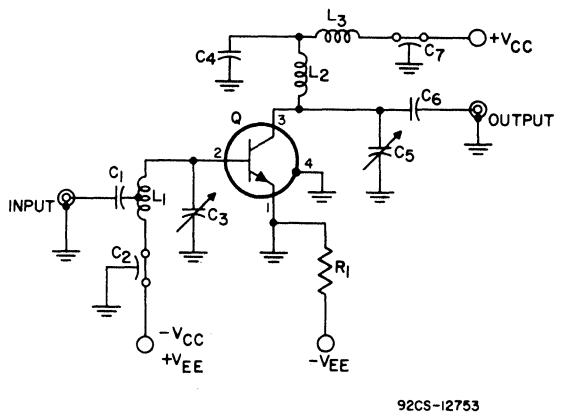
ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS					LIMITS			Units
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N5180			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		1		0		-	-	0.025	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.001	30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0.001	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.001	0	2	-	-	V
Static Forward-Current Transfer Ratio	h_{FE}			8		2	20	-	200	
Magnitude of Small-Signal Forward-Current Transfer Ratio	$\lvert h_{fe} \rvert$[a]	100		8		2	6.5	9	16	
Collector-to-Base Feedback Capacitance	C_{cb}[b]	0.1 to 1	8		0		-	-	1	pF
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See Fig. 3)	MUG[a]	200		8		2	12	-	19	dB
VHF Noise Figure (See Fig. 3)	NF[a] NF[a,c]	200 60		8 8		2 1	- -	- 2.5	4.5	dB dB

[a]Fourth lead (case) grounded.

[b]C_{cb} is a three terminal measurement of the collector-to-base capacitance with the emitter and case connected to the guard terminal.

[c]Source Resistance, R_s=400 ohms.



C_1, C_4 = 510pF
C_2, C_7 = 2300pF
C_3, C_5 = 2-25pF
C_6 = 10pF
R_1 = 2000 ohms
Q = 2N5180
L_1 = ½ Turn #14 Formvar• center tapped; length = 2 inches
L_2 = ½ Turn #14 Formvar•; length = 1½ inches
L_3 = 1μH RF choke
Source (Generator) Resistance R_S = 50 ohms
Load Resistance R_L = 50 ohms
• Trademark, Shawinidan Products Corporation.

Fig. 3 – 200MHz Power Gain and Noise Figure Test Circuit for Type 2N5180

TYPICAL y PARAMETER CHARACTERISTICS

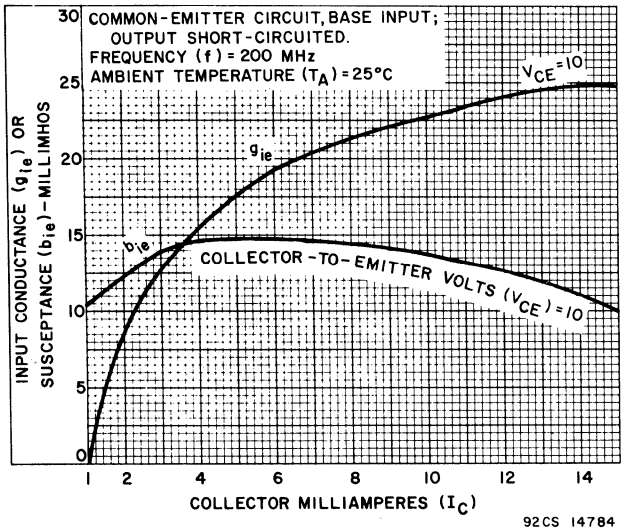


Fig. 4 – Input Admittance (y_{ie}) vs Collector Current (I_C)

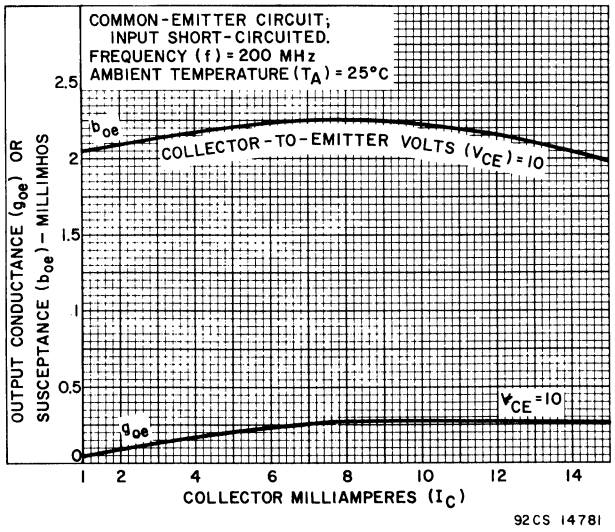


Fig. 5 – Output Admittance (y_{oe}) vs Collector Current (I_C)

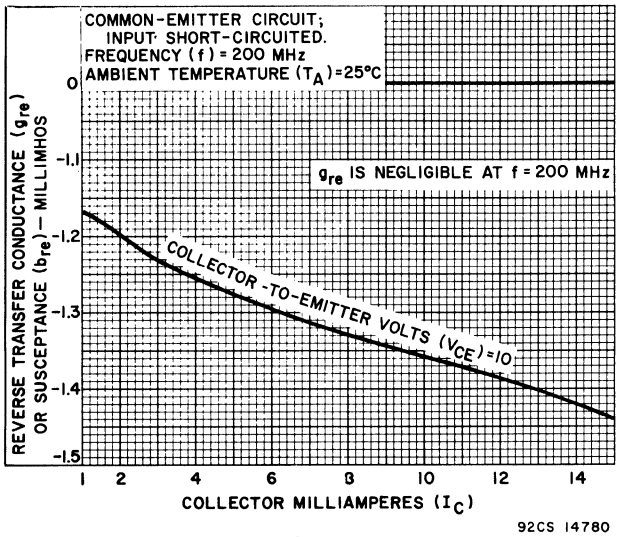


Fig. 6 – Reverse Transadmittance (y_{re}) vs Collector Current (I_C)

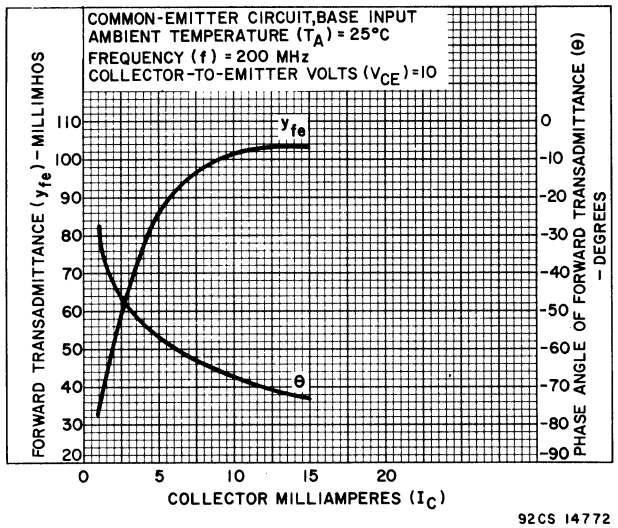


Fig. 7 – Forward Transadmittance ($y_{fe}, \angle\theta$) vs Collector Current (I_C)

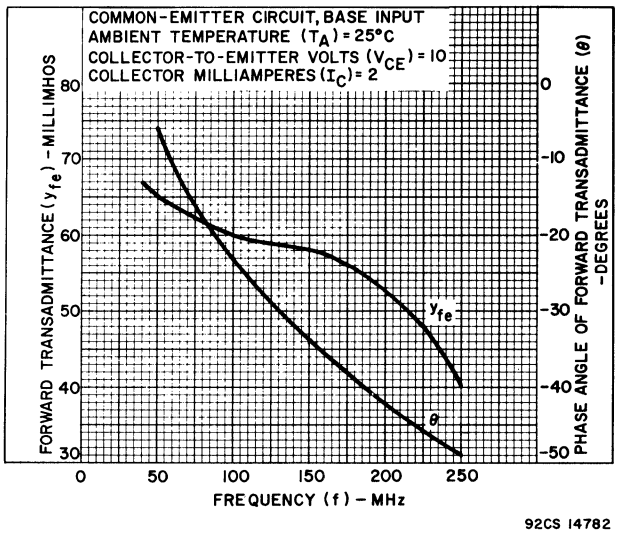
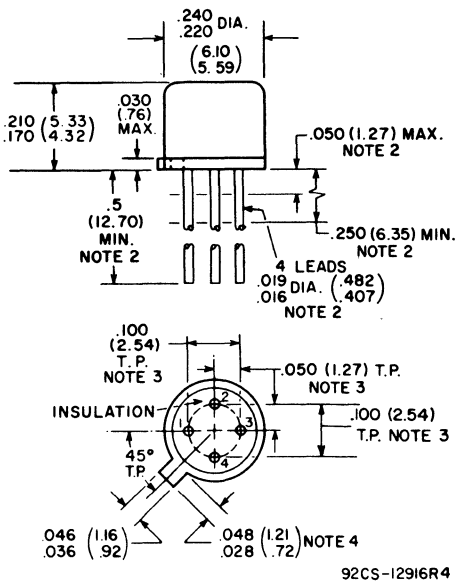


Fig. 8 – Forward Transadmittance ($y_{fe}, \angle\theta$) vs Frequency (f)

DIMENSIONAL OUTLINE
JEDEC TO-104



Dimensions in inches and millimeters

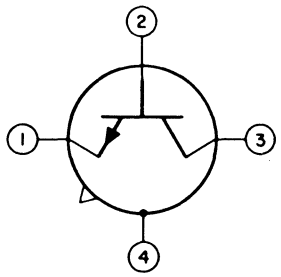
Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) - 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

TERMINAL DIAGRAM
Bottom View



LEAD 1 – EMITTER
LEAD 2 – BASE
LEAD 3 – COLLECTOR
LEAD 4 – CONNECTED TO CASE

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RCA VHF TRANSISTORS

General-Purpose Types for RF and IF Applications

2N5181
2N5182

File No. 290

RCA-2N5181 and 2N5182* are high-frequency general-purpose transistors of the silicon n-p-n type. They are intended primarily for use in rf and if amplifier circuits at frequencies up to 250MHz.

These types feature a New Terminal Arrangement in which the emitter and base connections are interchangd to provide maximum isolation between the output (collector) and the input (base) terminals. Although this new basing configuration does not appreciably change the measured device feedback capacitance, it permits the use of external inter-terminal shields to reduce feedback due to external capacitances, particularly on printed circuit boards. This feature makes it possible to achieve greater circuit stability, or higher useable gain per stage in critical circuit designs.

The 2N5181 and 2N5182 also feature very low feedback capacitance, low noise, high useful power gains in their recommended applications, and a high-temperature capability permitting operation up to 175°C.

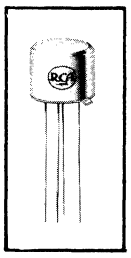
RCA-2N5181 and 2N5182 utilize a hermetically sealed JEDEC TO-104 metal package in which the case is electrically isolated from the transistor electrodes. The case is provided with a separate lead which may be grounded to minimize collector-to-base interlead capacitance and coupling to other circuit components.

* Formerly Dev. Nos. TA7304 and TA7305 respectively.

Absolute Maximum Ratings:

	2N5181	*2N5182*	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	45	45 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	3 max.	V
COLLECTOR CURRENT, I_C	50	4 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures: up to 25°C	180	180 max.	mW
At ambient temperatures: above 25°C	derate at 1.2 mW/°C		
TEMPERATURE RANGE:			
Storage and Operating (Junction)	−65 to +175		°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32" from seating surface for 10 seconds max.	255	255 max.	°C

SILICON N-P-N HIGH-FREQUENCY TRANSISTORS



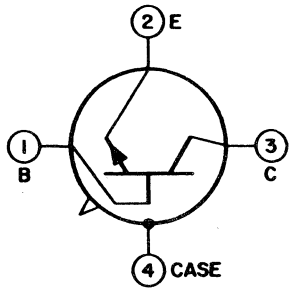
JEDEC TO-104

General-Purpose Types For RF- and IF-Amplifier Applications

Features

- **New Terminal Arrangement For Superior High-Frequency Performance**

1 - Base
2 - Emitter
3 - Collector
4 - Case



- **low collector-to-base feedback capacitance — C_{cb} = 0.32pF max.**
- **high gain-bandwidth product — f_T = 700MHz typ.**
- **low device noise figure — NF = 3.5dB typ. at 200MHz for 2N5181, 4.5dB typ. at 200MHz for 2N5182**
- **high useful power gain (neutralized) — MUG — 24.2 26dB typ. for 2N5181, — 24.2 28dB typ. for 2N5182 } at 200MHz**
- **high operating temperature capability — to 175°C**
- **hermetically sealed 4-lead TO-104 metal package**

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Printed in U.S.A.
2N5181, 2N5182 8-67

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS			LIMITS						Units
		Frequency f	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	Type 2N5181			Type 2N5182			
		MHz	Volts	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	- -	(V_{CB})= 1 (V_{CB})=45 V_{CB} =35	0 0 0	- -	- -	0.02 1 -	- -	- -	0.03 1 -	μA μA μA
Emitter-Cutoff Current	I_{EBO}	-	(V_{EB})=3	(I_C)=0	-	-	1	-	-	1	μA
Static Forward Current-Transfer Ratio	h_{FE}	-	6	-1	27	-	275	27	-	275	-
Gain-Bandwidth Product	f_T	100	6	-2	-	700	-	-	700	-	MHz
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1	10	-3	-	0.22	0.34	-	0.22	0.34	pF
Max. Available Amplifier Gain	MAG	200	10	-2	-	29.9	-	-	29.5	-	dB
Max. Usable Amplifier Gain (Unneutralized)	MUG	200	10	-2	-	20.4 -	-	-	20.4	-	dB
Max. Usable Amplifier Gain (Neutralized)	MUG	200	10	-2	-	24.2	-	-	24.2	-	dB

TYPICAL y-PARAMETER CHARACTERISTICS at 100MHz for RCA-2N5181

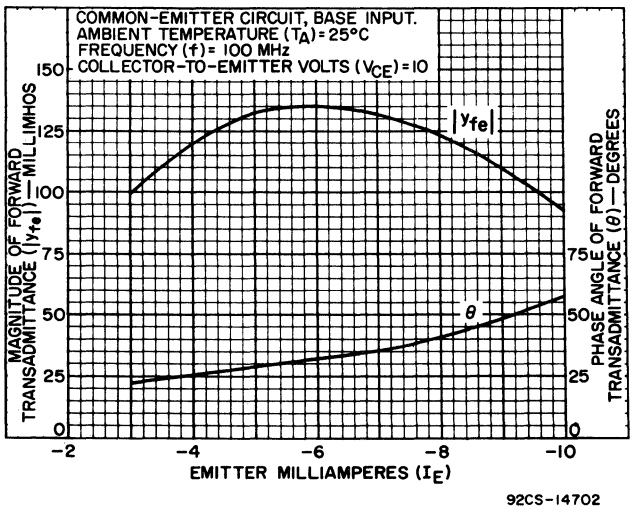


Fig. 1 – Y_{fe} vs I_E

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TYPICAL y-PARAMETER CHARACTERISTICS at 200MHz for RCA-2N5181

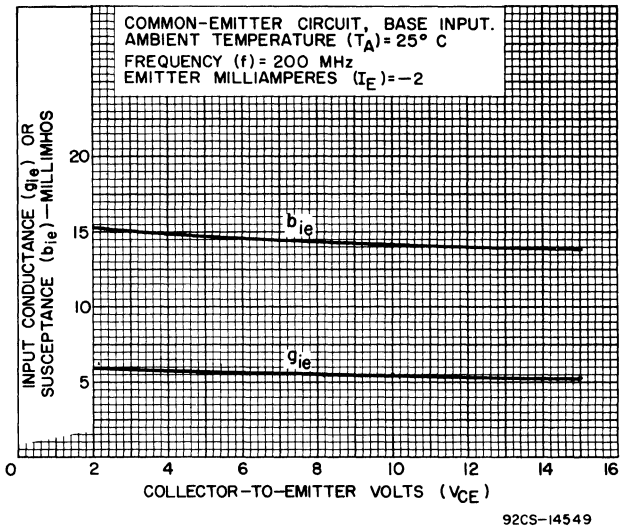


Fig. 2 — Y_{ie} vs V_{CE}

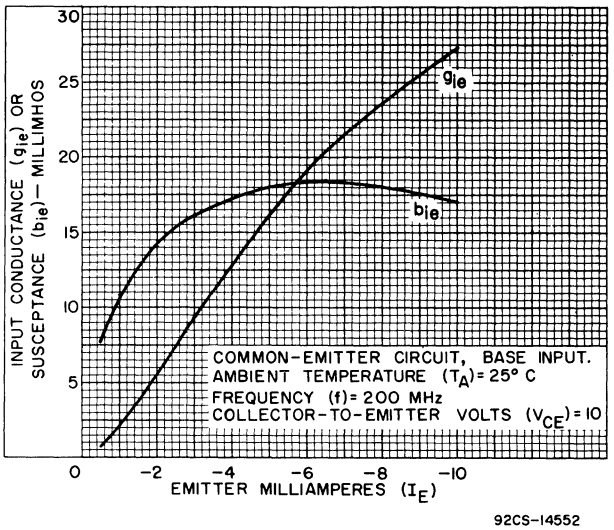


Fig. 5 — Y_{ie} vs I_E

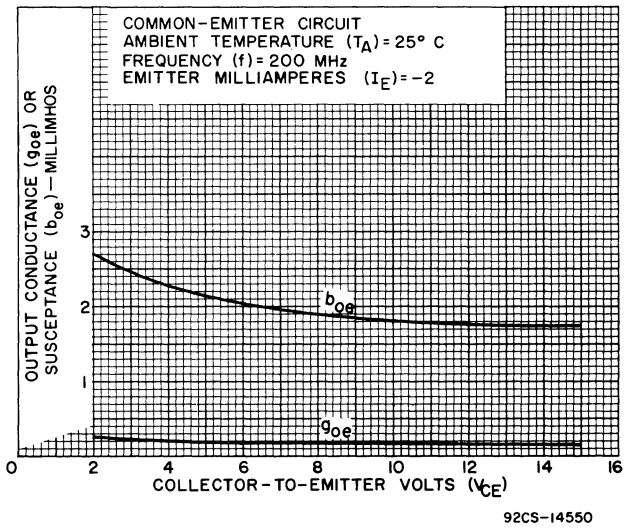


Fig. 3 — Y_{oe} vs V_{CE}

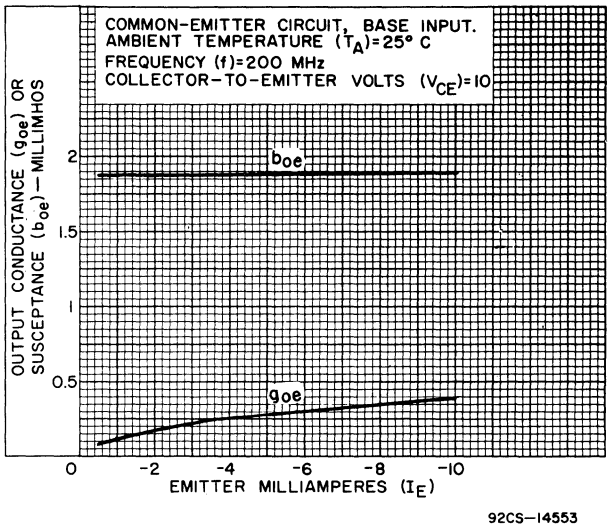


Fig. 6 — Y_{oe} vs I_E

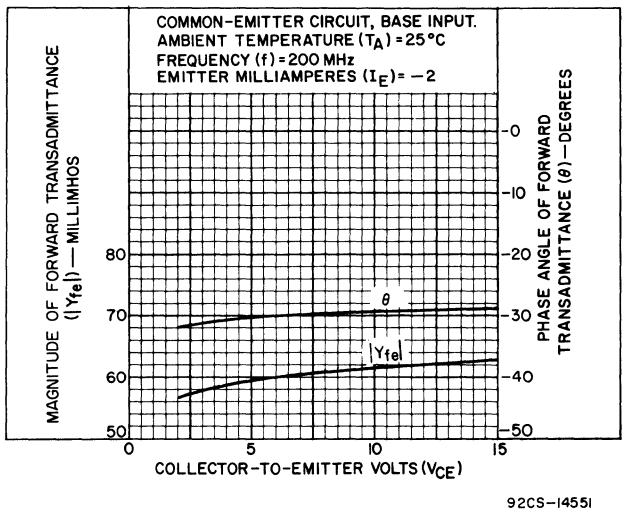


Fig. 4 — Y_{fe} vs V_{CE}

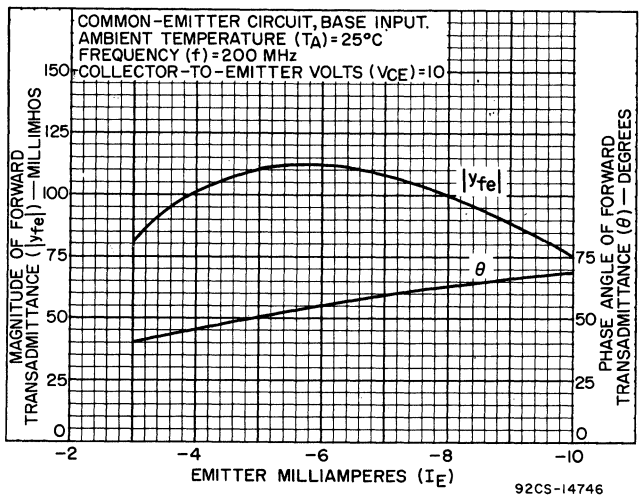


Fig. 7 — Y_{fe} vs I_E

TYPICAL y-PARAMETER CHARACTERISTICS at 44MHz for 2N5181

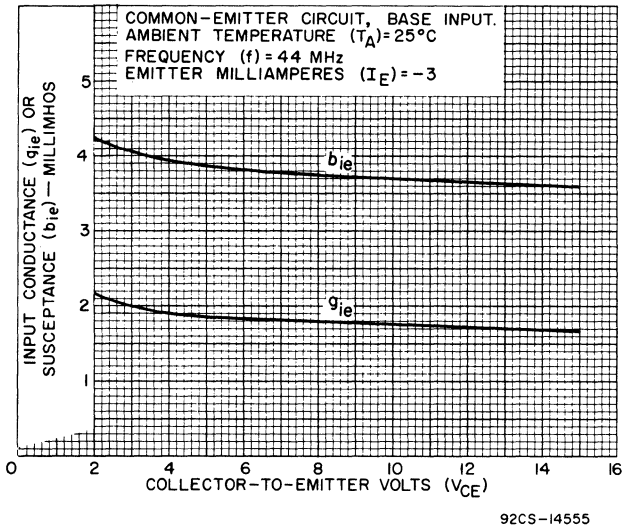


Fig. 8 — Y_{ie} vs V_{CE}

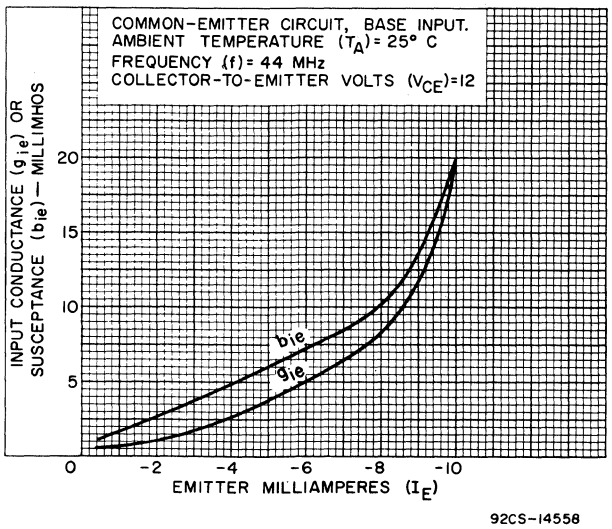


Fig. 11 — Y_{ie} vs I_E

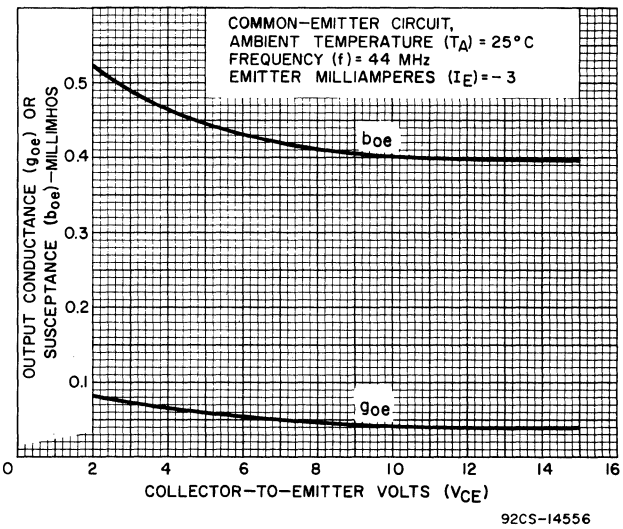


Fig. 9 — Y_{oe} vs V_{CE}

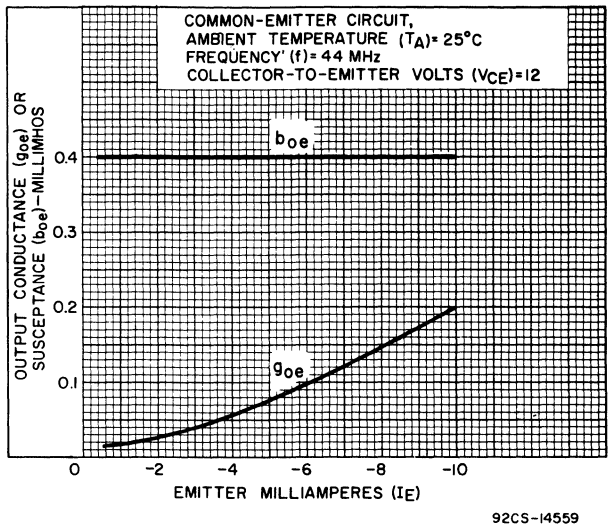


Fig. 12 — Y_{oe} vs I_E

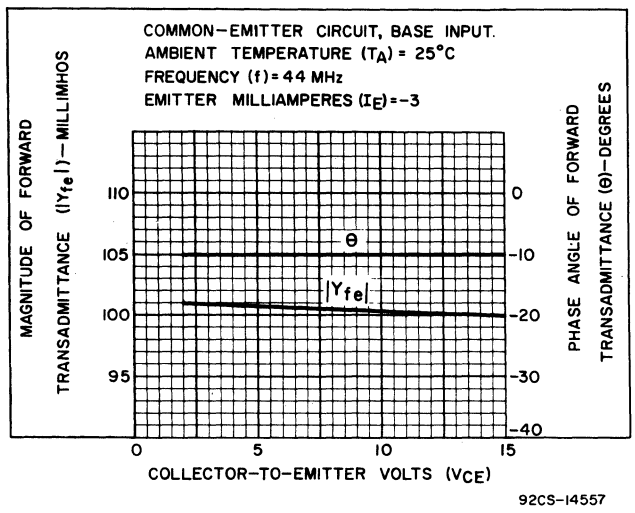


Fig. 10 — Y_{fe} vs V_{CE}

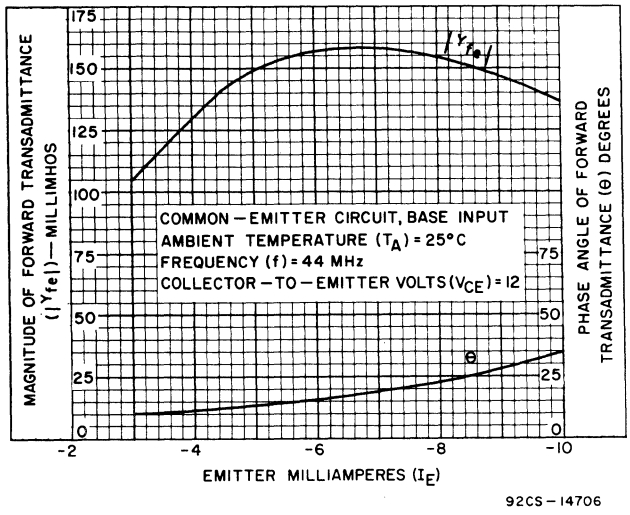


Fig. 13 — Y_{fe} vs I_E

TYPICAL CHARACTERISTICS FOR RCA-2N5181

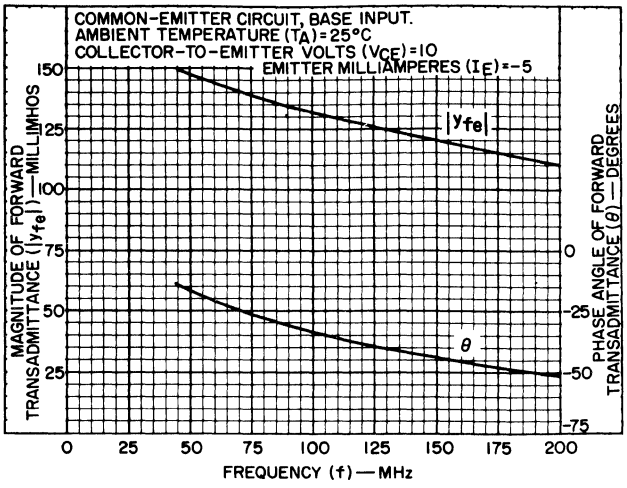


Fig. 26 – Y_{fe} vs f

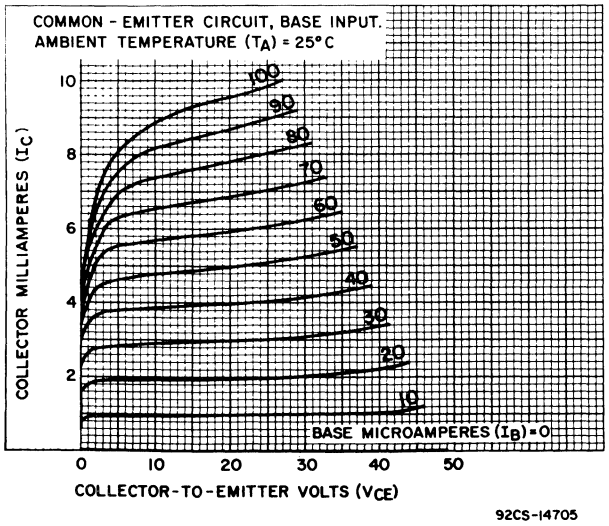


Fig. 29 – I_c vs V_{CE}

TYPICAL CHARACTERISTICS FOR RCA-2N5182

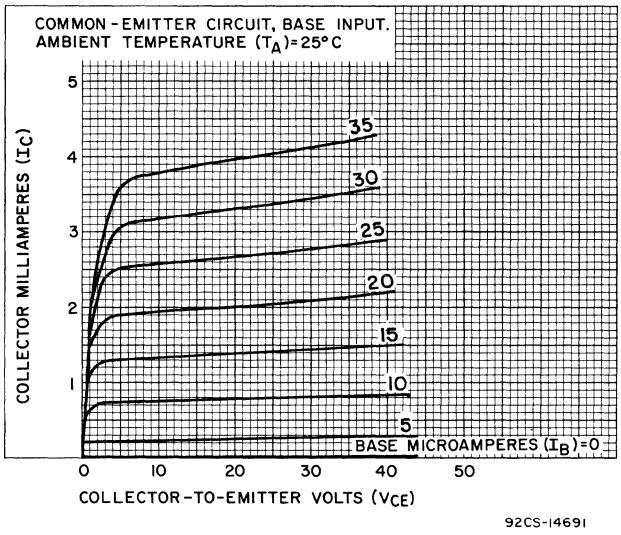


Fig. 27 – I_c vs V_{CE}

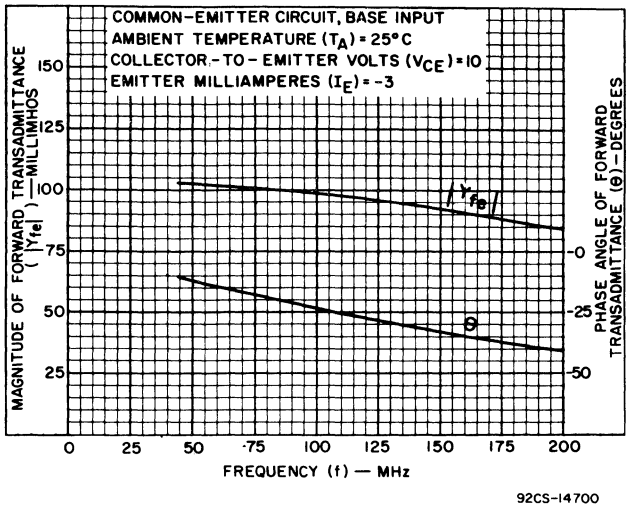


Fig. 30 – Y_{fe} vs f

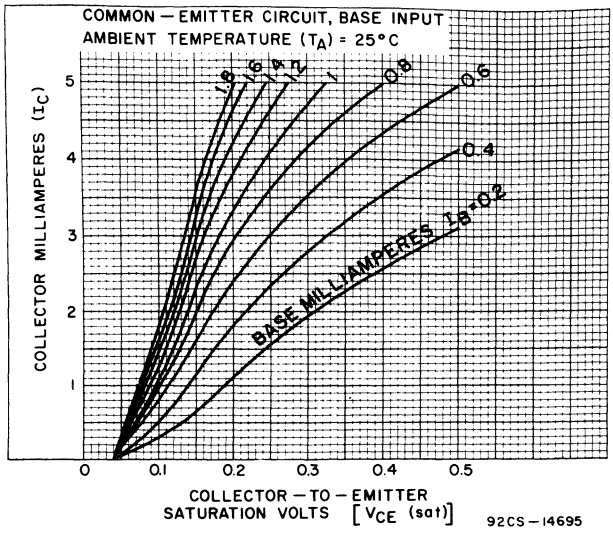


Fig. 28 – I_c vs V_{CE}(sat)

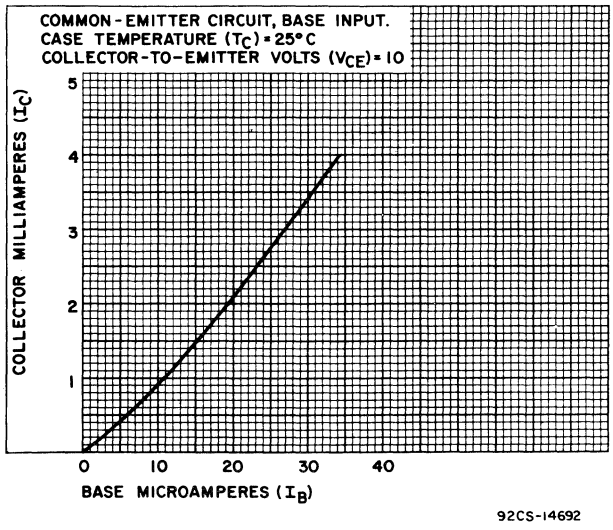


Fig. 31 – I_c vs I_B

TYPICAL CHARACTERISTICS FOR RCA 2N5181 AND 2N5182

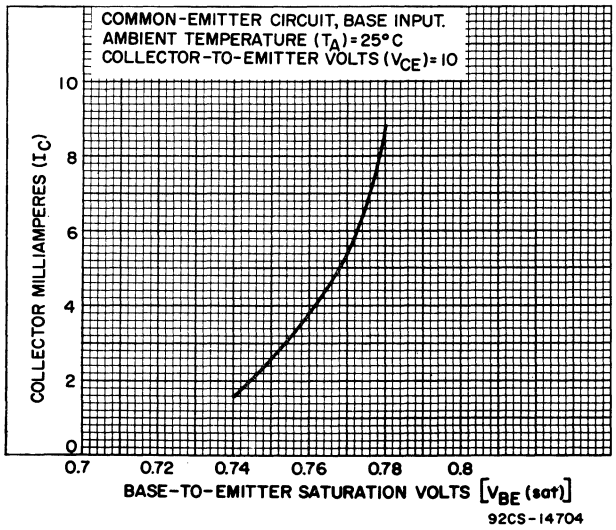


Fig. 32 – I_c vs V_{BE}(sat)

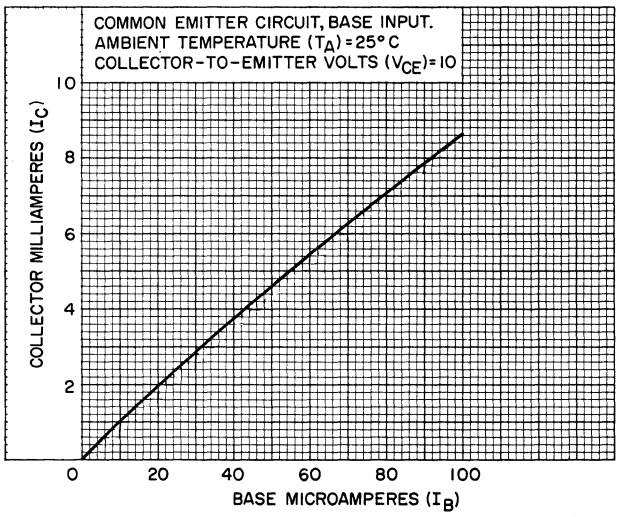


Fig. 33 – I_c vs I_B

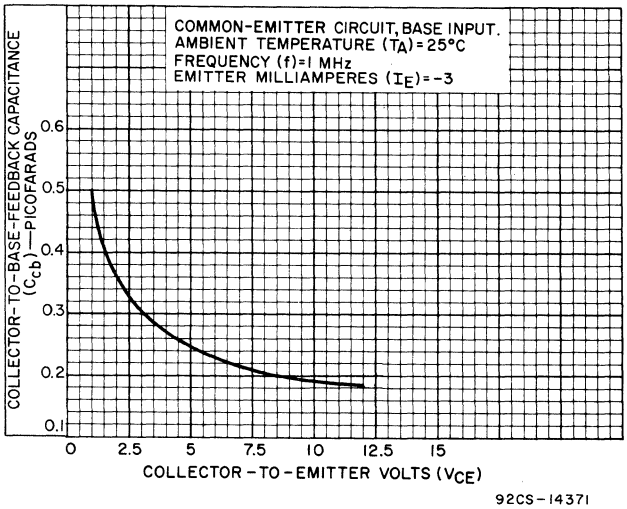
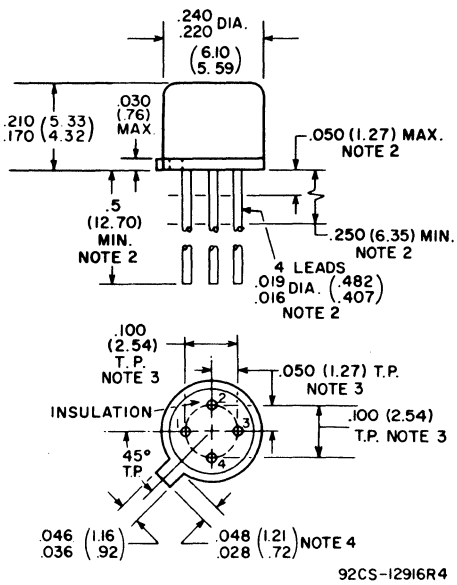


Fig. 34 – C_{cb} vs V_{CE}

DIMENSIONAL OUTLINE FOR TO-104



DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250"(6.35 mm) from the seating plane. From 0.250"(6.35 mm) to the end of the lead a maximum diameter of 0.021"(0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054"(1.372 mm) + 0.001" (0.025 mm) -0.000"(0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

TYPICAL y-PARAMETER CHARACTERISTICS at 200MHz for 2N5182

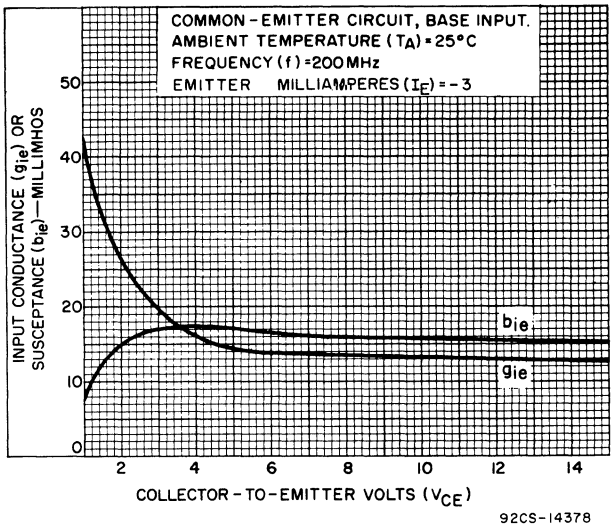


Fig. 14 – Y_{ie} vs V_{CE}

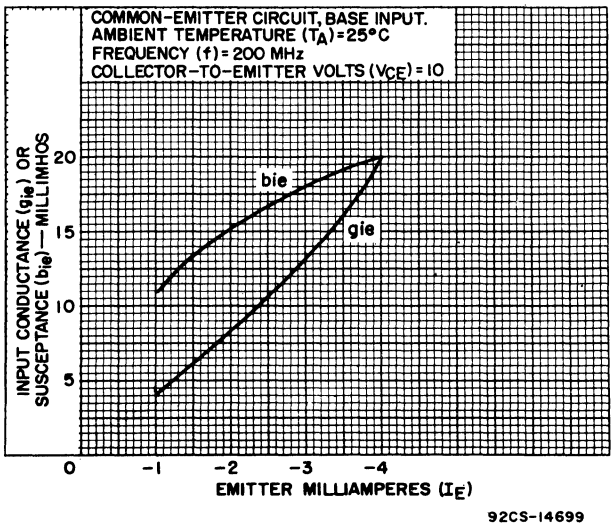


Fig. 17 – Y_{ie} vs I_E

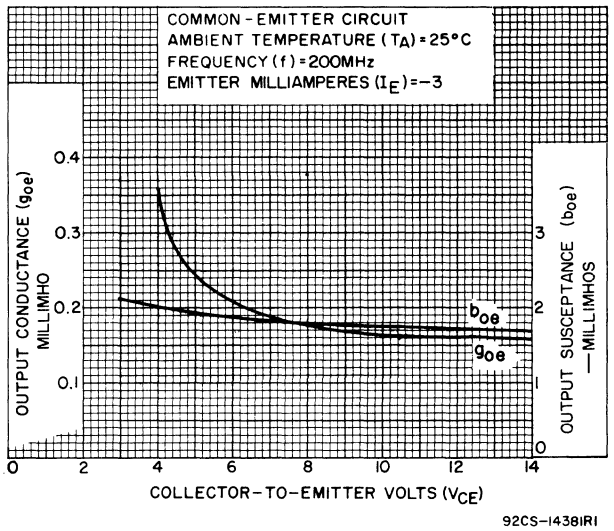


Fig. 15 – Y_{oe} vs V_{CE}

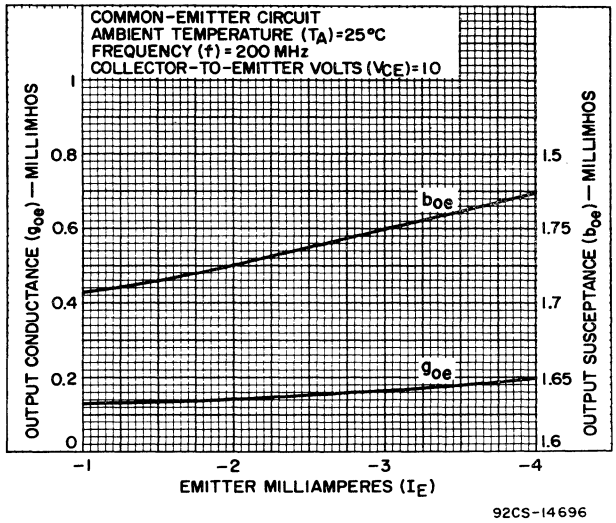


Fig. 18 – Y_{oe} vs I_E

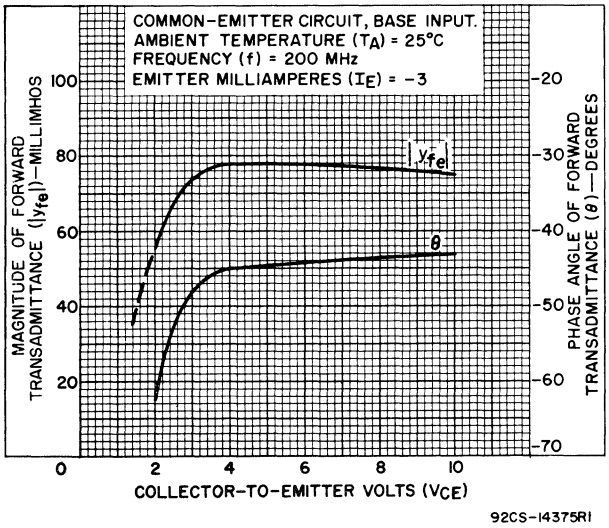


Fig. 16 – Y_{fe} vs V_{CE}

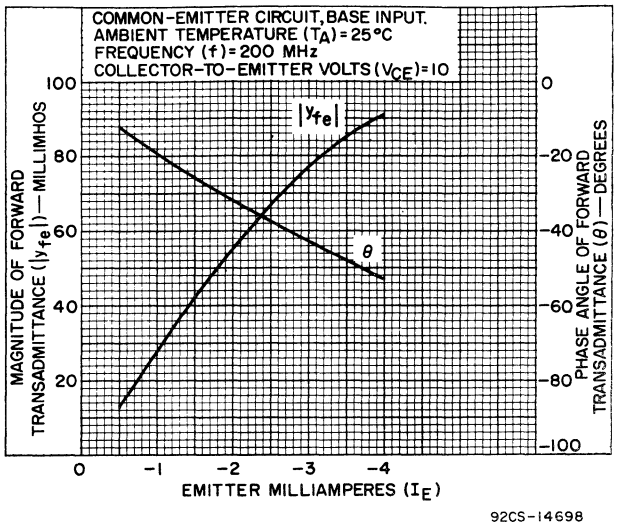


Fig. 19 – Y_{fe} vs I_E

TYPICAL y-PARAMETER CHARACTERISTICS at 44MHz for 2N5182

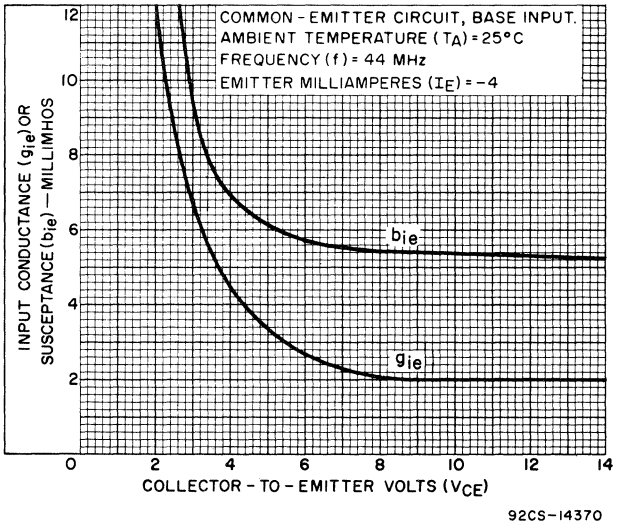


Fig. 20 — Y_{ie} vs V_{CE}

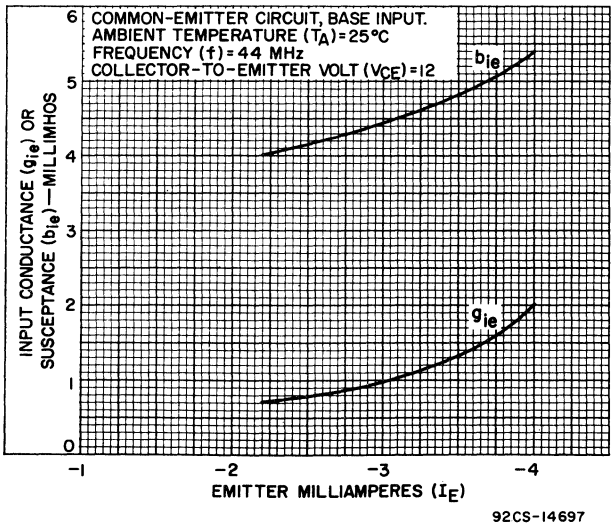


Fig. 23 — Y_{ie} vs I_E

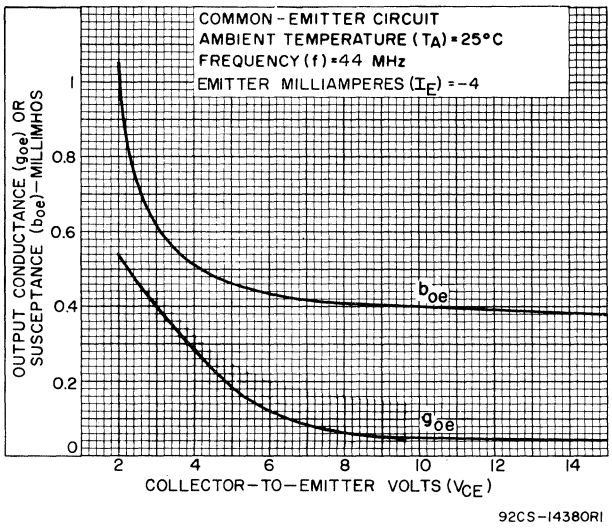


Fig. 21 — Y_{oe} vs V_{CE}

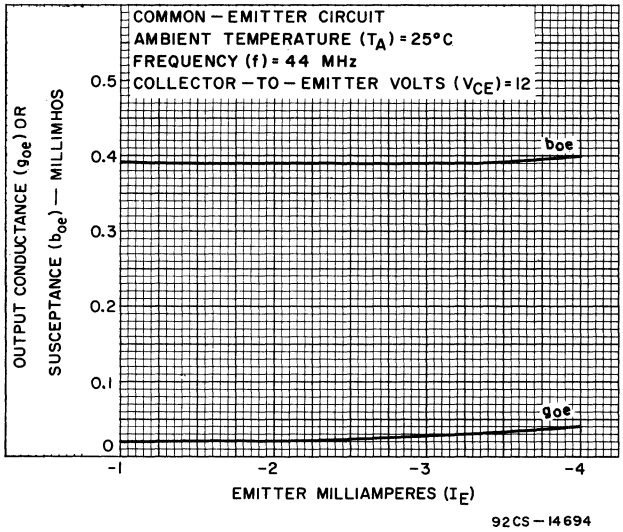


Fig. 24 — Y_{oe} vs I_E

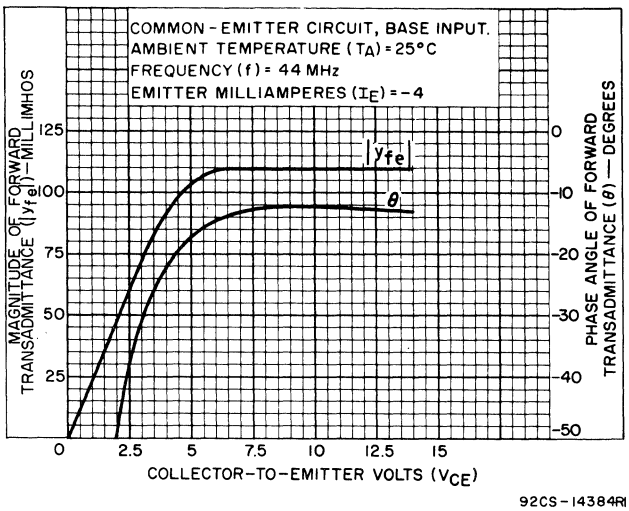


Fig. 22 — Y_{fe} vs V_{CE}

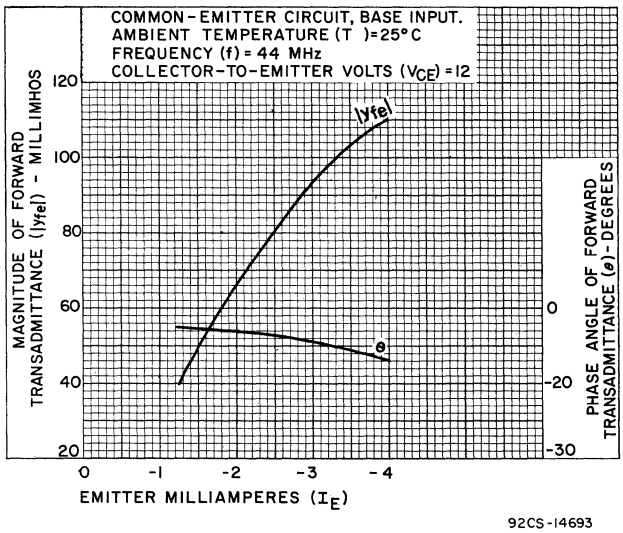


Fig. 25 — Y_{fe} vs I_E

RCA TRANSISTOR

General-Purpose Type for Amplifier & Switching Service

2N5183

File No. 291

RCA-2N5183* is a general-purpose silicon n-p-n transistor utilizing a double-diffused epitaxial planar construction. It features high beta, low-leakage characteristics, and high peak-current capabilities which make it especially useful for critical amplifier applications in the audio and video frequency ranges.

The 2N5183 also features low saturation voltages, high switching speeds, and high voltage-breakdown capabilities, which make this transistor desirable for switching and driver applications in computer equipment.

RCA-2N5183 is also useful in other applications where a transistor having excellent linearity of characteristics over a wide range of collector current, high dissipation capabilities, and a high maximum operating temperature is essential.

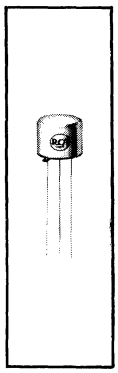
The 2N5183 utilizes a hermetically sealed, 3-lead metal package. An internal connection between the collector and the case provides a low-resistance path for effective heat transfer.

* Formerly Dev. No. TA7301.

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For High-Peak-Current Amplifier Applications In Commercial and Industrial Equipment

For High-Current Switching Service in Computer Equipment



JEDEC TO-104

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	18 max.	V
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	18 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	7 max.	V
COLLECTOR CURRENT, I_C	1 max.	A
TRANSISTOR DISSIPATION, P_T:		
At ambient temperatures: up to 25°C	0.5 max	W
At ambient temperatures: above 25°C derate at	3.3	mW/°C
At case temperatures[a]: up to 75°C	2 max.	W
At case temperatures[a]: above 75°C derate at	20	mW/°C
TEMPERATURE RANGE: Storage and operating (junction)	−65 to +175	°C
LEAD TEMPERATURE (During soldering): At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

[a] Measured on case perimeter at junction with seating surface.

Features

- **high collector-current capability —** I_C = 1A max.
- **low saturation voltages —** $V_{CE}(sat)$ = 0.5V max., $V_{BE}(sat)$ = 1.5V max. at I_C = 300mA, I_B = 15mA
- **high dissipation capabilities —** P_T = 0.5W max. at T_A = 25°C; 2W max. at T_C = 75°C
- **hermetically sealed 3-lead TO-104 metal package**
- **collector lead internally connected to case**

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Printed in U.S.A.
2N5183 8-67

STATIC CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS							LIMITS			Units
		Ambient Temperature T_A	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N5183			
		°C	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25	12			0			-	-	500	nA
Emitter-Cutoff Current	I_{EBO}	25			2.5		0		-	-	500	nA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	25					0.1		18	-	-	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO(sus)}$	25					10	0	18	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	25				0.05	0		7	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	25					300	15	-	0.35	0.5	V
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	25					300	15	-	0.05	1.5	V
Static Forward Current-Transfer Ratio	h_{FE}			10 10 1			10 150 300		75 - 40	150 120 75	400 - -	

DYNAMIC CHARACTERISTICS, at $T_A = 25°C$

Characteristics	Symbols	TEST CONDITIONS					LIMITS			Units
		Frequency	V_{CB}	V_{CE}	I_E	I_C	Type 2N5183			
			V	V	mA	mA	Min.	Typ.	Max.	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\lvert h_{fe} \rvert$	1 kHz		12		10	70	175	-	
Small-Signal Short-Circuit Input Impedance	h_{ie}	1 kHz		12		10	-	600	-	Ω
Small-Signal Open-Circuit Output Admittance	h_{oe}	1 kHz		12		10	-	75	-	mmho
Small-Signal Open-Circuit Reverse Voltage-Transfer Ratio	h_{re}	1 kHz		12		10	-	125×10^{-6}	-	
Collector-to-Base Feedback Capacitance	C_{cb}‡	1 MHz	6		0		-	-	20	pF
Gain-Bandwidth Product	f_T	50 MHz		1		50	125	200	-	MHz
Extrinsic Base-Lead Resistance	$r_{bb'}$	100 MHz		6		1	-	20	-	Ω
Thermal Resistance: Junction to Case	$\theta_{J\text{-}C}$						-	-	50	°C/W
Thermal Resistance: Junction to Ambient	$\theta_{J\text{-}A}$						-	-	300	°C/W

‡This is a three-terminal measurement with the emitter lead guarded.

TYPICAL CHARACTERISTICS FOR RCA-2N5183

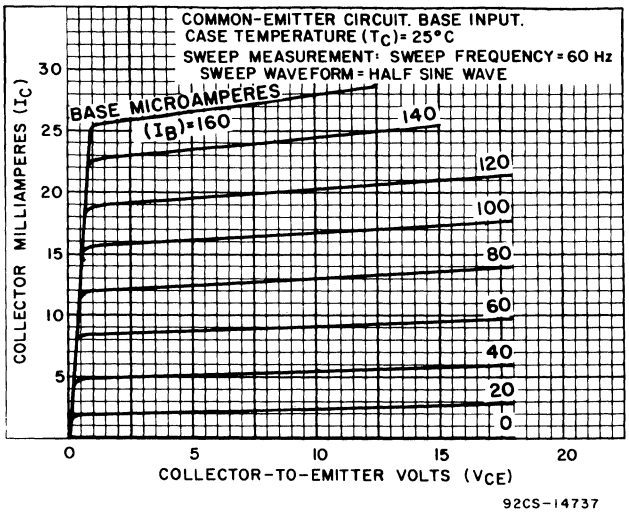


Fig. 2 – Collector Characteristics

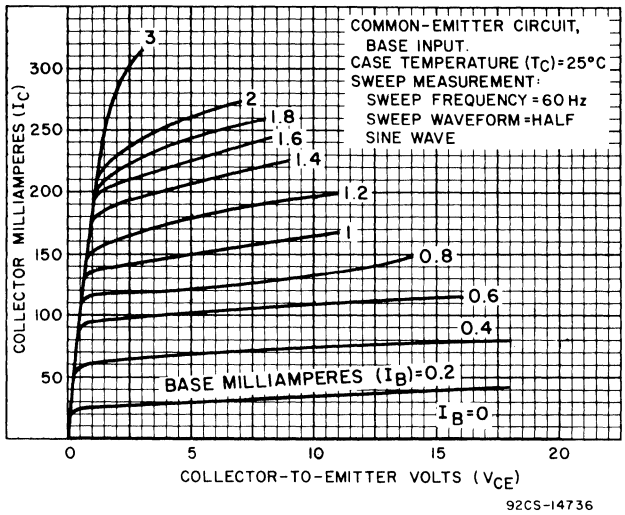


Fig. 3 – Collector Characteristics

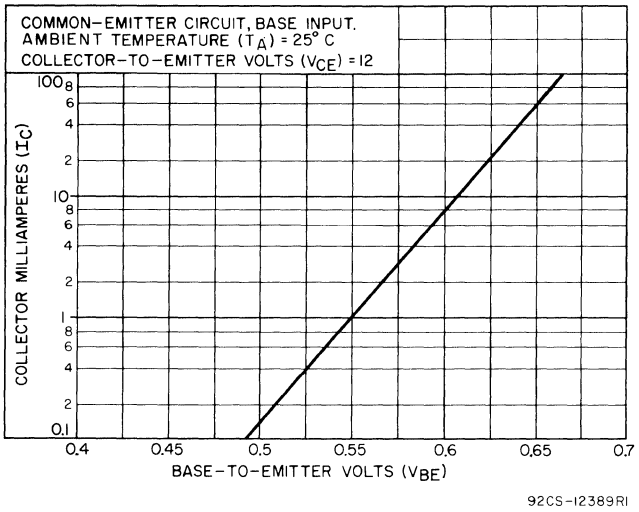


Fig. 4 – Transfer Characteristic

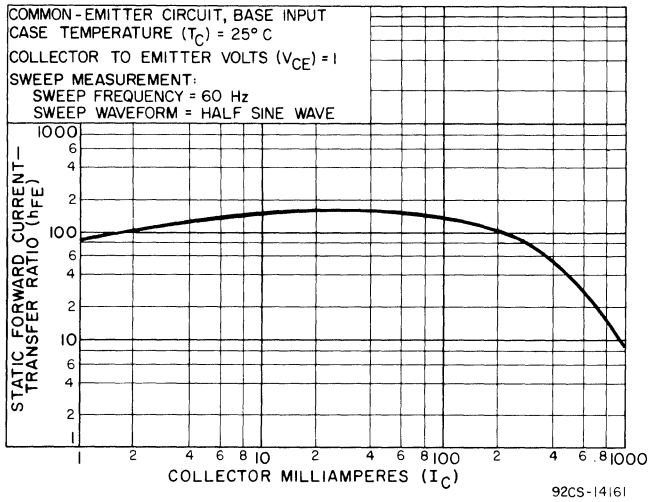


Fig. 5 – Static Beta Characteristic

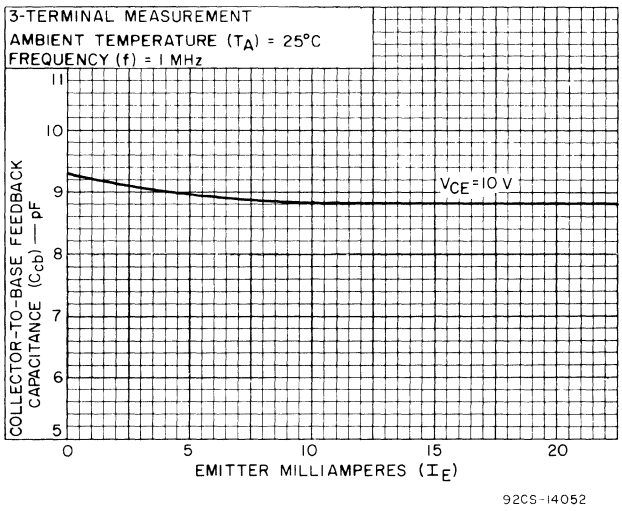


Fig. 6 – Feedback Capacitance Characteristics

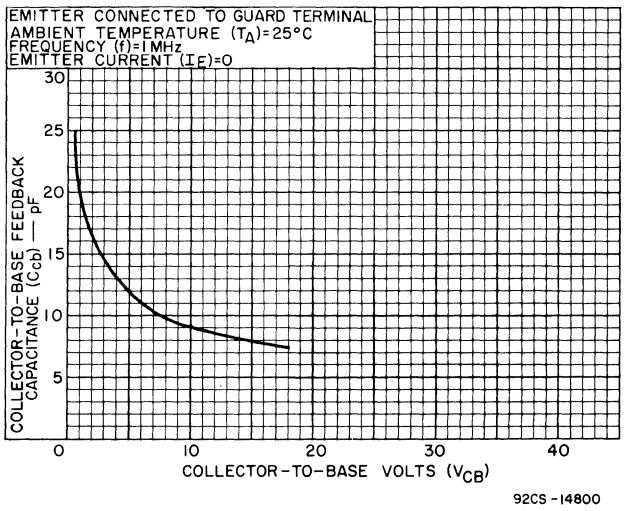


Fig. 7 – Feedback Capacitance Characteristic

TYPICAL CHARACTERISTICS FOR RCA-2N5183

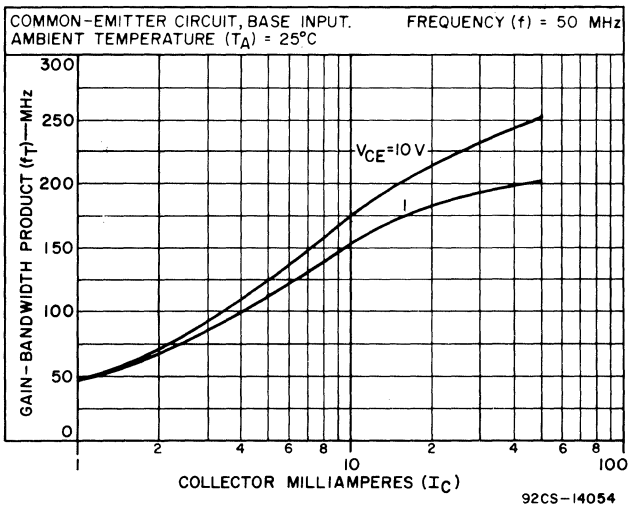


Fig. 8 – Gain-Bandwidth Product Characteristics

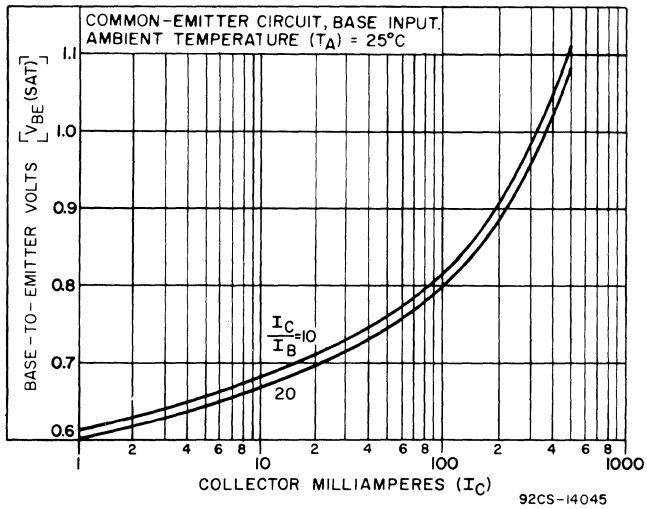


Fig. 9 – V_{BE}(sat) Characteristics

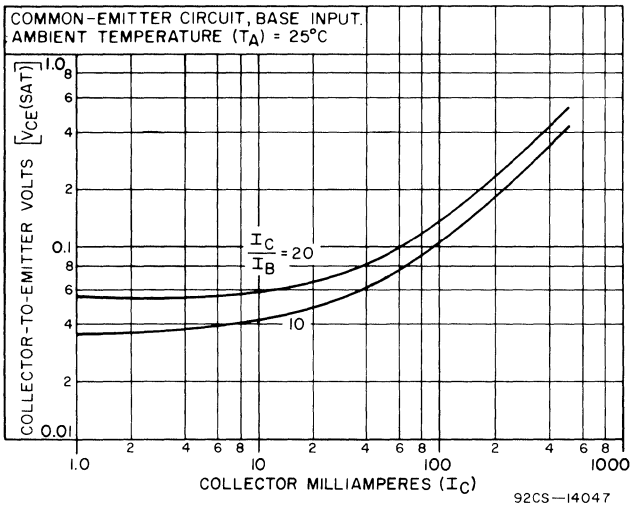


Fig. 10 – V_{CE}(sat) Characteristics

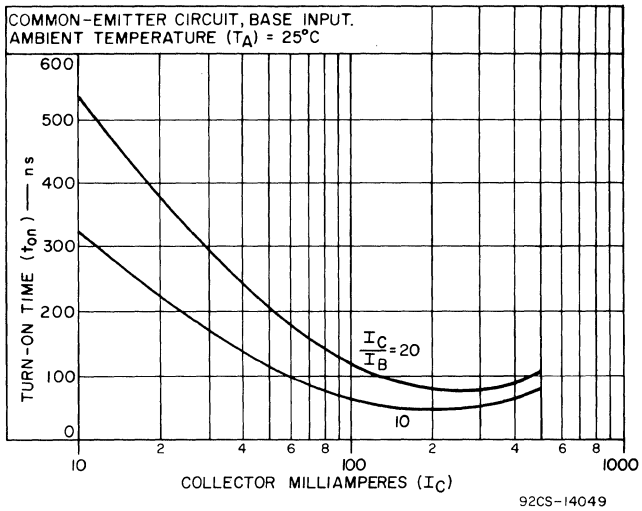


Fig. 11 – "Turn-On" Time Characteristics

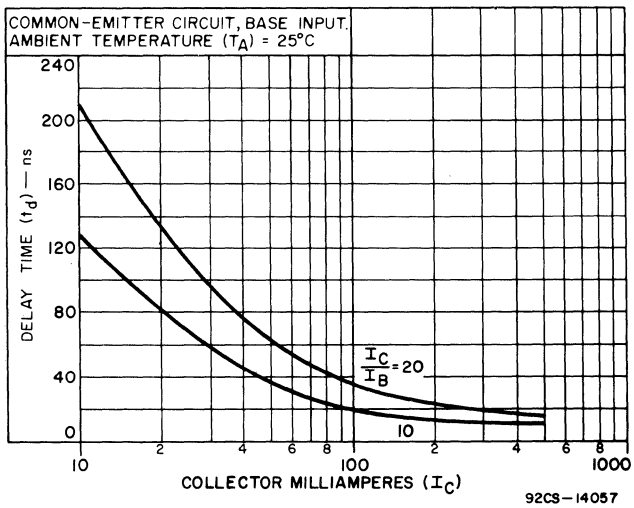


Fig. 12 – Delay Time Characteristics

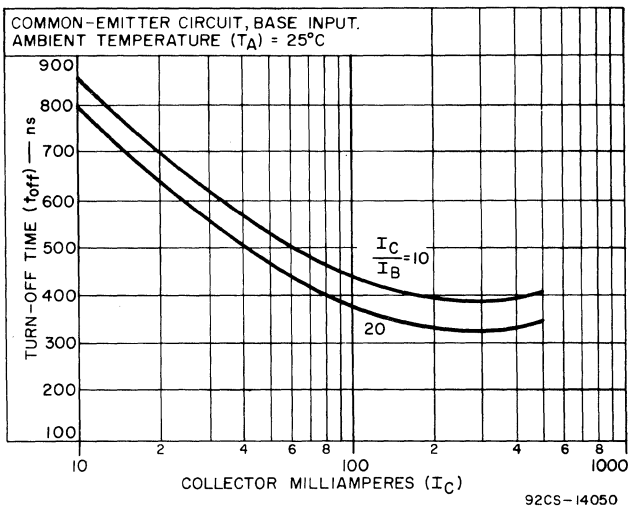
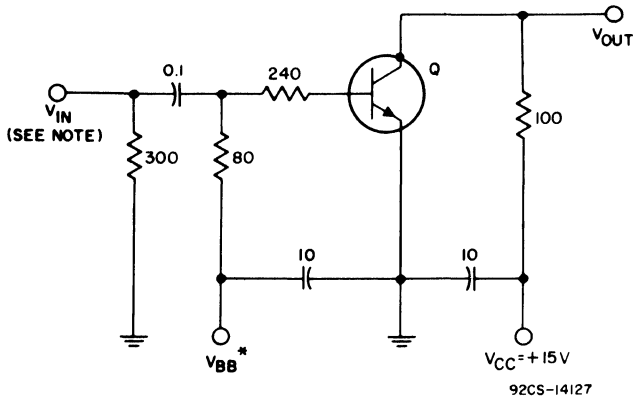


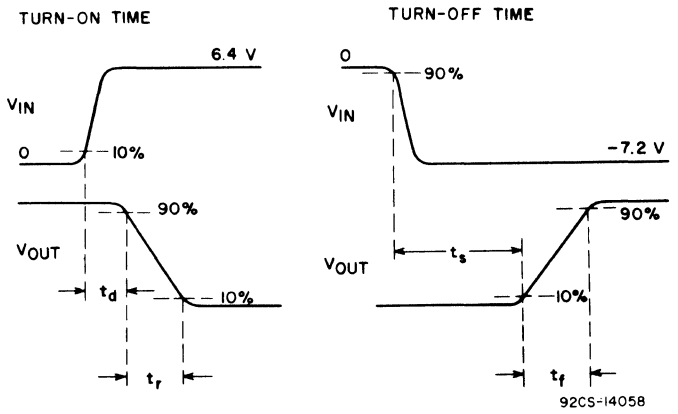
Fig. 13 – "Turn-Off" Time Characteristics



Note: V_{in} rise time $\leq$ 1 ns, pulse width $\geq$ 100 ns, duty factor $\leq$0.02.
Resistance values in ohms, Capacitance values in μF.

* For t_{on} Test V_{BB} = -2 V
For t_{off} Test V_{BB} = +5.6 V

Q = RCA-2N5183



$t_{on} = t_d + t_r$
$t_{off} = t_s + t_f$

Fig. 1 – Turn-On and Turn-Off Time Test Circuit and Waveforms for RCA Type 2N5183

SWITCHING CHARACTERISTICS AT T_A = 25°C
(Measured in Test Circuit Shown in Fig. 1)

Characteristics	Symbols	TEST CONDITIONS					MAX. VALUES
		"Off" Base-to-Emitter Voltage V_{BE}(off)	"Turn-On" Base Current I_{B_1}	"On" Collector Current I_C	"On" Base-to-Emitter Voltage V_{BE}(on)	"Turn-Off" Base Current I_{B_2}	Type 2N5183
		V	mA	mA	V	mA	ns
Turn-On-Time	t_{on}						
Delay Time	t_d	–2	15	150	—	—	25
Rise Time	t_r	–2	15	150	—	—	50
Turn-Off-Time	t_{off}						
Storage Time	t_s	—	—	150	5.6	–15	500
Fall Time	t_f	—	—	150	5.6	–15	75

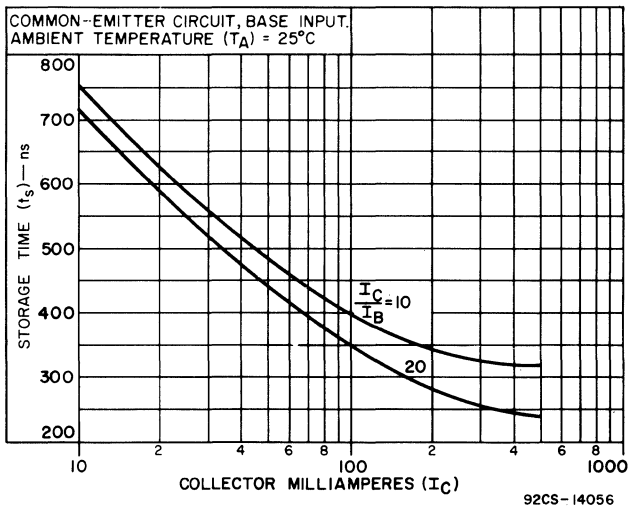


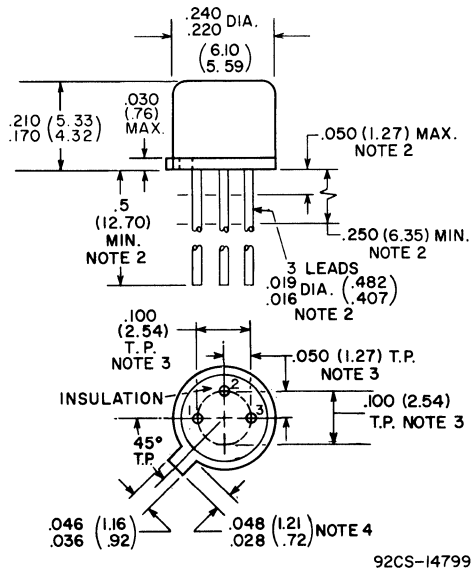
Fig. 14 – Storage Time Characteristics

OPERATING CONSIDERATIONS

RCA-2N5183 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

In the 2N5183 the collector is connected to the case. Consequently, in applications where the collectors of these transistors are operated at voltages above or below ground potential suitable precautions should be observed.

DIMENSIONAL OUTLINE
JEDEC TO-104



Lead No.4 omitted.

DIMENSIONS IN INCHES AND MILLIMETERS

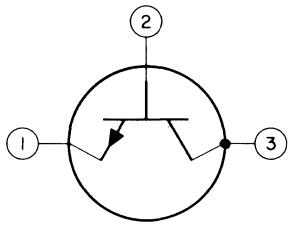
Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250"(6.35 mm) from the seating plane. From 0.250"(6.35 mm) to the end of the lead a maximum diameter of 0.021"(0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054"(1.372 mm) + 0.001" (0.025 mm) -0.000"(0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maxi- width of tab.

Note 4: Measured from actual maximum diameter.

TERMINAL DIAGRAM
2N5183

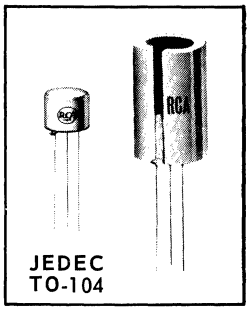


Lead 1 - Emitter
Lead 2 - Base
Lead 3 - Collector, Case

RCA TRANSISTORS
High-Voltage General-Purpose Types

2N5184
2N5185

SILICON N-P-N TRANSISTORS
For TV Video-Output-Amplifier Applications and for Control Applications in Industrial Equipment



RCA-2N5184 and 2N5185* are general-purpose, high-voltage silicon n-p-n transistors intended for use in video-output-amplifier applications in black-and-white television receivers, and for a wide variety of control applications in industrial equipment.

The 2N5185 is provided with an integral cylindrical heat radiator which gives this transistor twice the dissipation capability of the 2N5184.

The 2N5184 and 2N5185 feature high voltage-breakdown capabilities, low collector-to-base feedback capacitance, and low saturation voltage.

Both types utilize a compact hermetically sealed metal package in which the collector is internally connected to the case.

* Formerly Dev. Nos. TA7292 and TA7293, respectively.

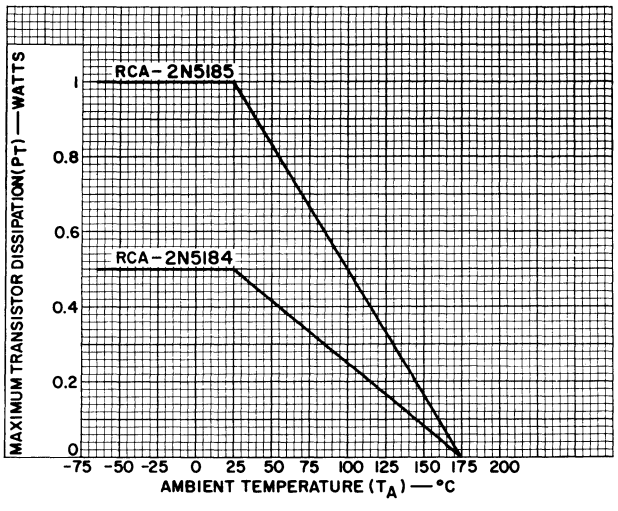
Features

- **high collector-to-emitter breakdown voltage capability —**
  $V_{(BR)CEO}$ = **120V min.**
- **low collector-to-base feedback capacitance —**
  C_{cb} = **2.8pF typ., 3.5pF max.**
- **low saturation voltage —**
  $V_{CE}(sat)$ = **1V typ. at** I_C = **30mA,** I_B = **1mA**
- **hermetically sealed 3-lead metal packages — collector internally connected to case**
- **RCA-2N5185 has integral heat radiator for increased dissipation capability**

Maximum Ratings, Absolute-Maximum Values:

	RCA 2N5184	*RCA 2N5185*	
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	120	120 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	5 max.	V
COLLECTOR CURRENT, I_C	50	50 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures { up to 25°C	0.5	1 max.	W
At ambient temperatures { above 25°C	See Fig. 1		
TEMPERATURE RANGE:			
Storage and operating (Junction)	−65 to +175		°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32" from seating surface for 10 seconds max.	255	255 max.	°C

RATING CHART FOR RCA-2N5184 AND 2N5185



92CS-14738

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Printed in U.S.A.
2N5184, 2N5185 8-67

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols and Units	LIMITS Types 2N5184 2N5185			TEST CONDITIONS DC Collector-Voltage V_{CB} or V_{CE}	DC Base Current I_B	DC Collector Current I_C	DC Emitter Current I_E
		Min.	Typ.	Max.	volts	mA	mA	μA
Collector-Cutoff Current	I_{CBO} nA	—	—	100	V_{CB} = 120			0
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$ volts	120	—	—		0	1	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$ volts	5	7	—			0	-10
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$ volts	—	1	5		1	30	
Static Forward Current-Transfer Ratio	h_{FE}	10	55	—	V_{CE} = 10	—	50	—
Collector-to-Base Feedback Capacitance	C_{cb} pF	—	2.8	3.5	V_{CE} = 10	f = 1MHz	30	
Gain-Bandwidth Product	f_T MHz	30 50	100 100	— —	V_{CE} = 10 120		45 2	
Thermal Resistance, Junction-to-Case	θ_{J-C} °C/Watt	—	45	60	—	—	—	—

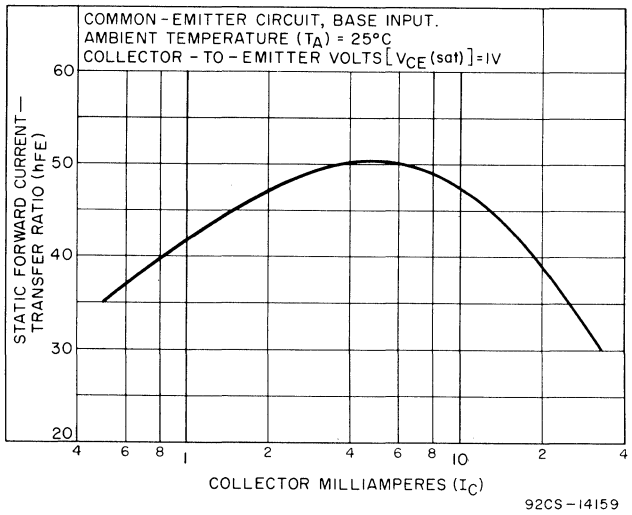


Fig.2 - Typical h_{FE} Characteristics for 2N5184 and 2N5185 (in Saturated Conditions)

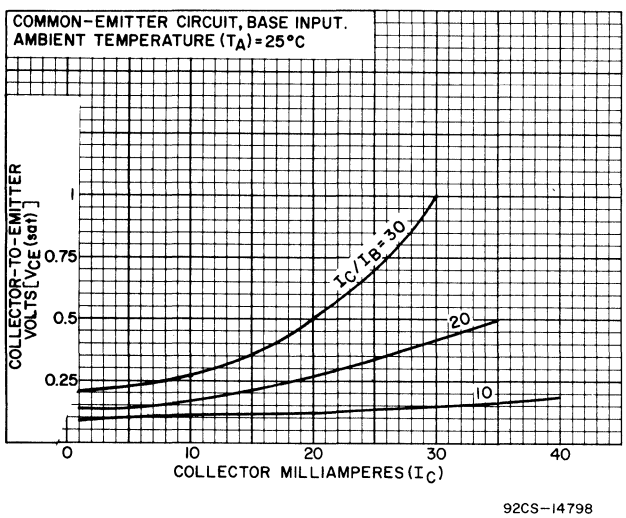


Fig.3 - Typical $V_{CE}(sat)$ Characteristics for 2N5184 and 2N5185

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

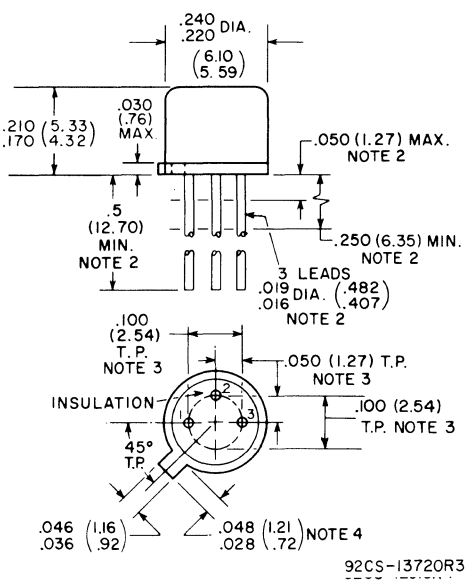
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

RCA-2N5184 and 2N5185 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

These transistors can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

DIMENSIONAL OUTLINE FOR 2N5184
TO-104



DIMENSIONS IN INCHES AND MILLIMETERS

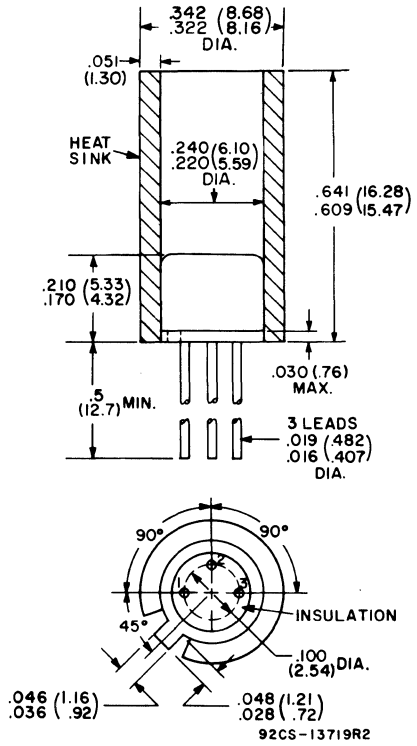
Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250"(6.35 mm) from the seating plane. From 0.250"(6.35 mm) to the end of the lead a maximum diameter of 0.021"(0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054"(1.372 mm) + 0.001" (0.025 mm) -0.000"(0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maxi- width of tab.

Note 4: Measured from actual maximum diameter.

DIMENSIONAL OUTLINE FOR 2N5185
WITH INTEGRAL HEAT RADIATOR



DIMENSIONS IN INCHES AND MILLIAMETERS

Note: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

RCA SWITCHING TRANSISTOR

High-Speed General-Purpose Type

2N5186

File No. 293

RCA-2N5186* is a silicon n-p-n epitaxial planar transistor specifically designed for low-voltage high-speed switching applications.

The 2N5186 has low saturation voltages and short storage time—features which make this transistor especially well suited for a wide variety of uses in the handling without distortion of square-wave pulse signals having very high repetition rates, as in data communication, instrumentation, and control systems.

The 2N5186 is hermetically sealed in the compact JEDEC TO-52 package.

* Formerly Dev. No. TA7320.

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	10 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max.	V
COLLECTOR CURRENT, I_C	300 max.	mA
TRANSISTOR DISSIPATION:		
At free-air temperatures: up to 25°C	300 max.	mW
above 25°C	See Fig. 1	
At case temperatures: up to 100°C	500 max.	mW
up to 100°C	See Fig. 1	
TEMPERATURE RANGE:		
Storage	−65 to +200	°C
Operating (Junction)	−65 to +200	°C
LEAD TEMPERATURE:		
At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

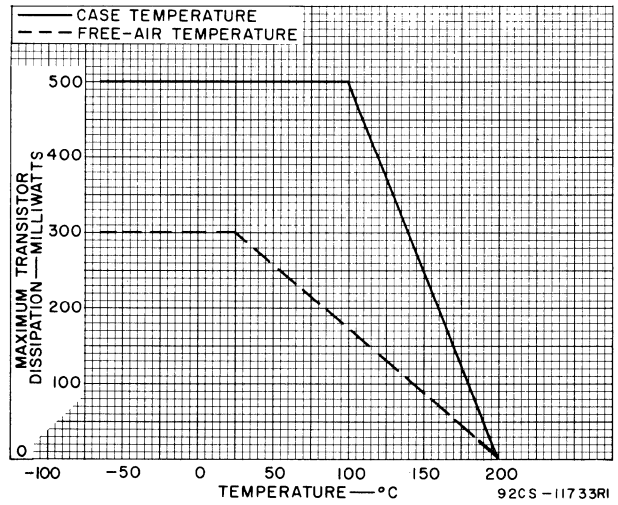
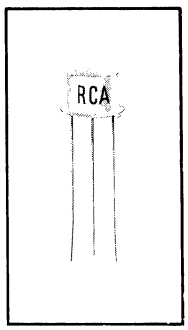


Fig. 1 – Rating Chart

SILICON N-P-N HIGH-SPEED TRANSISTOR



JEDEC TO-52

Epitaxial Planar Type For Switching Applications in Data-Processing Equipment and Other Critical Military and Industrial Equipment

Features

- **high switching speeds —**
  t_{on} = 25ns max., t_{off} = 25ns max.
  @ I_C = 10 mA, I_{B1} = $-I_{B2}$ = 1 mA
- **low saturation voltages —**
  V_{CE}(sat) = 0.3 V max. at I_C = 10mA
  V_{BE}(sat) = 1 V max. at I_C = 10mA
- **low input and output capacitances —**
  C_{ibo} = 3pF max.
  C_{obo} = 3pF max.
- **wide operating temperature range —**
  −65 to +200°C
- **high small-signal beta at high frequencies**
  $|h_{fe}|$ = 4 min. at f = 100MHz, I_C = 10mA
- **high reliability —**
  production lots of RCA-2N5186 are subjected to and meet the minimum mechanical environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See Page 6 for a description of the Group A and Group B Tests.

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Printed in U.S.A.
2N5186 8-67

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS								LIMITS			Units
		Ambient Temp. T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N5186			
		°C	MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	25 150		5 5			0 0			- -	0.002 0.9	0.05 5	μA μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	25					0	0.01		10	-	-	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO}(sus)$	25						10	0	6	10	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	25					-0.01	0		3	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25						10	1	-	-	0.3	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25						10	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}	25			1			10		25	-	-	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\lvert h_{fe} \rvert$	25	100		4			10		4	6	-	
Output Capacitance	C_{obo}	25	0.140	5			0			-	-	3	pF
Input Capacitance	C_{ibo}	25	0.140			0.5		0		-	-	3	pF
			Test Circuits						$I_{B1}=-I_{B2}$				
Storage Time	t_s	25	Fig. 2					5	5	-	-	10	ns
Turn-On Time (Delay time plus rise time)	t_{on}	25	Fig. 3					10	1	-	-	25	ns
Turn-Off Time (Storage time plus fall time)	t_{off}	25	Fig. 3					10	1	-	-	25	ns

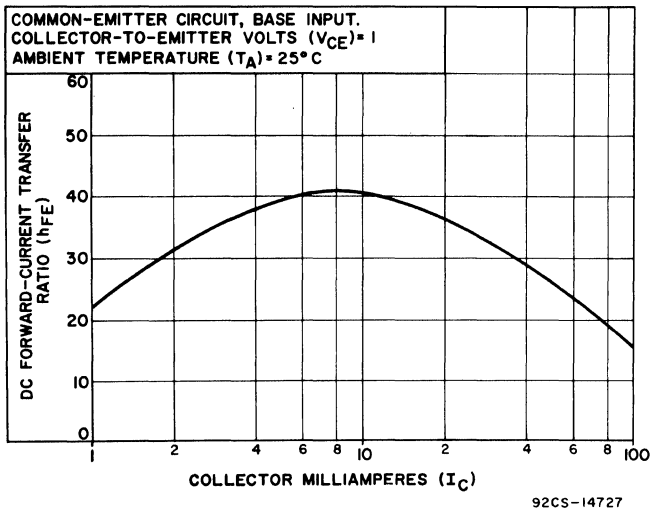


Fig. 4 – Typical DC Forward-Current Transfer-Ratio Characteristic for Type 2N5186

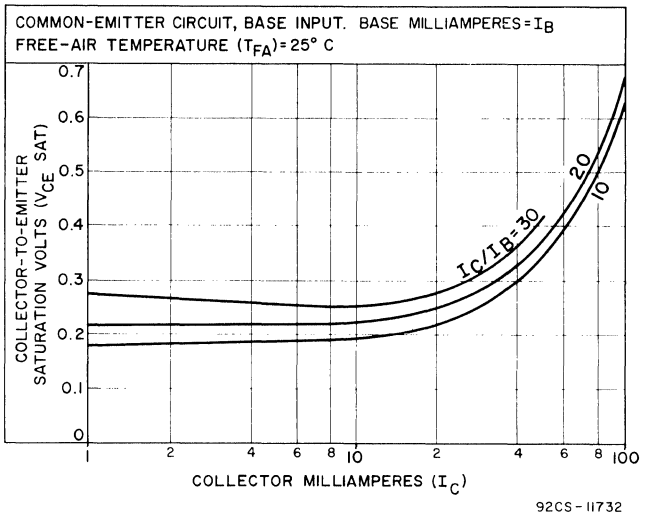


Fig. 7 – Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N5186

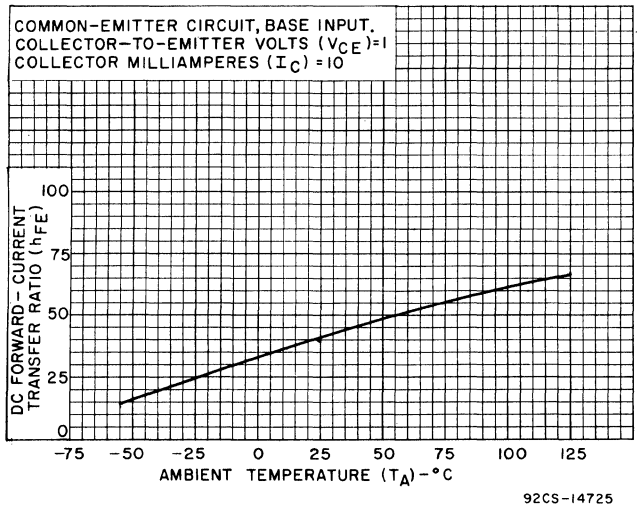


Fig. 5 – Typical DC Forward-Current Transfer-Ratio Characteristic for Type 2N5186

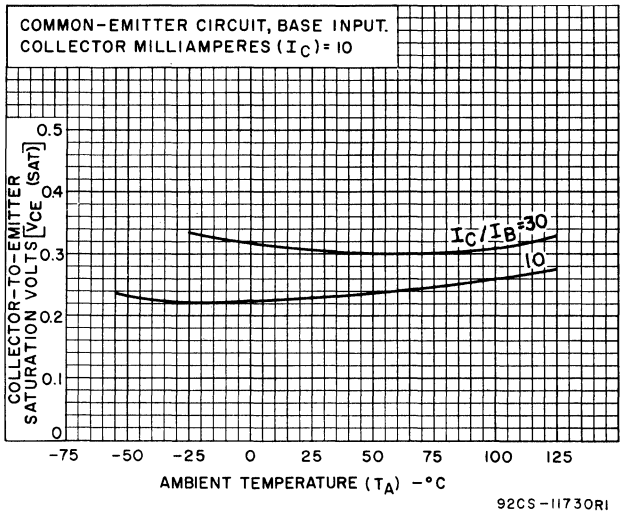


Fig. 8 – Typical Collector-to-Emitter Saturation Voltage Characteristics for Type 2N5186

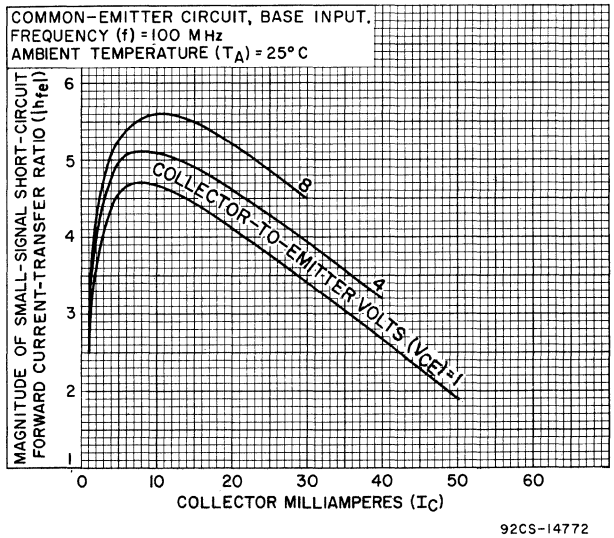


Fig. 6 – Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Type 2N5186

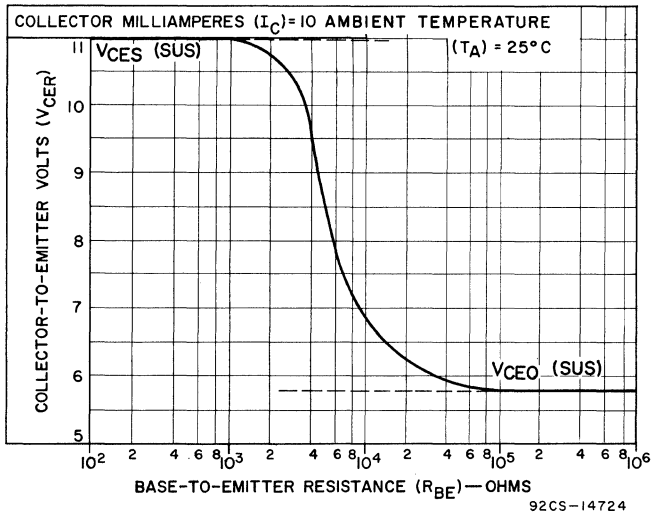


Fig. 9 – Typical Collector-to-Emitter Sustaining Voltage Characteristic for Type 2N5186

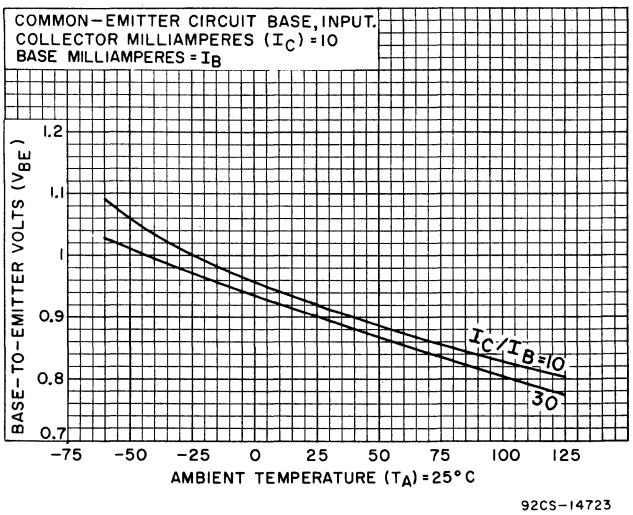


Fig. 10 – Typical Base-to-Emitter Voltage Characteristics for Type 2N5186

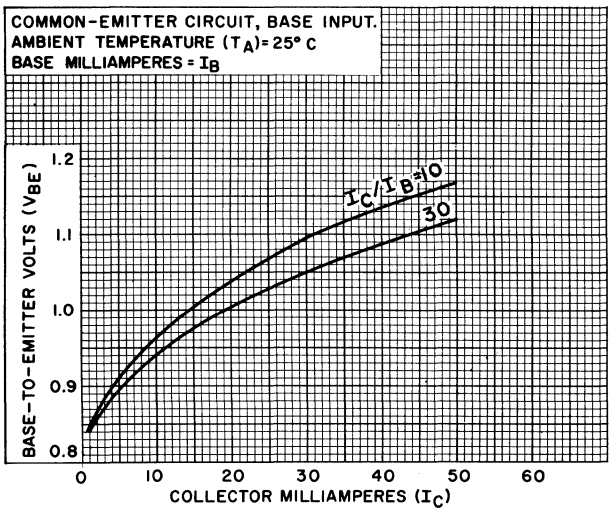


Fig. 11 – Typical Base-to-Emitter Voltage Characteristics for Type 2N5186

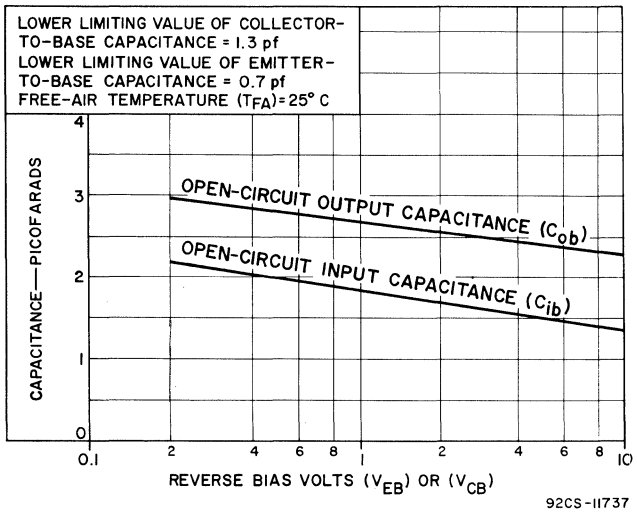
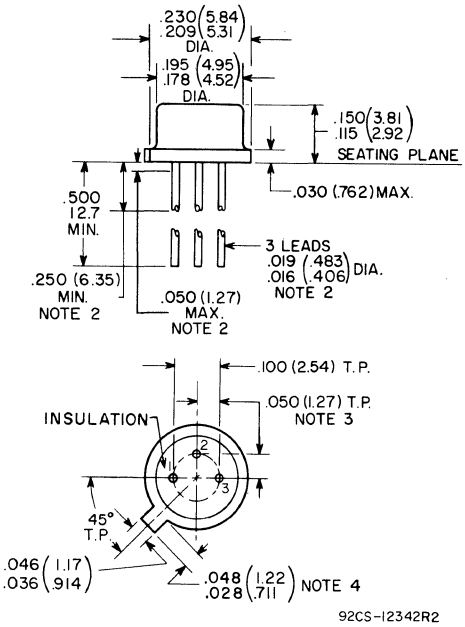


Fig. 12 – Typical Variation of Input and Output Capacitance vs Reverse Bias Voltage for Type 2N5186

DIMENSIONAL OUTLINE
JEDEC No. TO-52



Dimensions in Inches and Millimeters

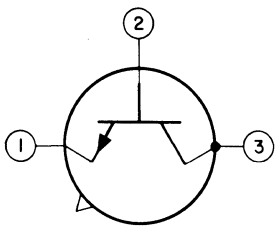
Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (5.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) − 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

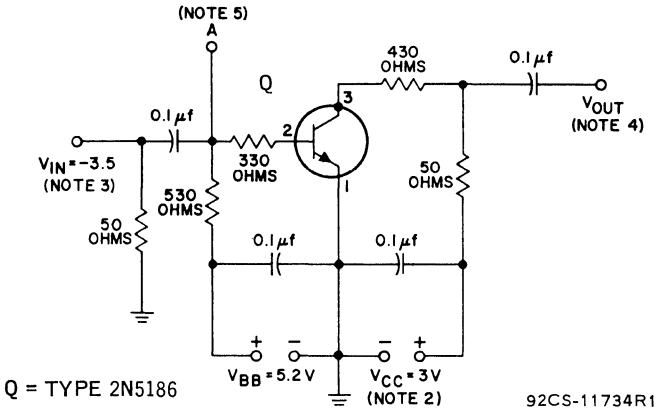
TERMINAL DIAGRAM
Bottom View

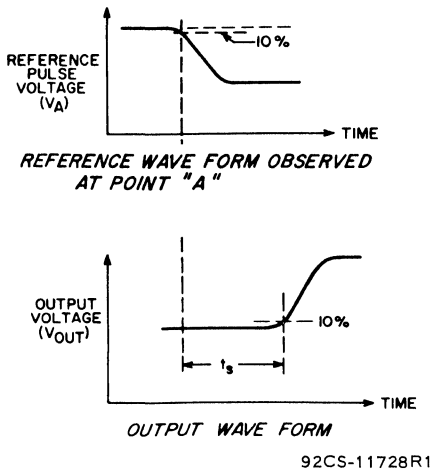


LEAD 1 — EMITTER

LEAD 2 — BASE

LEAD 3 — COLLECTOR, CASE





NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

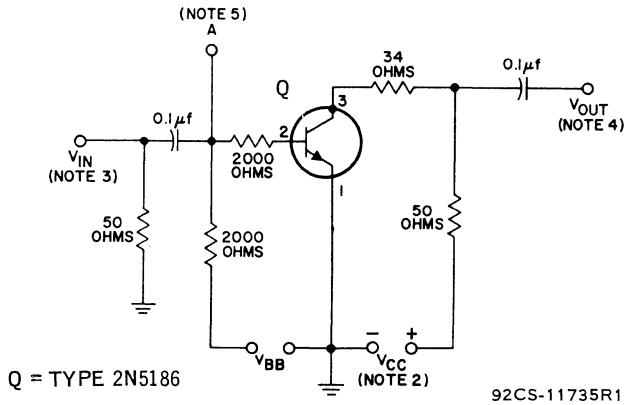
NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

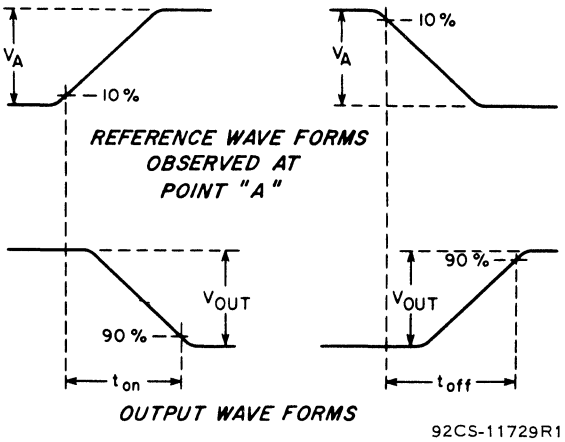
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 NSEC; PULSE DURATION > 300 NSEC; AND DUTY FACTOR < 2%.

NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

Fig.2 - Circuit Used to Measure Storage Time (t_s) for Type 2N5186.





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NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

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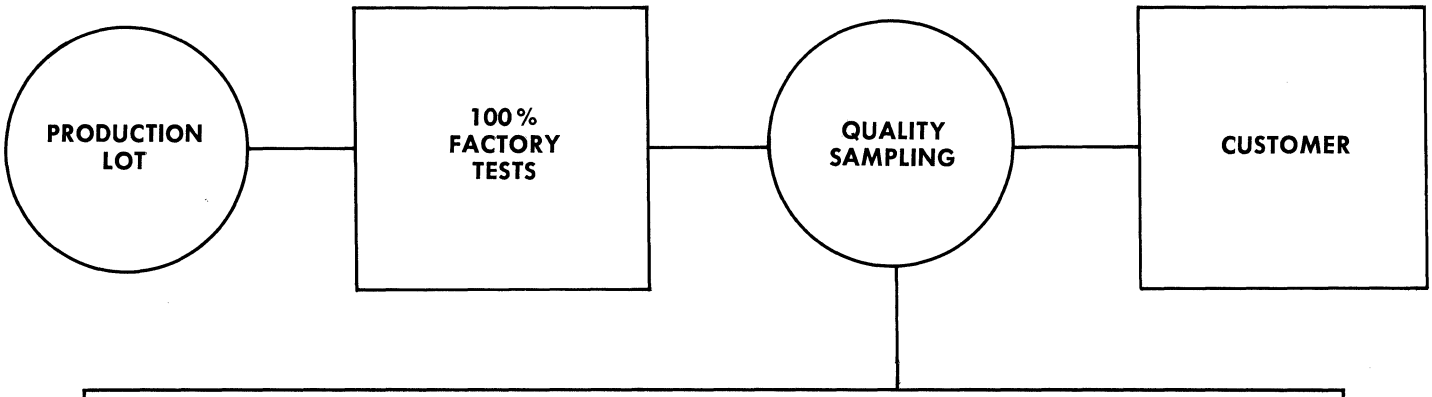
NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

t_{on}	t_{off}
$V_{BB} = -1.0V$	$V_{BB} = +5V$
$V_{IN} = +6V$	$V_{IN} = -4V$
$V_{CC} = +1V$	$V_{CC} = +1V$

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

Fig.3 - Circuit Used to Measure Turn-On Time (t_{on}) and Turn-Off Time (t_{off}) for Type 2N5186.

GROUP A AND GROUP B QUALITY SAMPLING TESTS



ITEM	TEST DESCRIPTION	LTPD
GROUP A TESTS		
Subgroup 1.	Visual and Mechanical Examination	10%
Subgroup 2.	Electrical	5%
GROUP B TESTS		
Subgroup 1.	Physical Dimensions	20%
Subgroup 2.	Solderability, Temperature Cycling, Thermal Shock, Moisture Resistance	20%
Subgroup 3.	Shock, Vibration Fatigue, Vibration Variable Frequency, Constant Acceleration	20%
Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 300mW, T_A = 25°C)	λ = 10%

RCA SWITCHING TRANSISTOR
High-Speed General-Purpose Type

2N5187

File No. 294

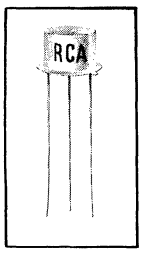
RCA-2N5187* is a planar epitaxial transistor of the silicon n-p-n type with exceptional versatility for switching applications. It is capable of high switching speed over an unusually wide range of collector current, which makes it especially useful in very fast circuits operating at low-to-moderate power levels.

The low saturation voltage and short storage time of this device permit a wide variety of uses in the handling without distortion of square-wave pulse signals having very high pulse-repetition rates, as in data communication, instrumentation, and control systems. The high-voltage and high-current capabilities of this transistor make it exceptionally useful in "interface" equipment of large information-handling systems.

The 2N5187 is hermetically sealed in the compact JEDEC TO-52 package.

* Formerly Dev. No. TA2762A.

SILICON N-P-N HIGH-SPEED TRANSISTOR



JEDEC TO-52

Planar Epitaxial Type For Switching Applications in Data-Processing Equipment and Other Critical Applications in Military and Industrial Equipment

Features

- **high switching speeds at high currents —**
  t_{on} = 12ns (typ.), t_{off} = 14ns (typ.)
  @ I_C = 100mA, I_{B1} = $-I_{B2}$ = 10mA
- **low saturation voltages —**
  $V_{CE}(sat)$ = 0.25V max. at I_C = 10mA
  $V_{BE}(sat)$ = 0.85V max. at I_C = 10mA
- **low input and output capacitances —**
  C_{ib} = 4pF max.
  C_{ob} = 3.5pF max.
- **wide operating temperature range —**
  −65 to +200°C
- **high small-signal beta at high frequencies**
  $|h_{fe}|$ = 4 min. at f = 100MHz, I_C = 10mA
- **high reliability —**
  production lots of RCA-2N5187 are subjected to and meet the minimum mechanical environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See Page 7 for a description of the Group A and Group B Tests.

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	25 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	10 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5 max.	V
COLLECTOR CURRENT, I_C	500 max.	mA
TRANSISTOR DISSIPATION, P_T:		
For case temperatures[a] up to 25°C	1 max.	W
For case temperatures[a] above 25°C	derate at 5.72mW/°C	
For free-air temperatures up to 25°C	0.3 max.	W
For free-air temperatures above 25°C	derate at 1.71mW/°C	
TEMPERATURE RANGE:		
Storage	−65 to +200	°C
Operating	−65 to +200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/16" from seating surface for 10 seconds max.	265 max.	°C

[a] Measured at center of seating surface.

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RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

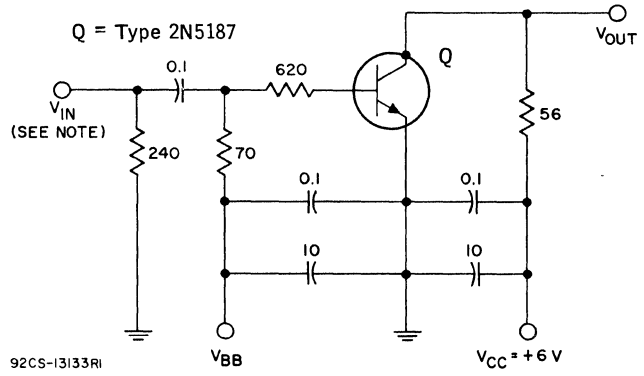
Trademark(s) ® Registered
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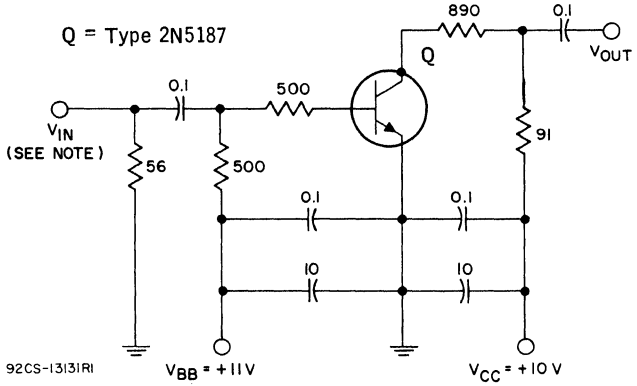
Printed in U.S.A.
2N5187 8-67

ELECTRICAL CHARACTERISTICS, at $T_A = 25°C$

Characteristics	Symbols	TEST CONDITIONS							LIMITS			Units
		Frequency f	DC Collector-to-Emitter Voltage V_{CE}	DC Collector-to-Base Voltage V_{CB}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	Type 2N5187			
		MHz	V	V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cut-off Current	I_{CBO}		20		0				-	-	450	nA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$					0	0.01		25	-	-	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$						10	0	10*	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					–0.01	0		5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$						100 10	10 1	- -	0.3* 0.2	0.5* 0.25	V V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$						100 10	10 1	- -	0.98* 0.8	1.2* 0.85	V V
Static Forward Current-Transfer Ratio	h_{FE}		1 0.4				10 30		30 25	- -	- -	
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\lvert h_{fe} \rvert$	100	10				10		4	6	-	
Common-Base, Open-Circuit Output Capacitance	C_{ob}	0.140		5		0			-	2.8	3.5	pF
Common-Base, Open-Circuit Input Capacitance	C_{ib}	0.140			0.5		0		-	3	4	pF
(See Fig. 1)				V_{CC} V	$V_{BE}(off)$ V	I_{B1} mA	I_{CS} mA	I_{B2} mA				
Delay Time	t_d			6	–4	10	100	–10	-	6	8	ns
Rise Time	t_r			6	–4	10	100	–10	-	6	10	ns
(See Fig. 1)												
Storage Time	t_s			6	–	10	100	–10	-	9	13	ns
Fall Time	t_f			6	–	10	100	–10	-	5	8	ns
(See Fig. 2) Storage Time	t_s			10	–	10	10	–10	-	9	13	ns

*Pulse Test: Pulse duration $\leq$ 100 μs, Duty Factor $\leq$ 0.02.





Note: V_{IN} rise time ≤ 1 nsec, pulse width ≥ 100 nsec, duty cycle ≤ 2%, Resistance values in ohms, Capacitance values in μf.

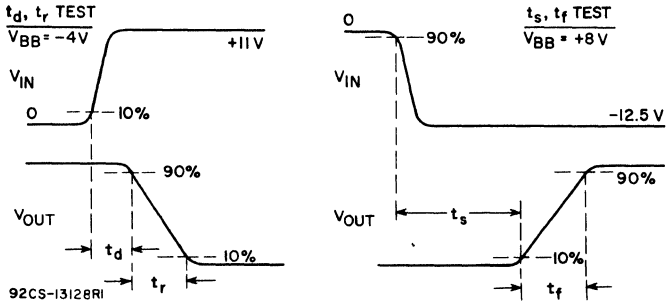


Fig. 1 – Switching Time Test Circuit

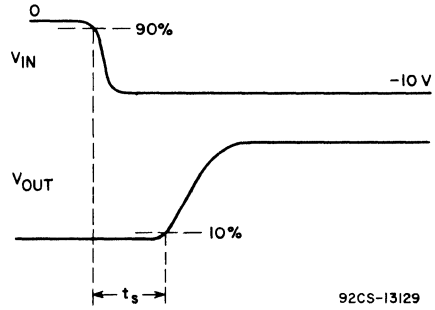


Fig. 2 – Storage Time Test Circuit

TYPICAL SWITCHING CHARACTERISTICS

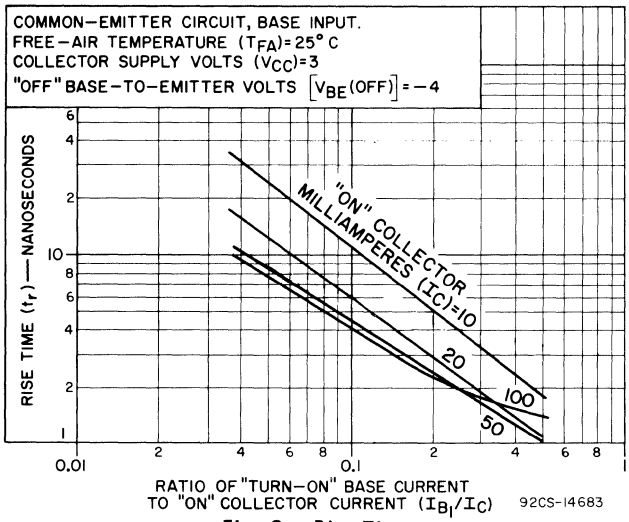


Fig. 3 – Rise Time

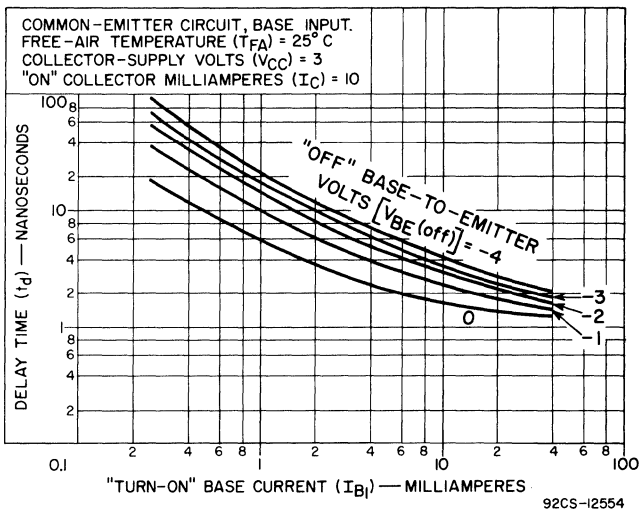


Fig. 4 – Delay Time

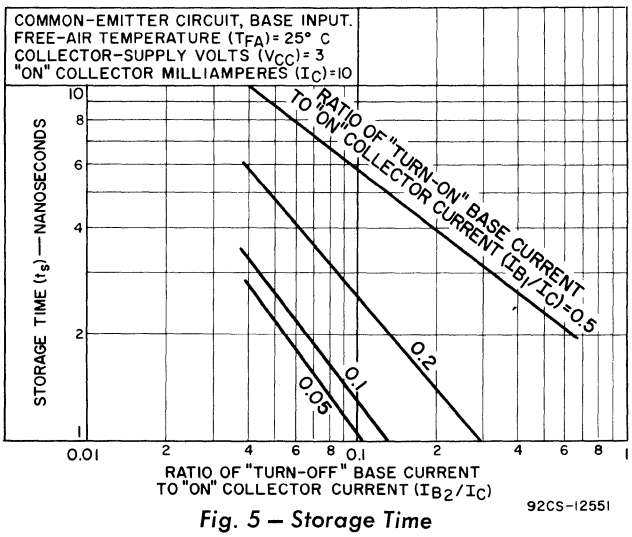


Fig. 5 – Storage Time

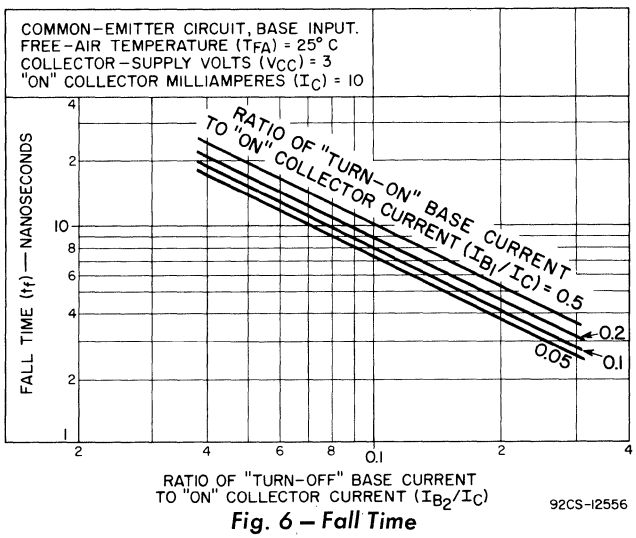


Fig. 6 – Fall Time

TYPICAL SWITCHING CHARACTERISTICS

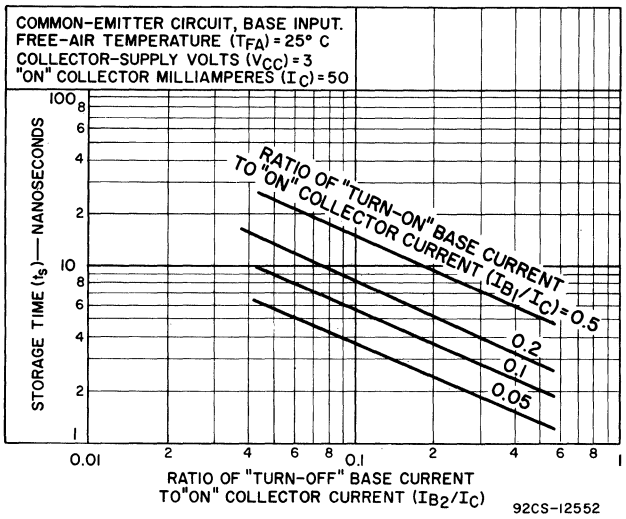


Fig. 7 — Storage Time

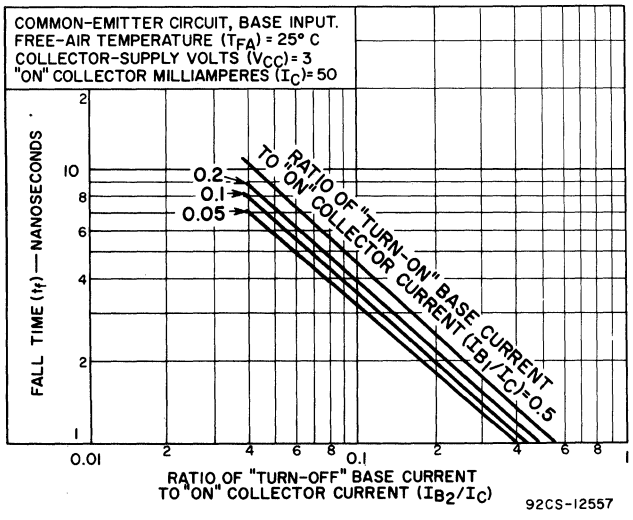


Fig. 8 – Fall Time

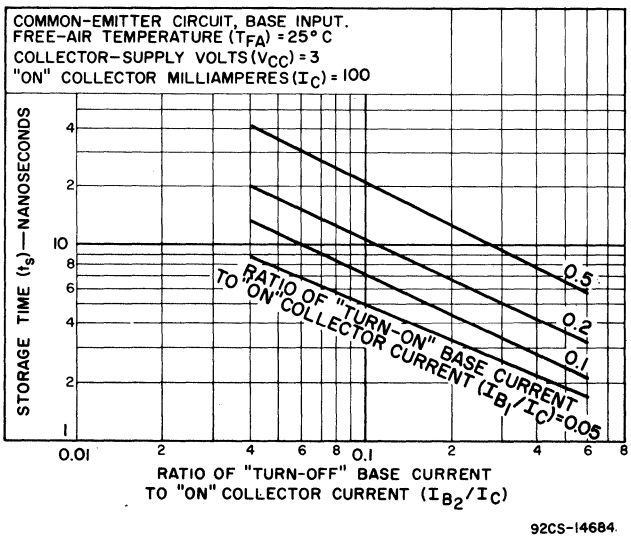


Fig. 9 – Storage Time

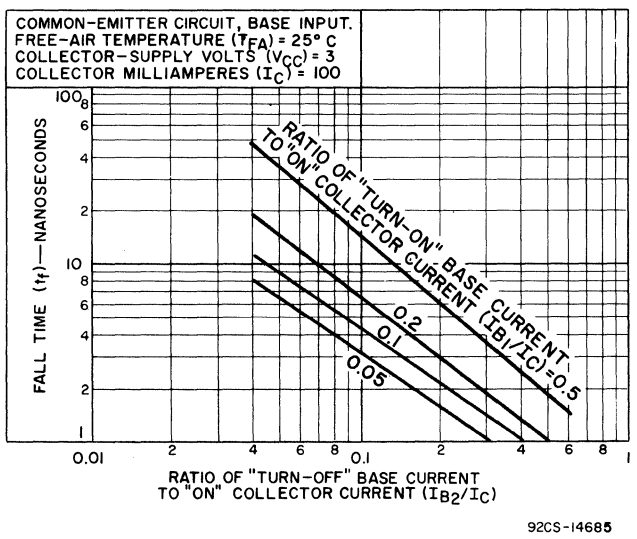


Fig. 10 – Fall Time

TYPICAL CHARACTERISTICS

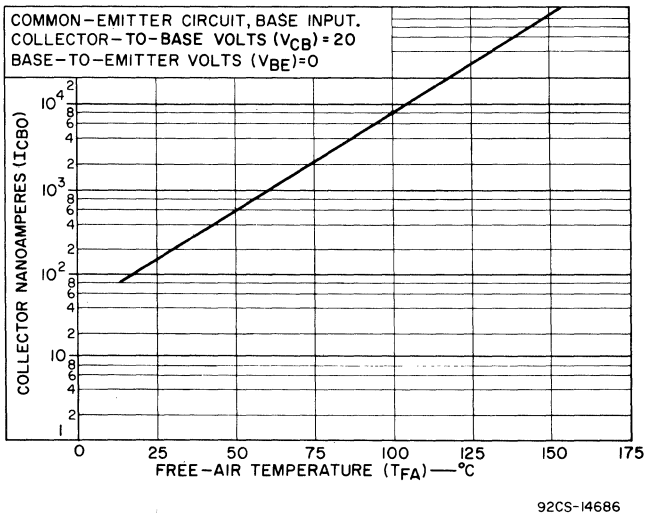


Fig. 11 – I_{CEV} vs Temperature

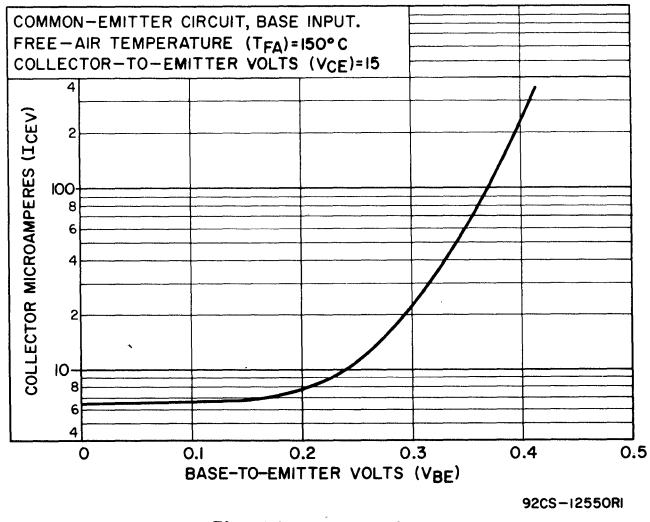
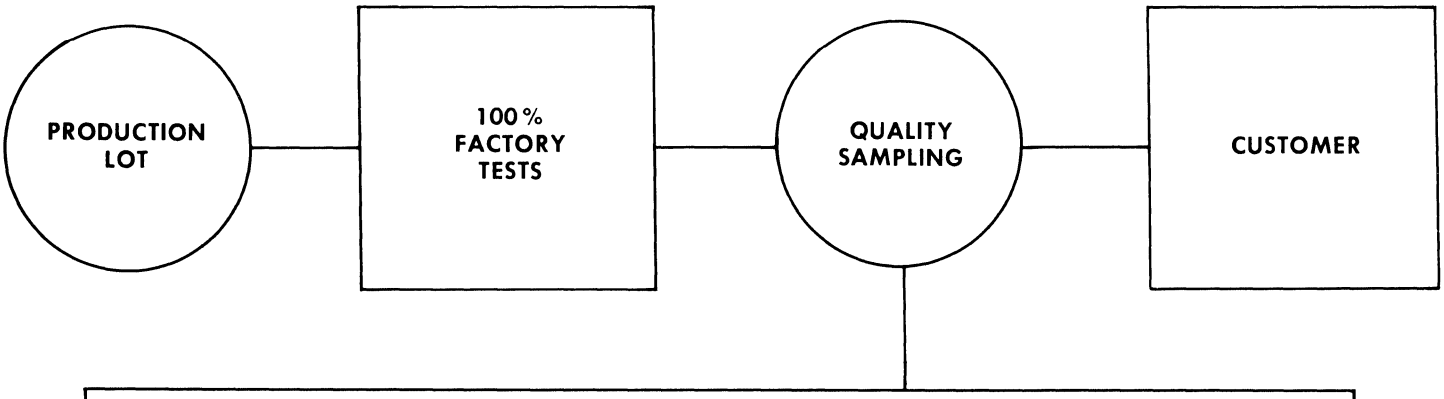


Fig. 12 – I_{CEV} vs V_{BE}

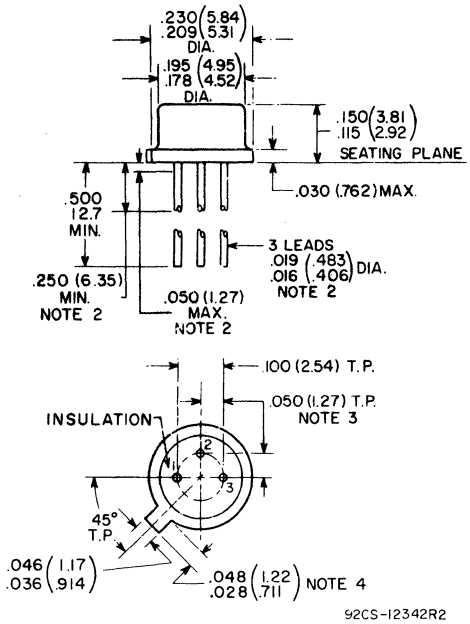
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Subgroup 2.	Electrical	10%
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Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 300mW, T_A = 25°C)	λ = 10%

DIMENSIONAL OUTLINE

JEDEC No. TO-52



Dimensions in Inches and Millimeters

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

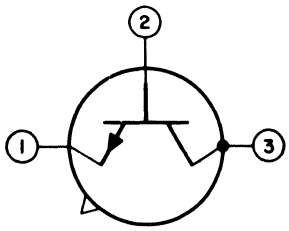
Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) − 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

TERMINAL DIAGRAM

Bottom View



LEAD 1 — EMITTER

LEAD 2 — BASE

LEAD 3 — COLLECTOR, CASE

TYPICAL CHARACTERISTICS

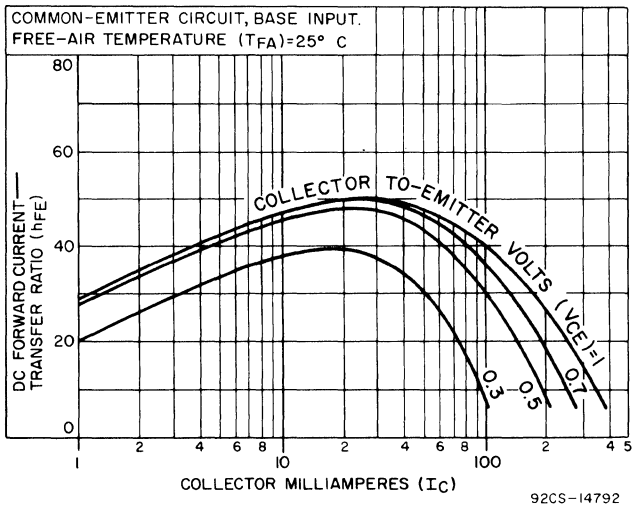


Fig. 13 – h_{FE} vs I_C

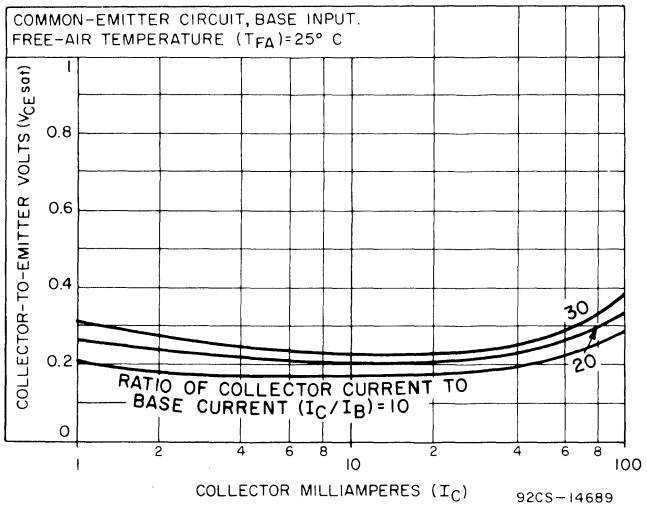


Fig. 14 – V_{CE}(sat) vs I_C

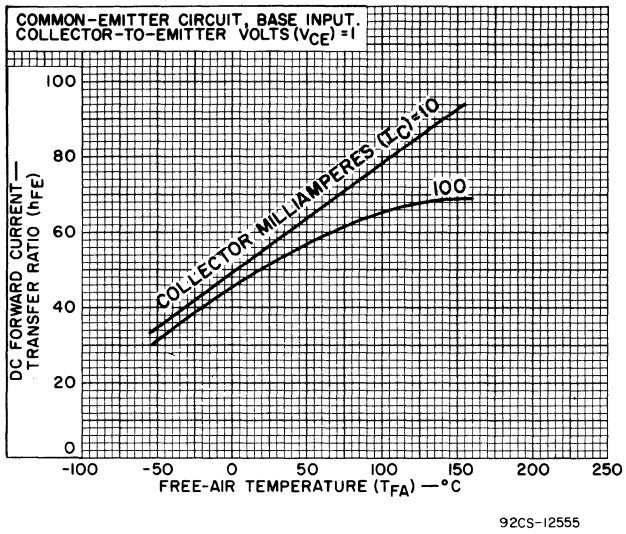


Fig. 15 – h_{FE} vs Temperature

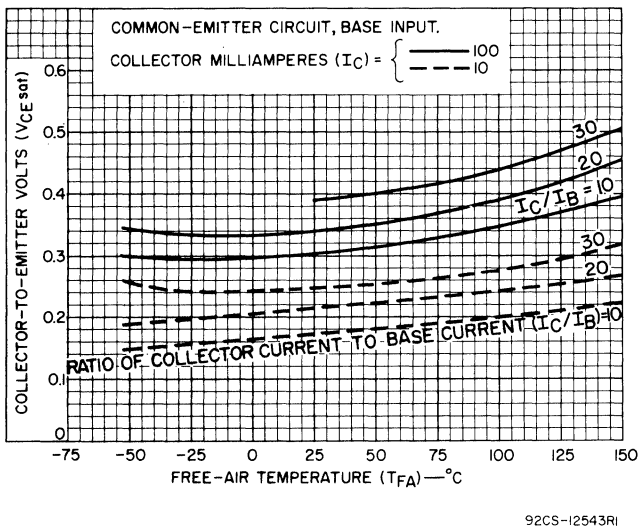


Fig. 16 – V_{CE}(sat) vs Temperature

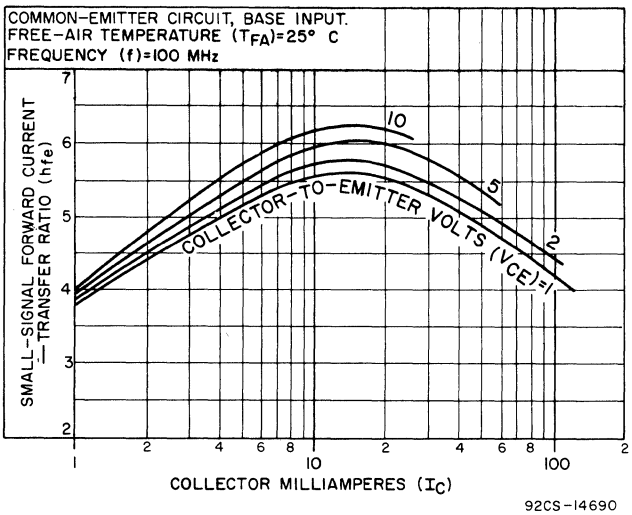


Fig. 17 – 100MHz h_{fe} vs I_C

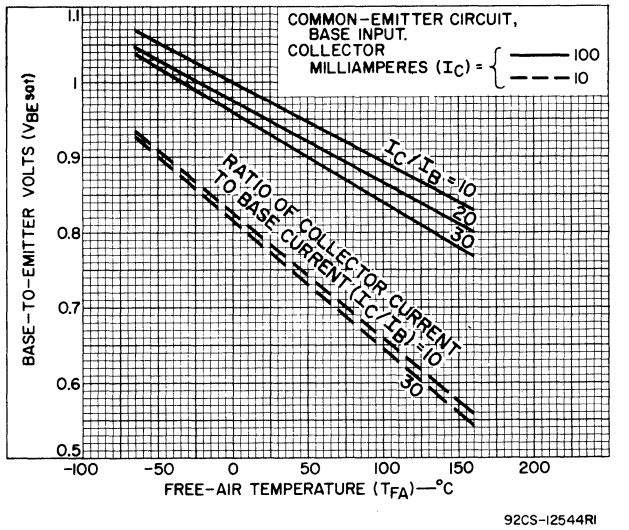


Fig. 18 – V_{BE}(sat) vs Temperature

TYPICAL CHARACTERISTICS

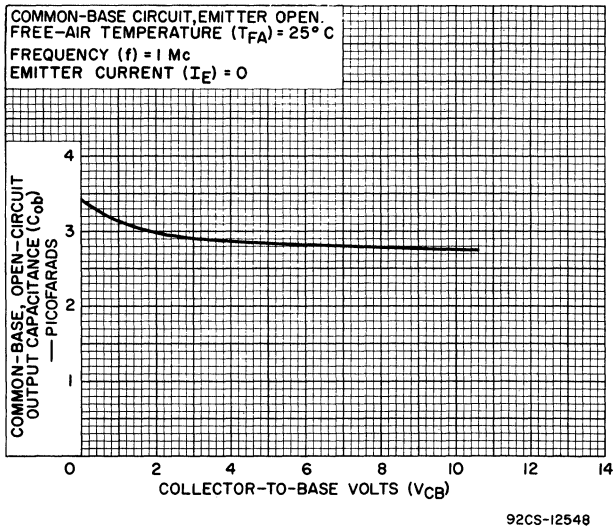


Fig. 19 – Output Capacitance

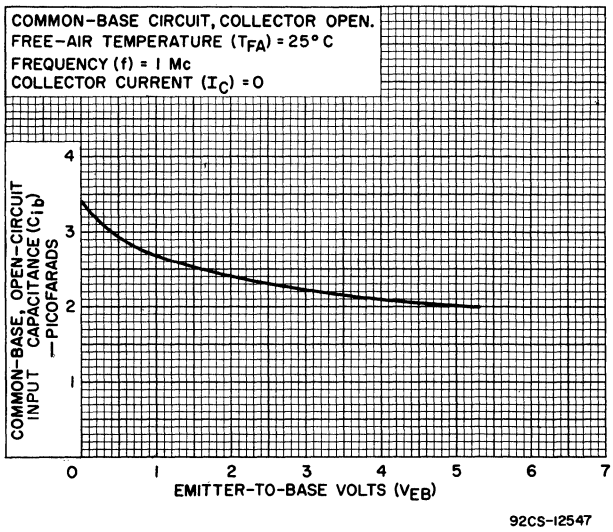


Fig. 20 – Input Capacitance

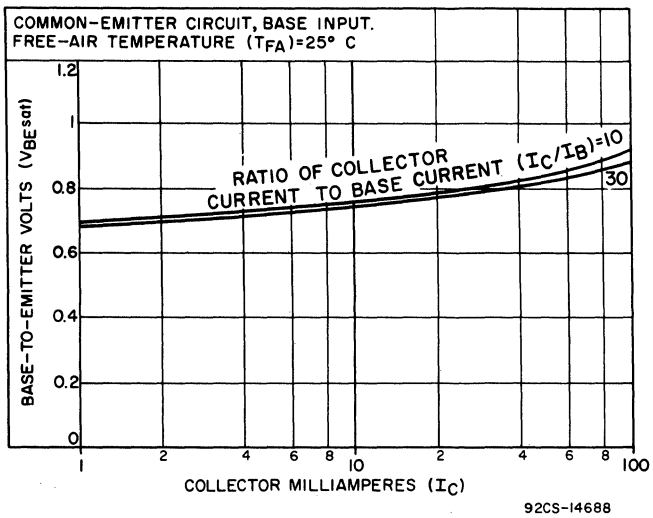


Fig. 21 – V_{BE}(sat) vs I_C

RCA TRANSISTOR
High-Voltage General-Purpose Type

2N5188

File No. 295

SILICON N-P-N HIGH-VOLTAGE TRANSISTOR



JEDEC TO-39

For Core-Driver and Line-Driver Service in Data-Processing Equipment and Other Critical Applications in Military and Industrial Equipment

RCA-2N5188* is a double-diffused epitaxial planar transistor of the silicon n-p-n type.

This transistor features high breakdown voltages, low saturation voltages, and high switching speeds over a wide range of collector current. These features make this device well suited for core-driver and line-driver service in high-performance computers and in other critical industrial applications, and in class C service in mobile and portable equipment.

The 2N5188 is hermetically sealed in a JEDEC TO-39 package designed to provide very low thermal resistance. This construction permits this device to dissipate substantial amounts of power internally in high-duty-factor or non-saturating applications.

* Formerly Dev. No. TA7184A.

Features

- **excellent power handling capability —** 4W max. at T_C = 25°C
- **high gain-bandwidth product —** f_T = 325MHz typ.
- **high switching speeds —** t_{on} = 20ns typ., t_{off} = 30ns typ. at I_C = 150mA
- **low output capacitance —** C_{ob} = 8pF typ.
- **high reliability —** production lots of RCA-2N5188 are subjected to and meet the minimum mechanical, environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See Page 7 for a description of the Group A and Group B Tests.

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	60 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	25 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5 max.	V
COLLECTOR CURRENT, I_C	Limited by dissipation	
TRANSISTOR DISSIPATION, P_T:		
For case temperatures[a] up to 25°C	4 max.	W
For case temperatures[a] above 25°C	derate at 22.8mW/°C	
For ambient temperatures up to 25°C	0.8 max.	W
For ambient temperatures above 25°C	derate at 4.6mW/°C	
TEMPERATURE RANGE: Storage and Operating (Junction)	−65 to +200	°C
LEAD TEMPERATURE (During Soldering): At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

[a] Measured at center of seating surface.

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Printed in U.S.A.
2N5188 8-67

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

Characteristics	Symbols	TEST CONDITIONS					LIMITS			
		Collector-to-Emitter Voltage V_{CE}	Emitter-to-Base Voltage V_{EB}	Collector Current I_C	Emitter Current I_E	Base Current I_B	Type 2N5188			Units
		V	V	mA	mA	mA	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		V_{CB}=30		0		-	-	0.5	μA
Collector-to-Emitter Breakdown Voltage	BV_{CEO}			30		0	25	-	-	V
Collector-to-Base Breakdown Voltage	BV_{CBO}			0.01	0		60	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0	−0.01		5	-	-	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			150 500		7.5 50	- -	- -	0.5 1 *	V V
Base-to-Emitter Voltage	V_{BE}			150 500		7.5 50	- -	- -	1.1 1.5 *	V V
Static Forward-Current Transfer Ratio	h_{FE}	1 0.5		500 150			20* 25	- -	- -	
Magnitude of Small-Signal Forward Current–Transfer Ratio at f = 100 MHz	$\lvert h_{fe} \rvert$	10		50			2.5	-	-	
Output Capacitance at f = 140 kHz	C_{ob}		V_{CB}=10		0		-	8	10	pF
			V_{CC}			I_{B1} -I_{B2}				
Storage Time See Fig. 21	t_s		6.4	150		15	-	-	35	ns
Turn-On-Time See Fig. 22	t_{on}		6.4	150		15	-	-	35	ns
Turn-Off-Time See Fig. 21	t_{off}		6.4	150		15	-	-	50	ns

*Pulsed conditions - Pulse duration < 400 μs; duty factor < 0.03.

TYPICAL CHARACTERISTICS

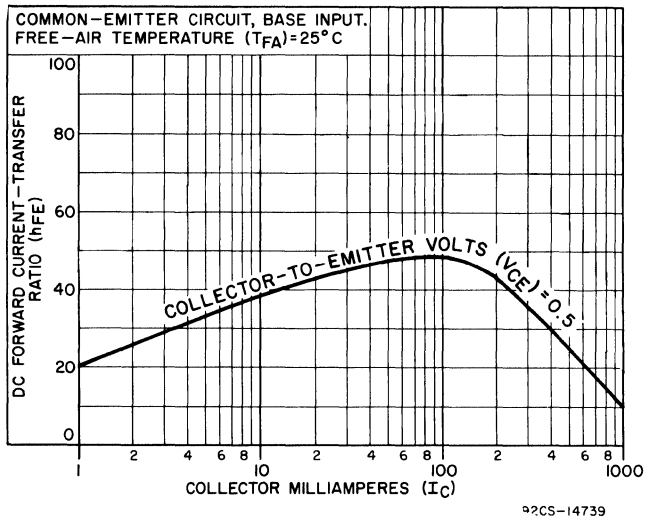


Fig. 1 – Static-Forward-Current Transfer-Ratio Characteristic

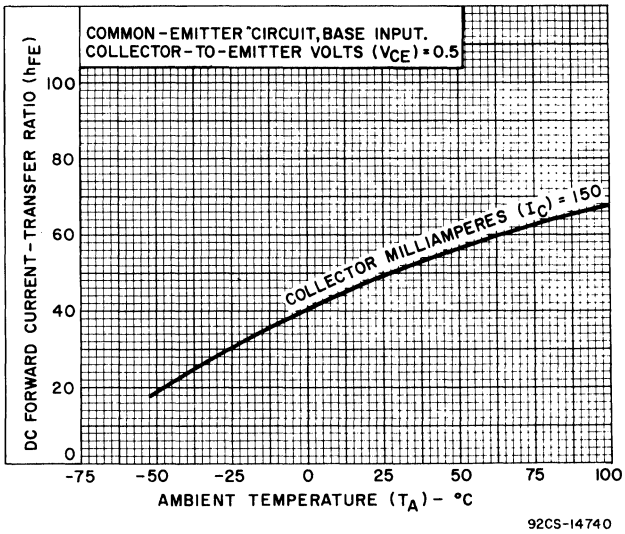


Fig. 2 – Static-Forward-Current Transfer-Ratio vs Temperature

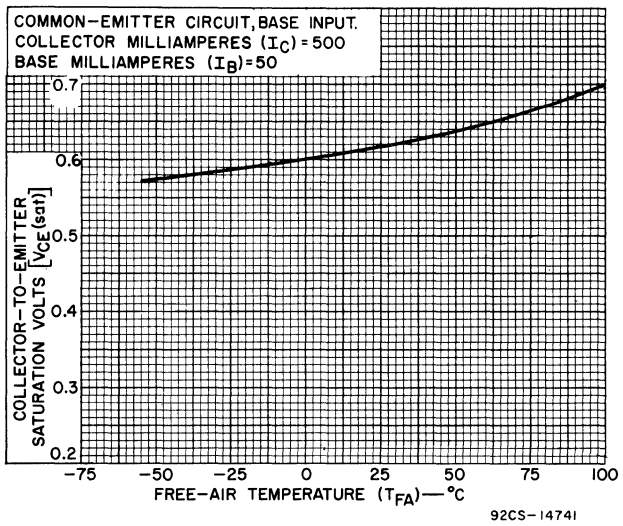


Fig. 3 – Collector-to-Emitter Saturation-Voltage vs Temperature

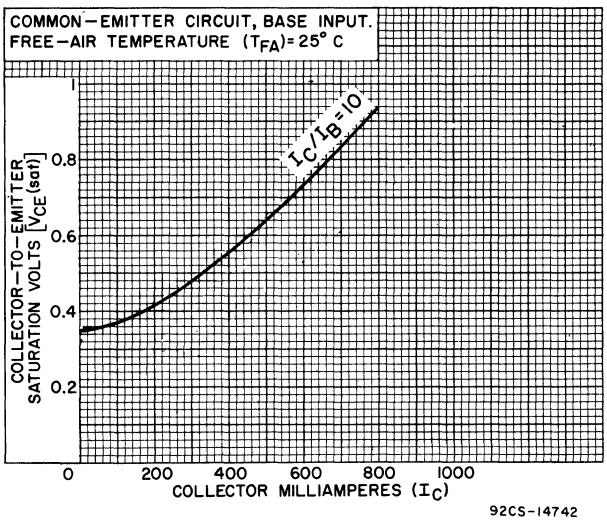


Fig. 4 – Collector-to-Emitter Saturation-Voltage Characteristic

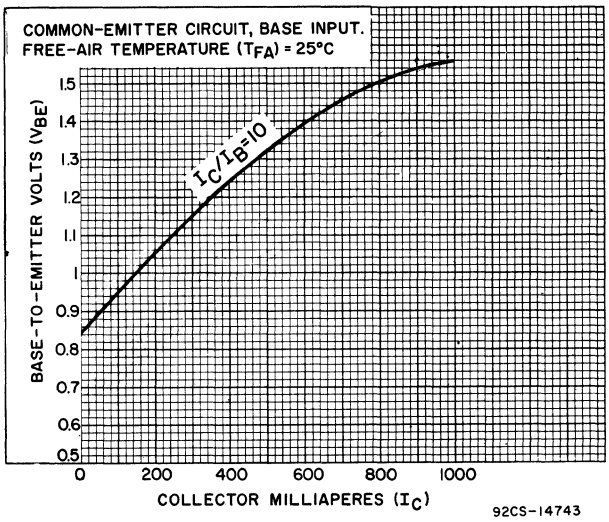


Fig. 5 – Base-to-Emitter Voltage Characteristic

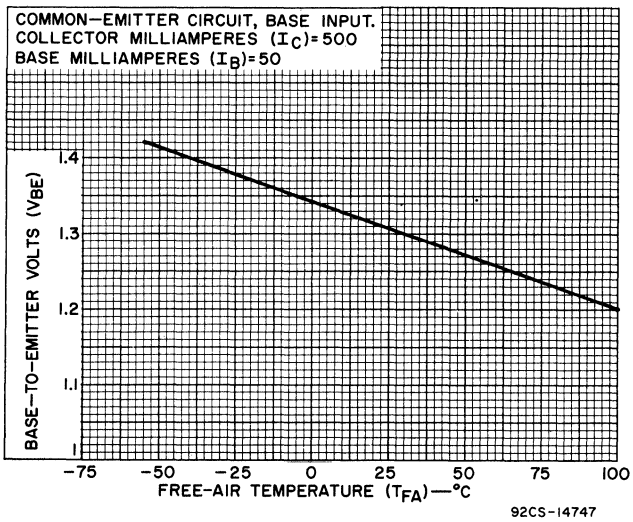


Fig. 6 – Base-to-Emitter Voltage vs Temperature

TYPICAL CHARACTERISTICS

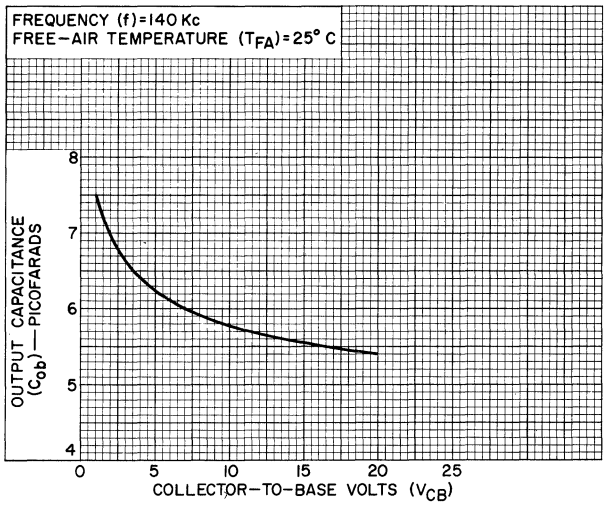


Fig. 7 – Output Capacitance Characteristic

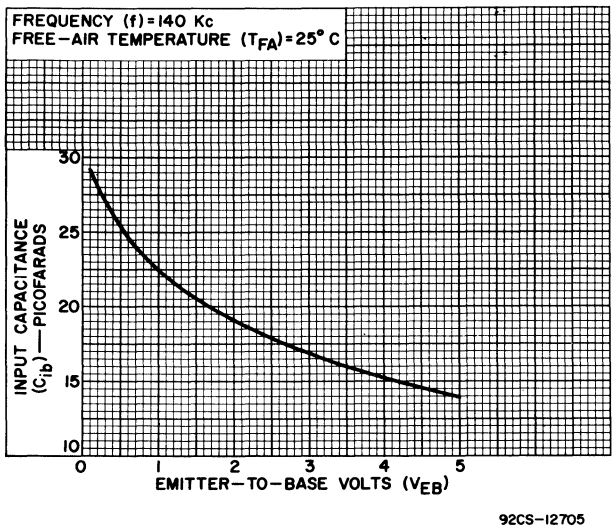


Fig. 8 – Input Capacitance Characteristic

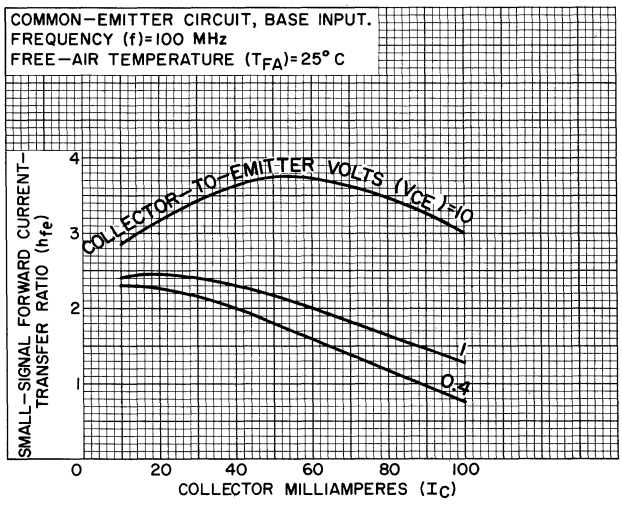
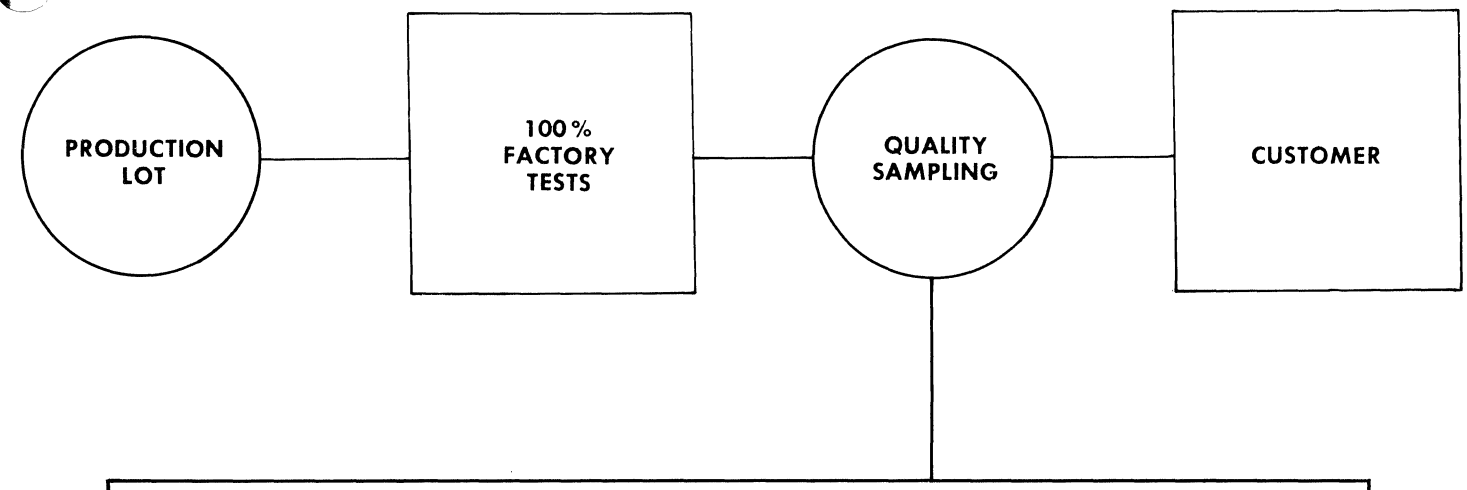


Fig. 9 – Small-Signal Forward-Current Transfer-Ratio

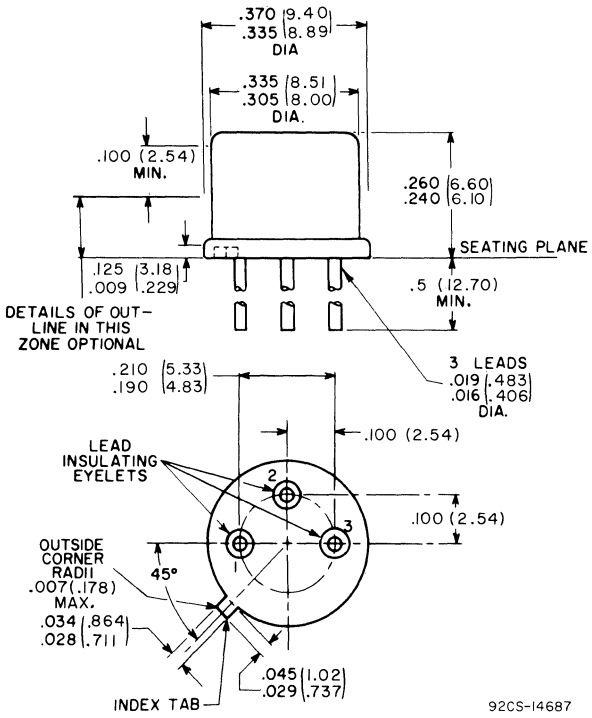
GROUP A AND GROUP B QUALITY SAMPLING TESTS



ITEM	TEST DESCRIPTION	LTPD
GROUP A TESTS		
Subgroup 1.	Visual and Mechanical Examination	10%
Subgroup 2.	Electrical	5%
GROUP B TESTS		
Subgroup 1.	Physical Dimensions	20%
Subgroup 2.	Solderability, Temperature Cycling, Thermal Shock, Moisture Resistance	20%
Subgroup 3.	Shock, Vibration Fatigue, Vibration Variable Frequency, Constant Acceleration	20%
Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 800 mW, T_A = 25°C)	λ = 10%

DIMENSIONAL OUTLINE

JEDEC TO-39

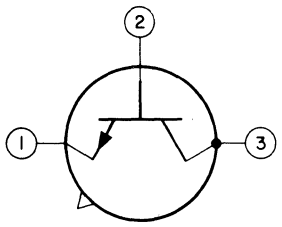


Dimensions in inches and millimeters

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.

TERMINAL DIAGRAM

Bottom View



LEAD 1 — EMITTER

LEAD 2 — BASE

LEAD 3 — COLLECTOR, CASE

TYPICAL FALL-TIME (t_f) CHARACTERISTICS

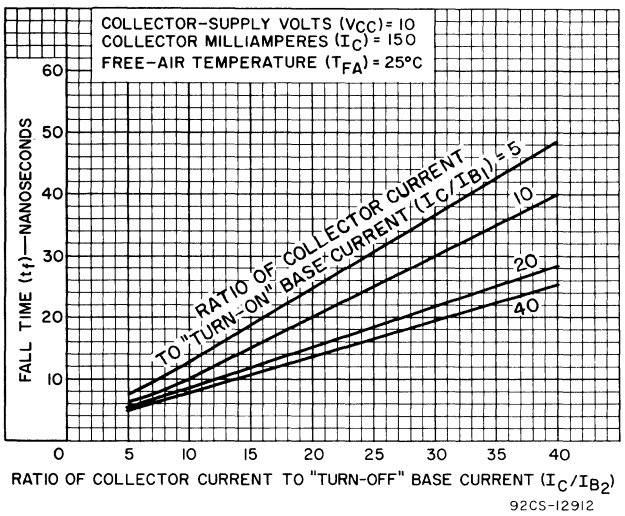


Fig. 10

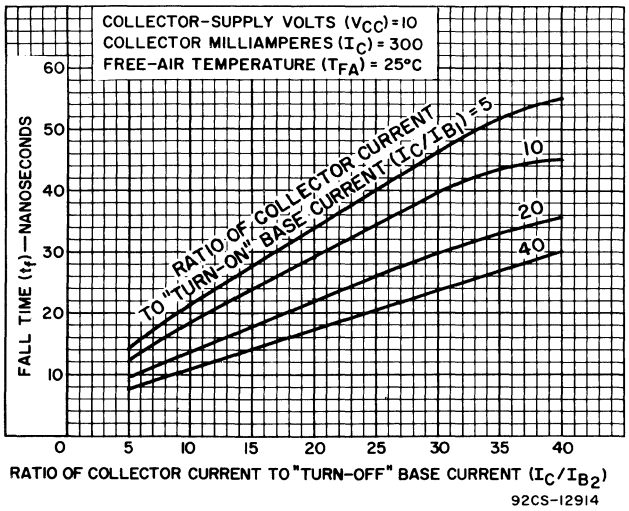


Fig. 11

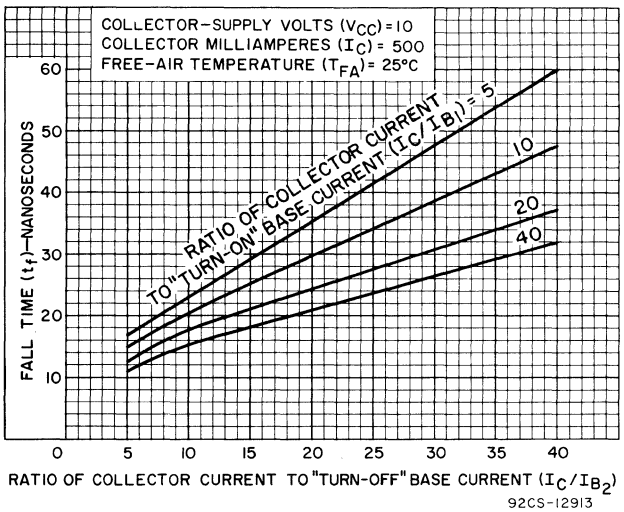


Fig. 12

TYPICAL STORAGE TIME (t_s) CHARACTERISTICS

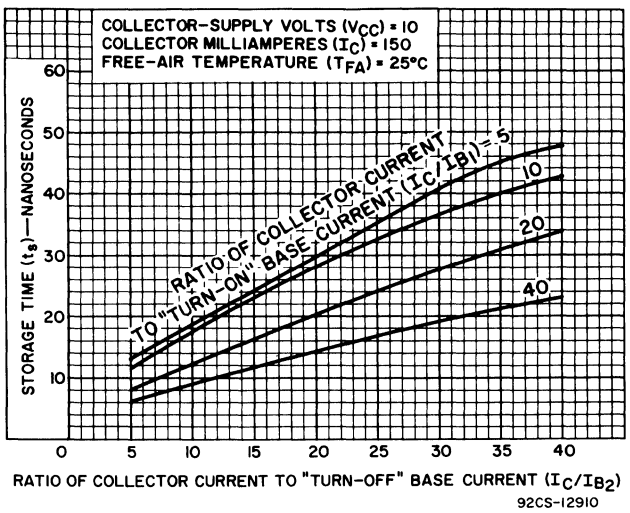


Fig. 13

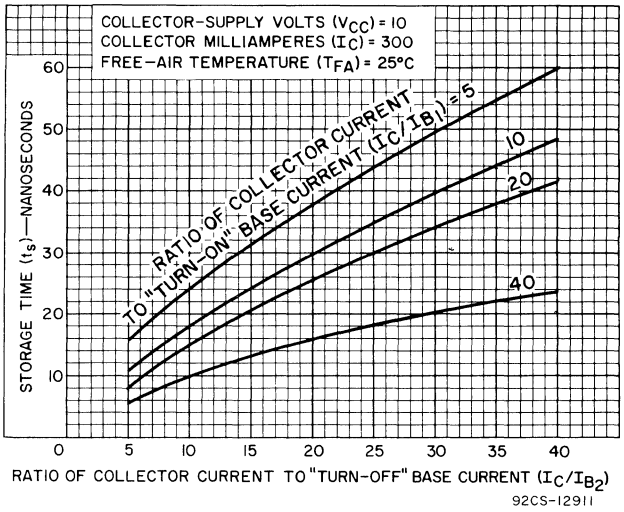


Fig. 14

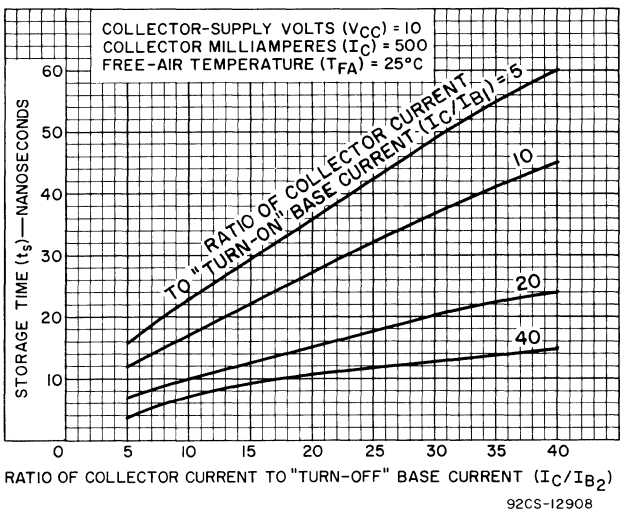


Fig. 15

TYPICAL RISE TIME (t_r) CHARACTERISTICS

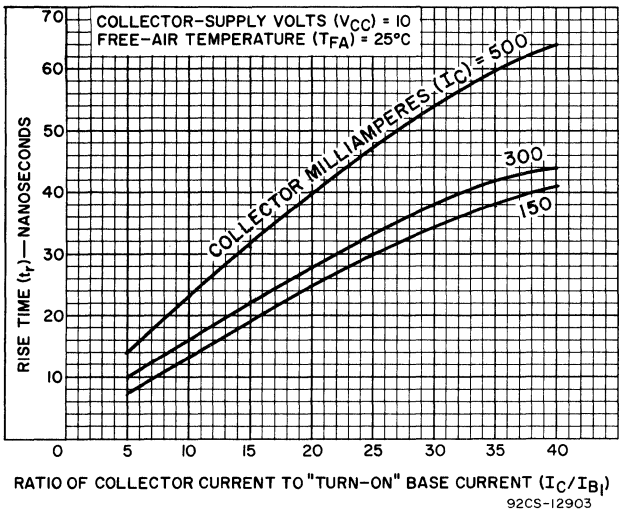


Fig. 16

TYPICAL "TURN-ON" TIME (t_{on}) CHARACTERISTICS

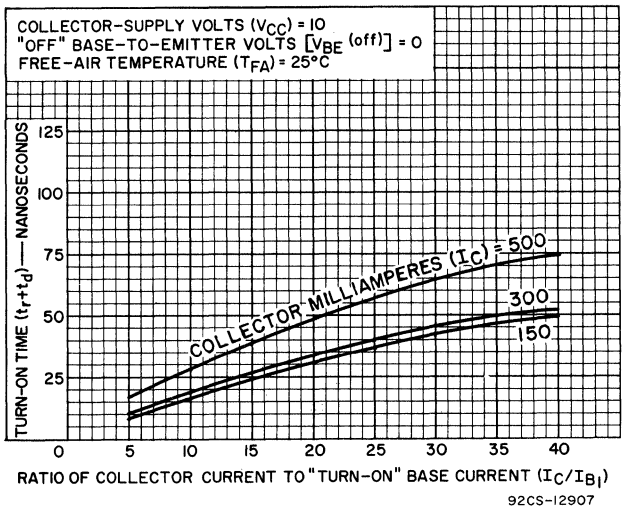
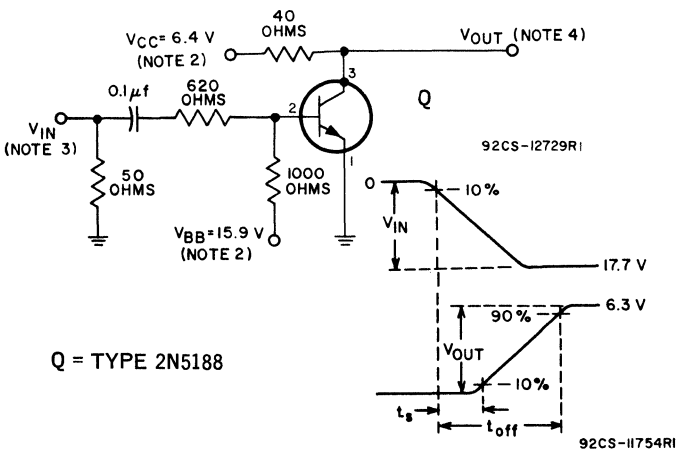
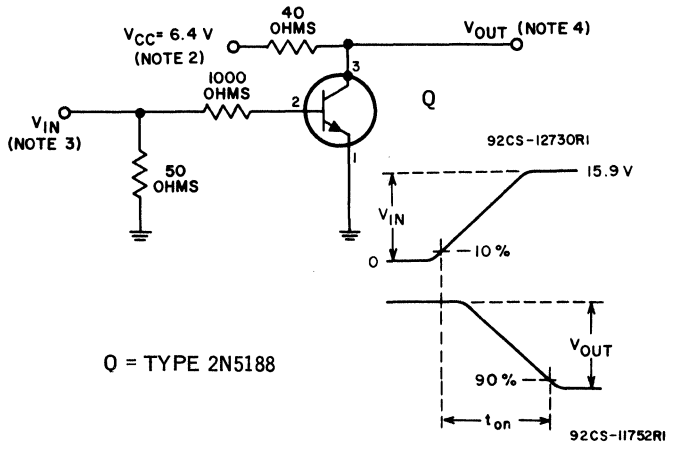


Fig. 17

CIRCUIT USED TO MEASURE TURN-OFF TIME (t_{off}) AND STORAGE TIME (t_s)



CIRCUIT USED TO MEASURE TUNE-ON TIME (t_{on})



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 2 NSEC; PULSE DURATION > 150 NSEC; AND DUTY FACTOR < 2%.

NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE < 2.5pf WITH SHUNT RESISTANCE OF 1 MEGOHM.

Fig. 18

NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25-μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB}.

NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 2 NSEC; PULSE DURATION > 150 NSEC; AND DUTY FACTOR < 2%.

NOTE 4: INPUT AND OUTPUT WAVE FORMS MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE < 2.5pf WITH SHUNT RESISTANCE OF 1 MEGOHM.

Fig. 19

RCA SWITCHING TRANSISTOR

High-Voltage General-Purpose Type

2N5189

File No. 296

RCA-2N5189* is a double-diffused epitaxial planar transistor of the silicon n-p-n type featuring high breakdown voltages, low saturation voltages, and high switching speeds over a wide range of collector current.

It is especially useful in switching applications of high-performance computers and in other critical industrial applications where high-voltage and high-current handling capabilities and short "turn-off" and "turn-on" times are important design features. These features also make the 2N5189 particularly useful in class C circuits for mobile and portable equipment.

The 2N5189 is hermetically sealed in a metal package like the JEDEC TO-39 but with a reduced height (0.195" max, 0.175" min) and 0.5" min. leads.

* Formerly Dev. No. TA7322.

SILICON N-P-N HIGH-VOLTAGE TRANSISTOR



For Core-Driver and Line-Driver Service in Data-Processing Equipment and Other Critical Applications in Military and Industrial Equipment

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	60 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	35 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5 max.	V
COLLECTOR CURRENT, I_C	Limited by dissipation	
TRANSISTOR DISSIPATION, P_T:		
For case temperatures[a] { up to 25°C	5 max.	W
{ above 25°C	Derate at 28.5mW/°C	
For ambient temperatures { up to 25°C	1 max.	W
{ above 25°C	Derate at 5.7mW/°C	
TEMPERATURE RANGE:		
Storage and Operating (Junction)	−65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32" from seating surface for 10 seconds max.	265 max.	°C

[a] Measured at center of seating surface.

Features

- **excellent power handling capability —**
  P_T = 5W max. at T_C = 25°C
  1W max. at T_A = 25°C
- **high switching speeds at high currents —**
  t_{on} = 40ns max. at I_C = 1A
  t_{off} = 70ns max. at I_C = 1A
- **high breakdown-voltage capabilities —**
  $V_{(BR)CBO}$ = 60V min.
  $V_{(BR)CEO}$ = 35V min.
- **high reliability —**
  production lots of RCA-2N5189 are subjected to and meet the minimum mechanical, environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See Page 5 for a description of the Group A and Group B Tests.

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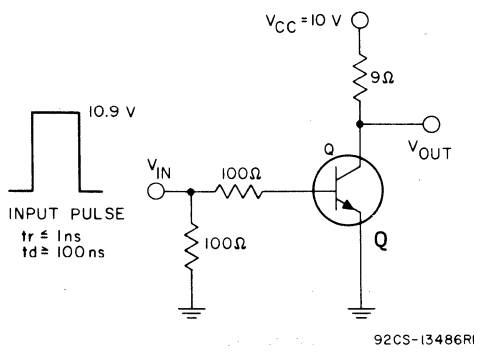
Printed in U.S.A.
2N5189 8-67

ELECTRICAL CHARACTERISTICS, at $T_A = 25°C$

Characteristics	Symbols	TEST CONDITIONS							LIMITS		Units
		T_A	f	V_{CB}	V_{CE}	I_C	I_E	I_B	Type 2N5189		
		°C	MHz	Volts			mA		Min.	Max.	
Collector-Cutoff Current	I_{CBO}	25			30				-	0.5	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	25				0.1			60	-	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$	25				10			35	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	25					-0.1		-	5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25				1000		100	-	1	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25				1000		100	-	1.5	V
Static Forward Current-Transfer Ratio	h_{FE}	25 25 25			1 1 1	100 500 1000			- - -	30 35 15*	
Small-Signal Forward-Current Transfer Ratio	h_{fe}		100		10	50			2.5	-	
Common-Base, Open-Circuit Output Capacitance	C_{ob}		0.1	10			0		-	12	pF
Turn-On Time (Delay Time + Rise Time)	$t_{on} = (t_d + t_r)$					I_C 1000	I_{B1} 100	I_{B2} -	-	40	ns
Turn-Off Time (Storage Time + Fall Time)	$t_{off} = (t_s + t_f)$					1000	100	-100	-	70	ns

*Pulsed condition—Pulse duration ≤ 400 μs, duty factor ≤ 0.03.

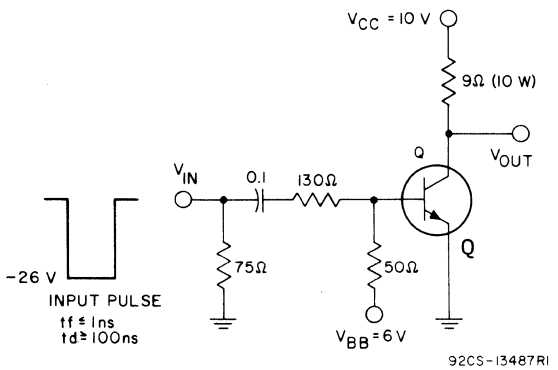
CIRCUIT USED TO MEASURE TURN-ON TIME (t_{on})



Q = Type 2N5189

Fig. 1

CIRCUIT USED TO MEASURE TURN-OFF TIME (t_{off})



Q = Type 2N5189

Fig. 2

TYPICAL CHARACTERISTICS

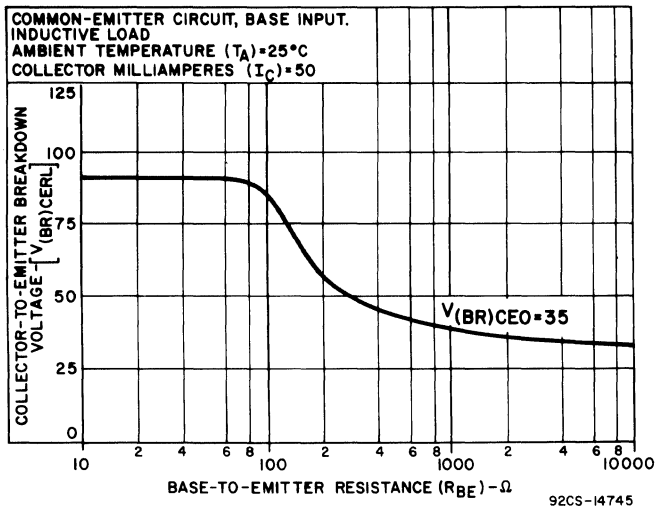


Fig. 9 – Collector-Cutoff Current vs Ambient Temperature

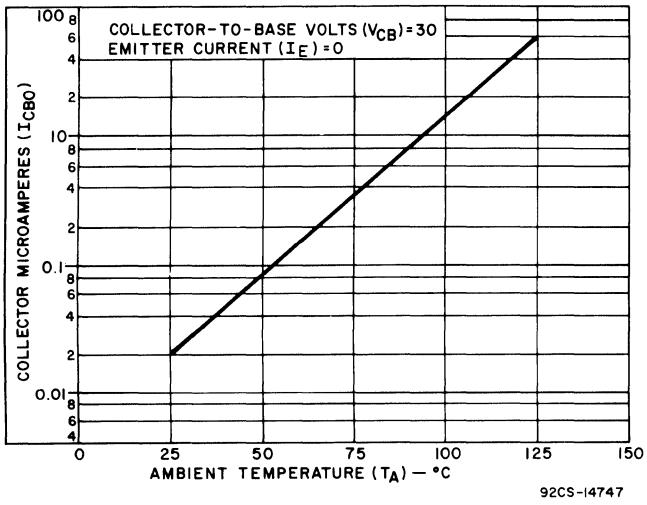


Fig. 10 – Collector-to-Emitter Breakdown Voltage vs Base-to-Emitter Resistance

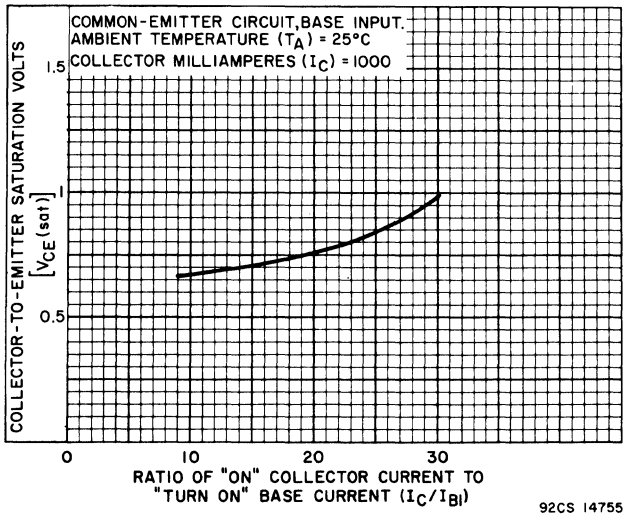


Fig. 11 – Collector-to-Emitter Saturation Voltage vs I_C/I_{B1}

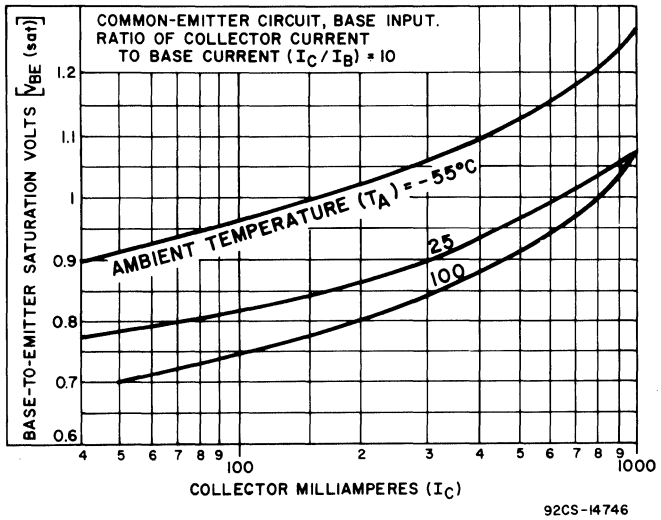


Fig. 12 – Base-to-Emitter Saturation Voltage vs I_C

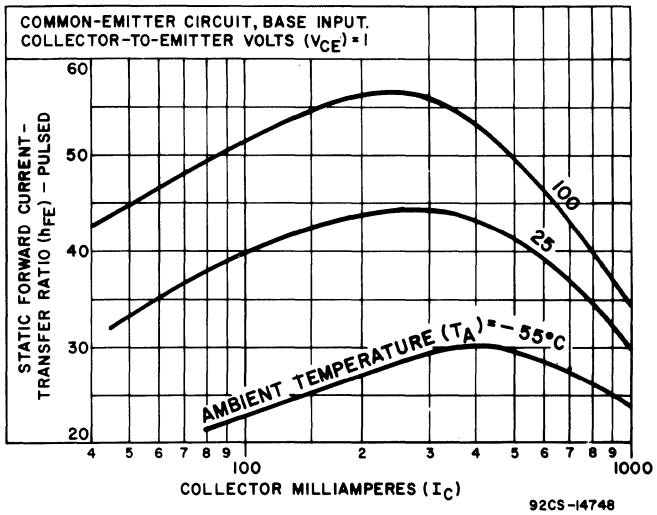


Fig. 13 – Static Forward Current-Transfer Ratio (Pulsed) vs I_C

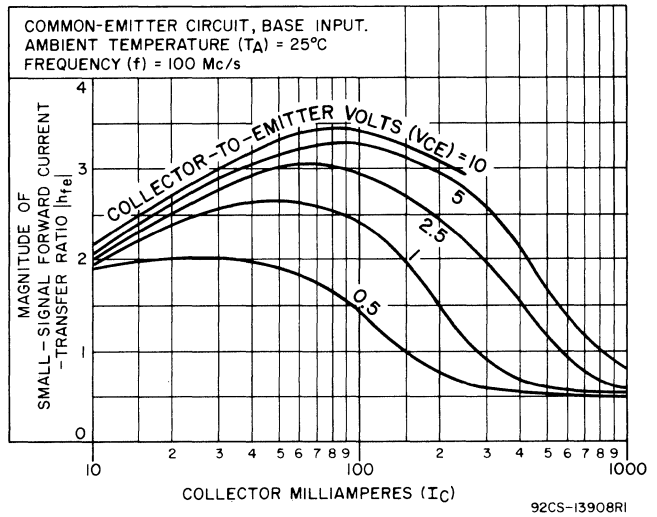
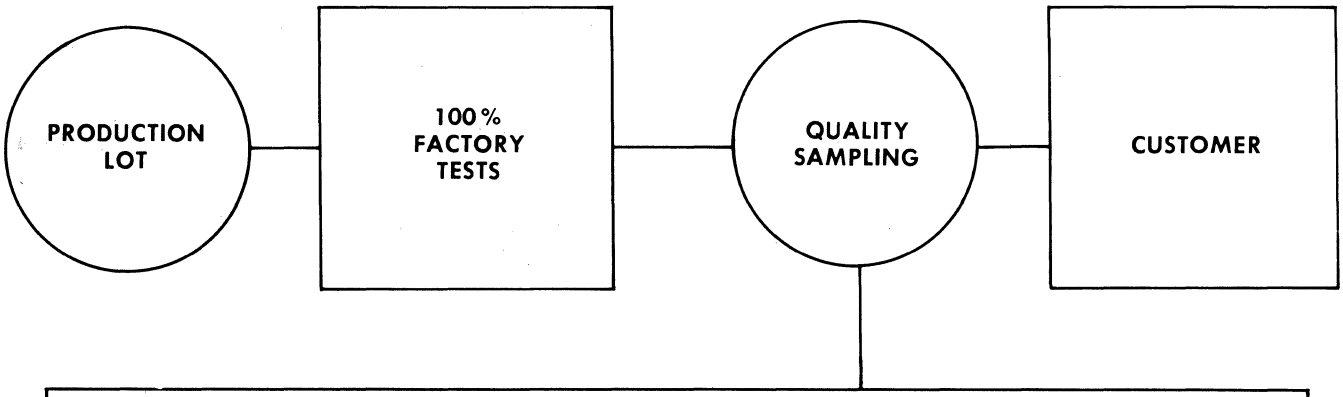


Fig. 14 – Small-Signal Forward Current-Transfer Ratio vs I_C

GROUP A AND GROUP B QUALITY SAMPLING TESTS



ITEM	TEST DESCRIPTION	LTPD
GROUP A TESTS		
Subgroup 1.	Visual and Mechanical Examination	10%
Subgroup 2.	Electrical	5%
GROUP B TESTS		
Subgroup 1.	Physical Dimensions	20%
Subgroup 2.	Solderability, Temperature Cycling, Thermal Shock, Moisture Resistance	20%
Subgroup 3.	Shock, Vibration Fatigue, Vibration Variable Frequency, Constant Acceleration	20%
Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 300mW, T_A = 25°C)	λ = 10%

TYPICAL CHARACTERISTICS

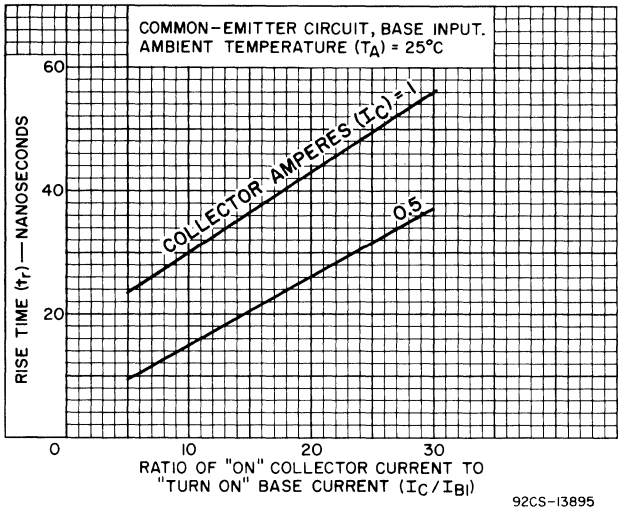


Fig. 3 – Rise Time vs I_C/I_{B1}

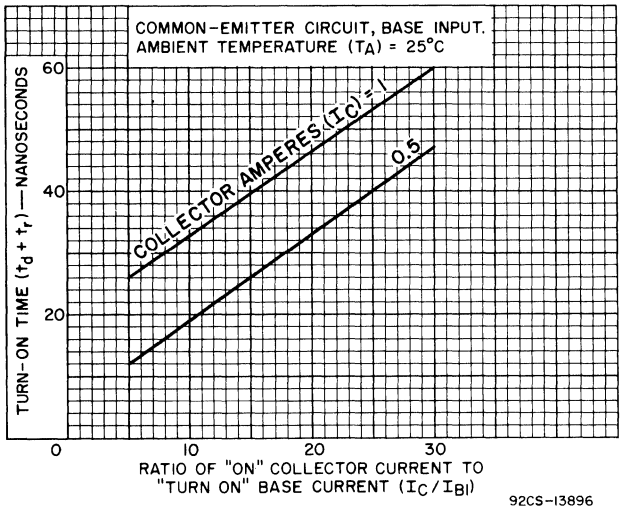


Fig. 4 – Turn-On Time vs I_C/I_{B1}

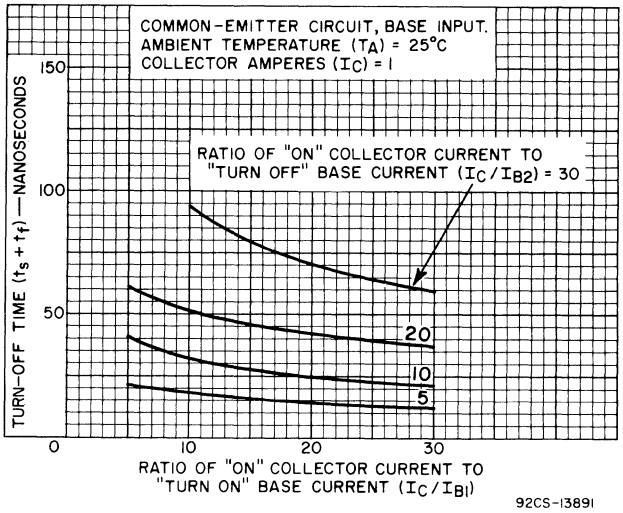


Fig. 5 – Turn-Off Time vs I_C/I_{B1}

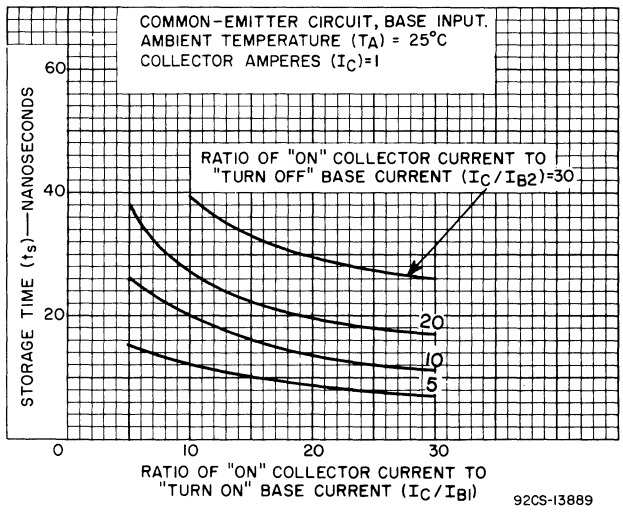


Fig. 6 – Storage Time vs I_C/I_{B1}

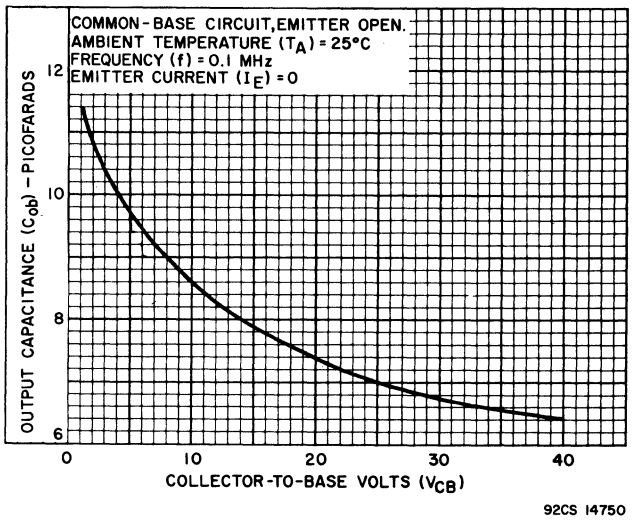


Fig. 7 – Output Capacitance vs Collector-to-Base Voltage

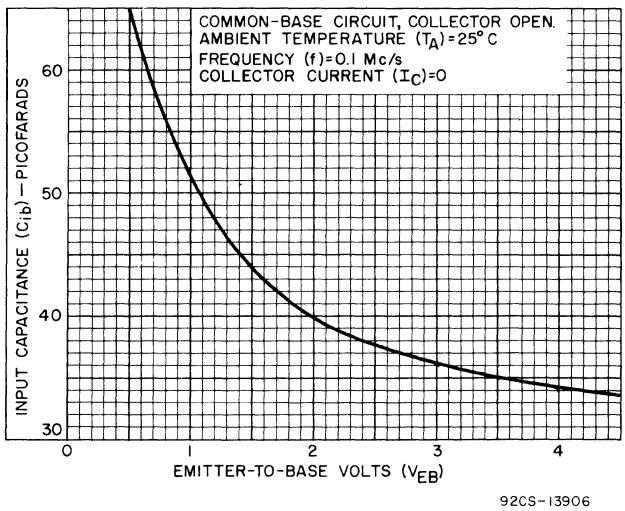
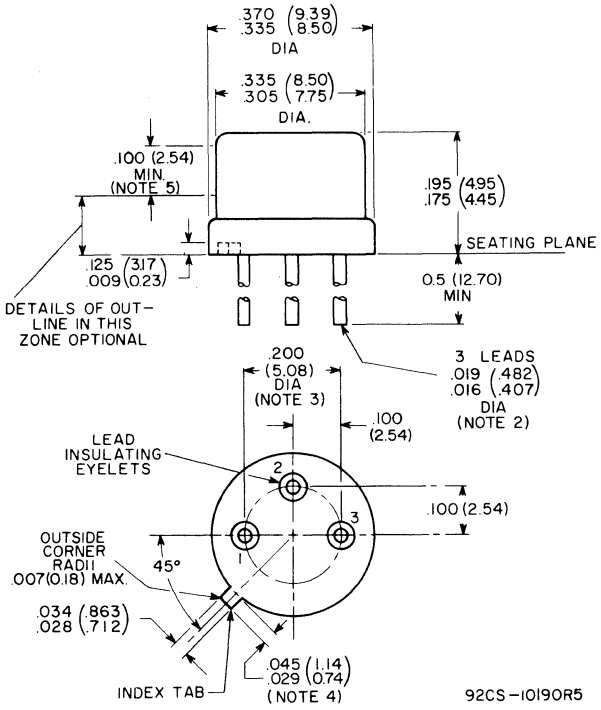


Fig. 8 – Input Capacitance vs Emitter-to-Base Voltage

DIMENSIONAL OUTLINE



Dimensions in Inches and Millimeters

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

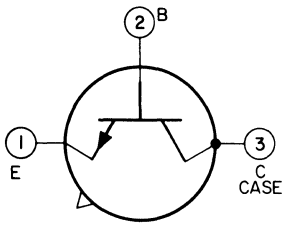
Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) - 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

Note 5: This zone is controlled for automatic handling. The variation in actual diameter within the zone shall not exceed 0.010" (0.25 mm).

TERMINAL DIAGRAM

Bottom View



LEAD 1 — EMITTER

LEAD 2 — BASE

LEAD 3 — COLLECTOR, CASE

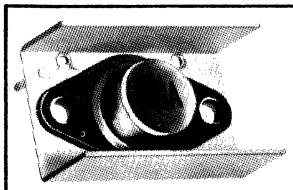
SILICON N-P-N TRANSISTORS

Amplifier and Switching Types for Industrial and Commercial Applications

RCA-2N3878, 2N3879, 2N5202* are epitaxial silicon n-p-n transistors. The 2N3878 is an amplifier type intended for audio-, ultrasonic-, and radio-frequency circuits. Types 2N3879 and 2N5202 are switching transistors intended for use in high-current, high-speed switching circuits.

Typical applications for these transistors include: low-distortion power amplifiers, oscillators, switching regulators, series regulators, converters, and inverters.

Formerly RCA Dev. Type Nos.TA2509, TA2509A, and TA7285, respectively.

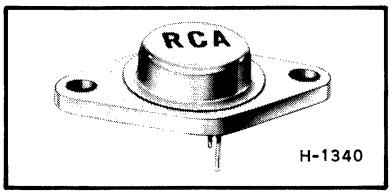


H-1470A

40375

ALSO AVAILABLE . . .

Type 40375 is a 2N3878 with a factory-attached heat radiator; it is intended for printed circuit-board applications.



2N3878, 2N3879, & 2N5202
(JEDEC TO-66)

- Maximum operating-area curves for DC and pulse operation. . $I_{S/b}$-limit line begins at: 36 V (2N3878) 28 V (2N3879) 23 V (2N5202)
- $V_{CER}(sus)$ = 90 V (2N3879) 75 V (2N5202) 65 V (2N3878)
- V_{CBO} = 120 V Max. (2N3878, 2N3879, 2N5202)
- Rated for safe operation in both forward- and reverse-bias conditions.
- Total saturated switching time typically less than 1 μs at 4 A for 2N3879 and 2N5202.

MAXIMUM RATINGS

Absolute-Maximum Values:		2N3878 40375	2N3879	2N5202	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	120	120	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$	65	90	75	V
With base open	$V_{CEO}(sus)$	50	75	–	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	7	7	4	A
PEAK COLLECTOR CURRENT		10	10	5	A
CONTINUOUS BASE CURRENT	I_B	5	5	2	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25° C and V_{CE} up to 36 V		35 (2N3878)	–	–	W
28 V		–	35	–	W
23 V		–	–	35	W
At case temperatures up to 25° C and V_{CE} above 36 V		See *Fig.5*	–	–	
28 V		–	See *Fig.6*	–	
23 V		–	–	See *Fig.6*	
At case temperatures above 25° C and V_{CE} above 36 V		See *Figs.4 & 5*	–	–	
28 V		–	See *Figs.4 & 6*	–	
23 V		–	–	See *Figs.4 & 6*	
At free-air temperatures up to 25° C		5.8 (40375)	–	–	W
At free-air temperatures above 25° C		See *Fig.7*	–	–	
TEMPERATURE RANGE:					
Storage & Operating (Junction)		← –65 to 200 →			°C
PIN TEMPERATURE (During soldering):					
At distances ≥ 1/32 in. from seating plane for 10 s max.		← 255 →			°C

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Supersedes File No.110 6/66

ELECTRICAL CHARACTERISTICS *Case Temperature (T_C) = 25° Unless Otherwise Specified*

Characteristic	Symbol	TEST CONDITIONS							LIMITS						Units
		DC Collector Volts		DC Emitter or Base Volts		DC Current (Amperes)			Types 2N3878 40375		Type 2N3879		Type 2N5202		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		40					0	–	5	–	5	–	–	mA
	I_{CEV}		100		−1.5				–	4	–	4	–	10	mA
	I_{CEV} (T_C = 150° C)		100		−1.5				–	4	–	4	–	10	mA
Emitter-Cutoff Current	I_{EBO}			4 6		0 0			– –	4 –	– –	2 –	– –	– 10	mA
DC Forward-Current Transfer Ratio	h_{FE}		1.2 2 5 5			4 4 0.5 4			– 8 50 20	– – 200 –	– 12 40 20	– – – 80	10 – – –	100 – – –	
Collector-to-Emitter Sustaining Voltage: *(See Fig. 1 & 2)* With base open	$V_{CEO(sus)}$					0.2		0	50[a]	–	75[a]	–	–	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER(sus)}$					0.2			65[a]	–	90[a]	–	75[a]	–	V
Base-to-Emitter Voltage	V_{BE}		1.2 2			4 4			– –	– 2.5	– –	– 1.8	– –	1.9 –	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					4 4		0.4 0.5	– –	– 2.0	– –	1.2 –	– –	1.2 –	V
Output Capacitance (At 1 MHz)	C_{ob}	10					0		–	175	–	175	–	175	pF
Second-Breakdown[b] Collector Current[d] (With base forward biased)	$I_{S/b}$[c]		40						750	–	500	–	400	–	mA
Second-Breakdown[b] Energy: With base reverse biased, R_B = 50 Ω, L = 50 μH With base reverse biased, R_B = 50 Ω, L = 125 μH	$E_{S/b}$[e]				V_{BB} = −4 V_{BB} = −4				– 1	– –	– 1	– –	0.4 –	– –	mJ
Small-Signal, Forward-Current Transfer Ratio (At 10 MHz)	h_{fe}		10			0.5			6.0	–	6.0	–	6.0	–	
Sat. Switching Turn-On Time: Delay Time	t_d		V_{CC} =			4		0.4[f]	–	–	–	40	–	40	ns
Rise Time *(See Fig. 24, 25, & 26)*	t_r		30			4		0.4[f]	–	–	–	400	–	400	ns
Sat. Switching Storage Time *(See Fig. 24, 25, & 27)*	t_s		V_{CC} = 30			4		−0.4[g]	–	–	–	800	–	800	ns
Sat. Switching Fall Time *(See Fig. 24, 25, & 28)*	t_f		V_{CC} = 30			4		−0.4[g]	–	–	–	400	–	400	ns
Thermal Resistance (Junction-to-Case)	θ_{J-C}								5 Max. 2N3878	–	5	–	5		°C/W
(Junction-to-Free Air)	θ_{J-FA}								30 Max. 40375	–	—	—	—		°C/W

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES
V_{CEO}(sus) & V_{CER}(sus)
FOR TYPES 2N3878, 2N3879, & 2N5202

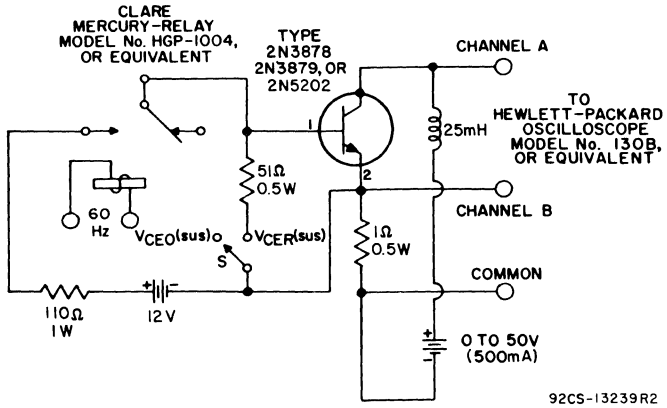
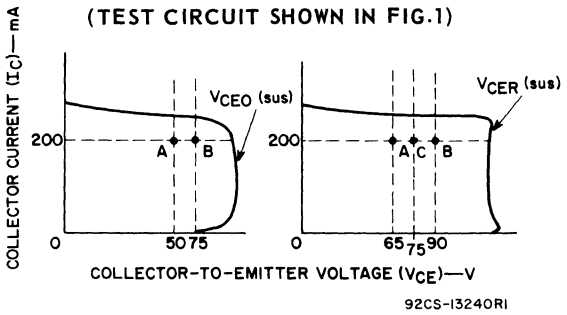


Fig. 1

OSCILLOSCOPE DISPLAY FOR MEASUREMENT
OF SUSTAINING VOLTAGES
(TEST CIRCUIT SHOWN IN FIG.1)



The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) are acceptable when the traces fall to the right and above point "A" for type 2N3878; and point "B" for type 2N3879. The sustaining voltage V_{CER}(sus) is acceptable when the trace falls to the right and above point "C" for type 2N5202.

Fig. 2

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE
FOR TYPES 2N3878 & 2N3879

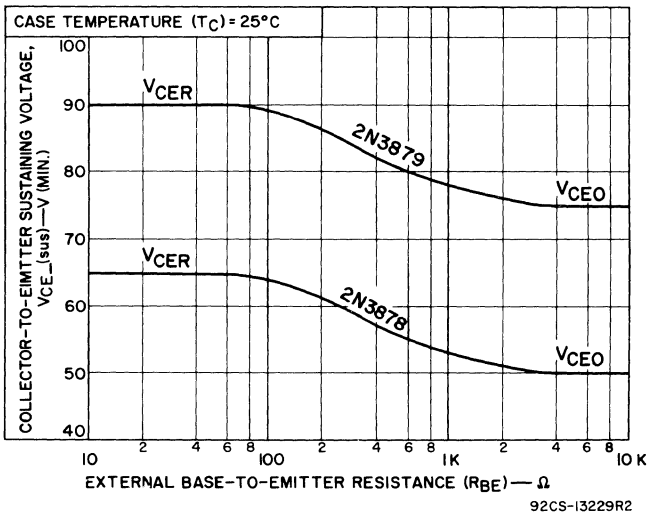


Fig. 3

DISSIPATION DERATING CURVE FOR
TYPES 2N3878, 2N3879, & 2N5202

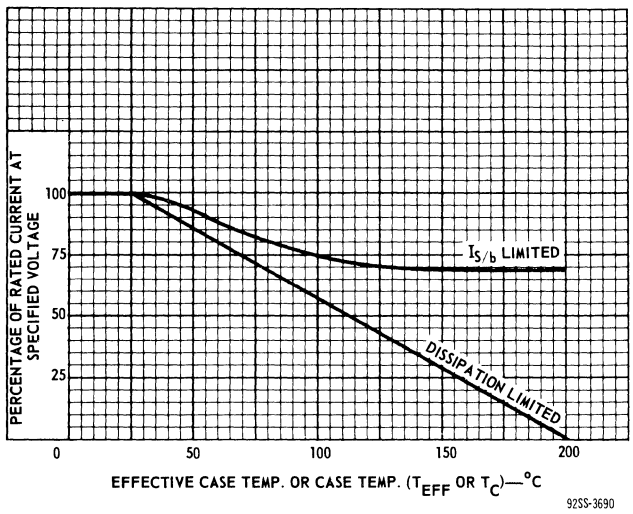


Fig. 4

FOOTNOTES (For Table of Electrical Characteristics)

[a] CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in *Fig.1*.

[b] Safe-operating region for forward- and reverse-bias operation is explained on pages 4 and 8.

[c] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[d] Pulsed; 1-s, non-repetitive pulse.

[e] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2LI^2$. where L is a series load or leakage inductance and I is the peak collector current.

[f] I_{B1} value (turn-on base current).

[g] I_{B2} value (turn-off base current).

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FORWARD-BIAS OPERATION

All transistors are power-dissipation limited and possibly second-breakdown limited. For a complete discussion of maximum operating area, refer to "RCA Silicon Power Circuits Manual" Form No. (SP-50) under sections: "MAXIMUM RATINGS" (page 68); "THERMAL CONSIDERATIONS" (page 70); "SECOND-BREAKDOWN" (page 84); and "SAFE-AREA RATINGS" (page 91).

With the emitter-base junction forward biased for transistor operation in the active region, the operating collector-to-emitter voltage, duration of the applied voltage and transistor temperature, will determine whether the device is second-breakdown limited.

For most transistors the maximum operating area is defined by four straight lines on a log-log plot of V_{CE} vs I_C. As shown in *Fig.5* and *6* a horizontal line defines the maximum current, a line with a slope of -1 defines the maximum power dissipation allowable; a line with a slope greater than -1 defines the forward-bias second breakdown limit; finally, a vertical line indicates the maximum voltage rating of the device.

As can be seen in *Fig.5* and *6* these transistors are free from second breakdown out to 36 V, 28 V, and 23 V for 2N3878, 2N3879, and 2N5202, respectively. Out to these points, the boundary is made up of the maximum current and maximum power curves. Then, the second breakdown effect becomes the controlling factor. This curve is made up of a line having a slope greater than -1.

Second breakdown is much less sensitive to temperature variations than normal power-dissipation limitations. Therefore, separate temperature derating curves are required for these two limiting factors as shown in *Fig.4*. For operation at temperatures greater than 25°C, *Fig.4* and *5* (2N3878) or *Fig.4* and *6* (2N3879, 2N5202) are used to obtain the maximum allowable power. This is done as follows:

(1) For a specified pulse width and collector-to-emitter voltage, V_{CE}, determine (from either *Fig. 5 or 6*) the maximum collector current at 25°C, using the curve marked "DISSIPATION LIMITED" (or its dashed-line extension).

(2) Refer to *Fig.4* and from the "DISSIPATION LIMITED" curve determine the percentage current derating at the specified temperature. Apply this derating to the value of I_C from step (1), to obtain the maximum current for dissipation-limited operation.

(3) If the specified value of V_{CE} required the use of a dashed-line extension of a dissipation-limited curve in step (1), then repeat step (1), using the curve marked "$I_{S/b}$ LIMITED".

(4) Repeat step (2) using the $I_{S/b}$-LIMITED curve in *Fig.4*.

(5) The maximum allowable current is the smaller of the two values obtained in steps (2) and (4).

For repetitive-pulse operation, the effective case temperature (T_{EFF}) to be used in *Fig.4* is the sum of the maximum ambient temperature, the rise in case temperature, and the rise in junction temperature resulting from the average transistor power dissipation.

The effective case temperature (T_{EFF}) may be calculated by using the following equations:

$$T_{EFF} = T_A + (P_{AVG})(\theta_{C\text{-}FA}) + (P_{AVG})(\theta_{J\text{-}C})$$

$$T_{EFF} = T_C + (P_{AVG})(\theta_{J\text{-}C})$$

Where:

P_{AVG} = Average power, W, of applied repetitive pulses

T_A = Ambient temperature, °C

T_C = Case temperature, °C

$\theta_{C\text{-}FA}$ = Thermal resistance, °C/W, case (heat-sink) to free-air

$\theta_{J\text{-}C}$ = Thermal resistance, °C/W, junction-to-case

MAXIMUM OPERATING AREAS FOR TYPE 2N3878

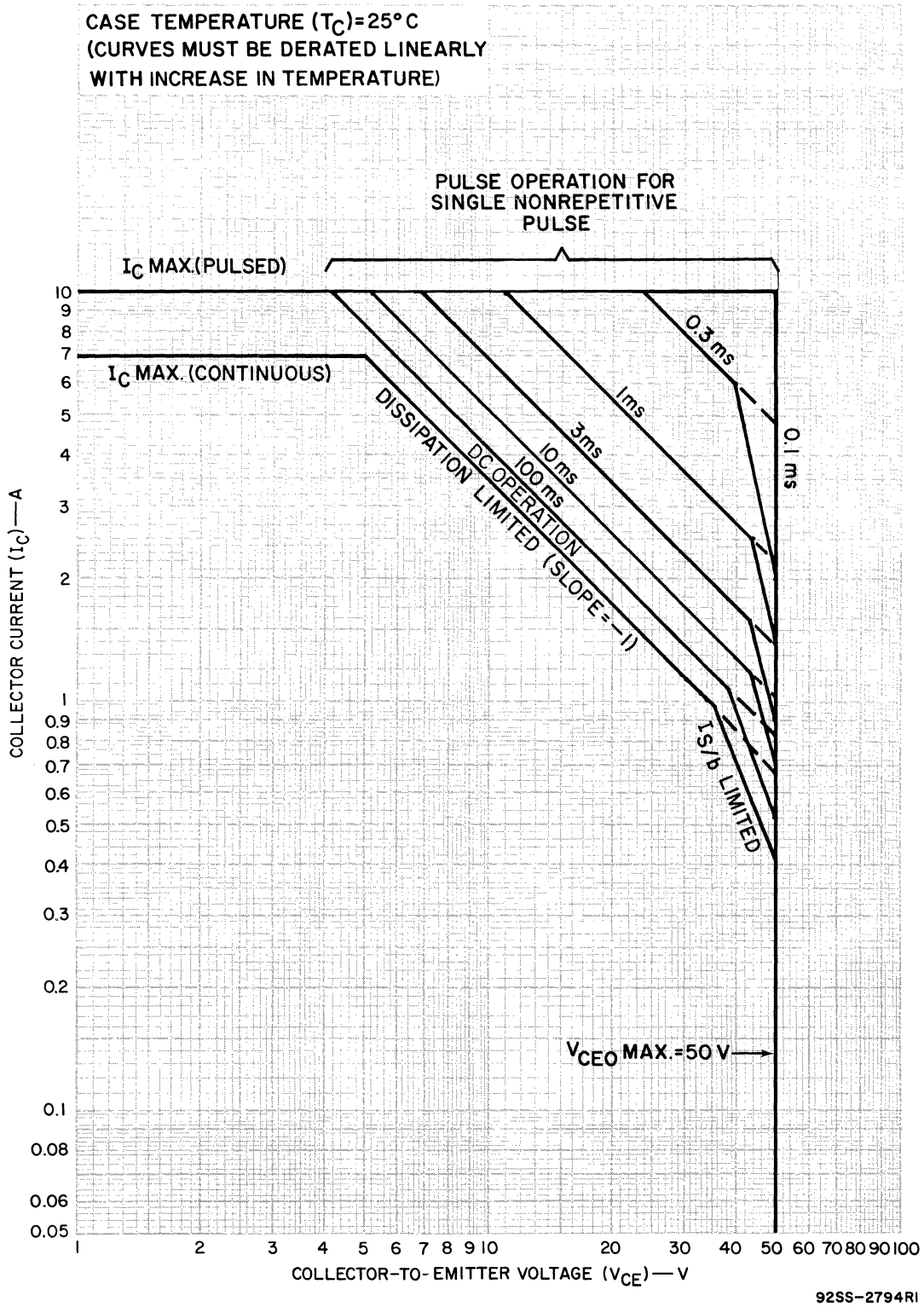


Fig. 5

MAXIMUM OPERATING AREAS FOR TYPES 2N3879 & 2N5202

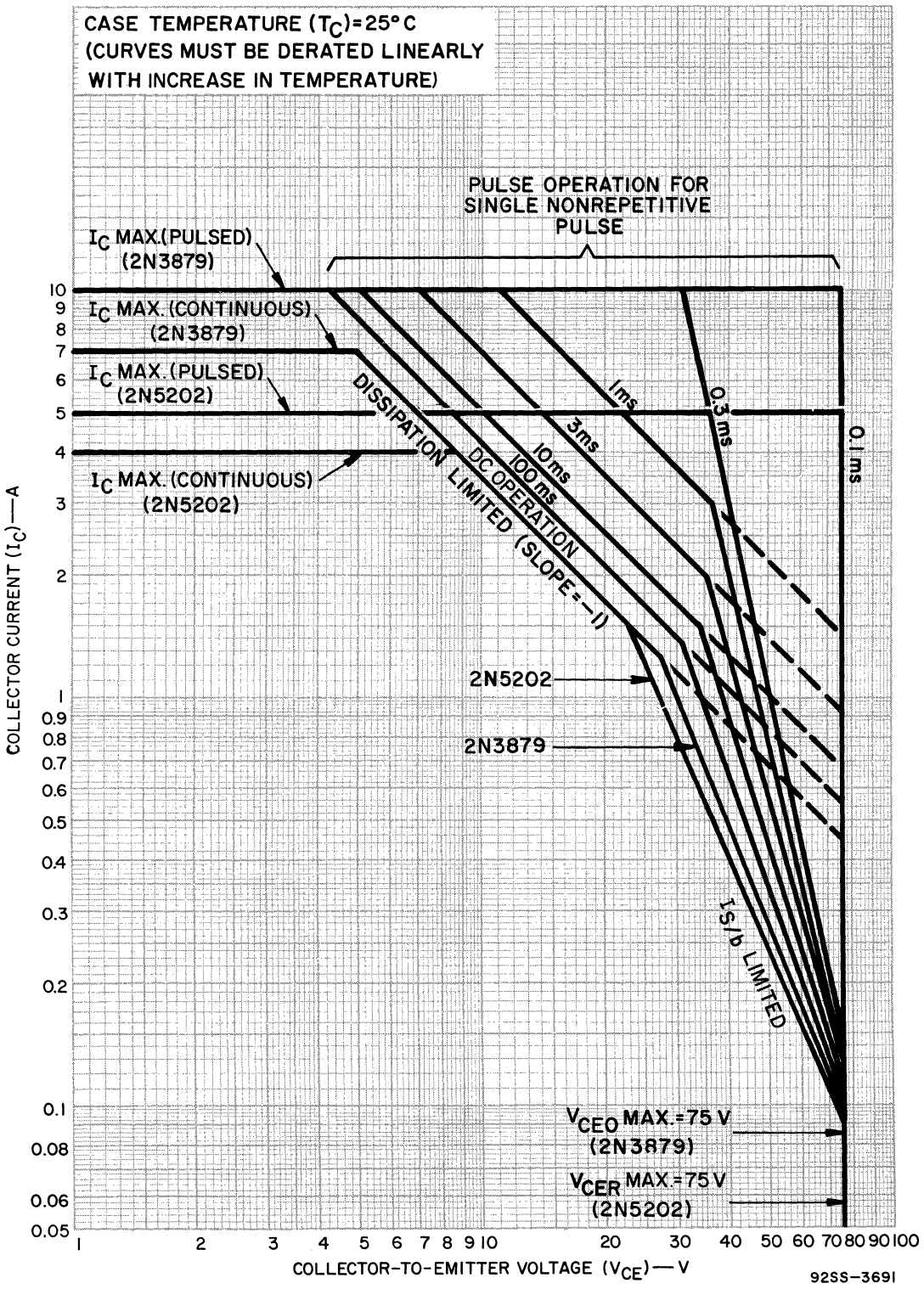


Fig. 6

MAXIMUM OPERATING AREAS FOR TYPE 40375

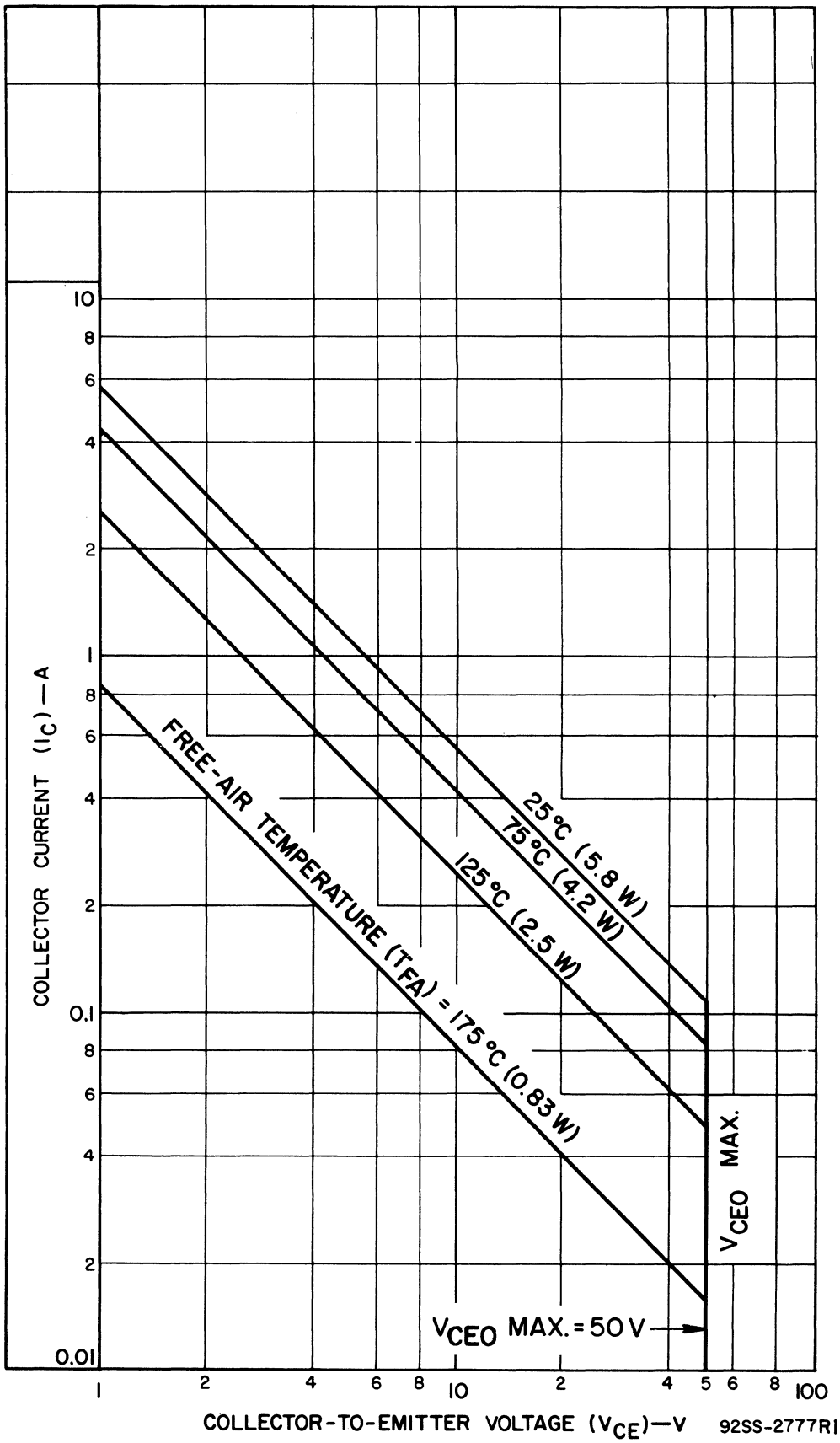


Fig. 7

REVERSE-BIAS OPERATION

The energy required to induce second breakdown when the transistor is turned off depends on the current during the "on" condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. The curves shown in *Fig. 8, 9, 10* (2N3878, 2N3879) or *Fig. 11, 12, 13* (2N5202) should prove useful in the design of circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-amplifier and -deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. Also, these curves can be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers.)

In general, reverse-bias, second breakdown energy ($E_{S/b}$) capability increases with a decrease in inductance. Therefore, the allowable energy shown in the above-mentioned curves (calculated from $E_{S/b} = 1/2LI^2$, where L is a series load or leakage inductance and I is the peak collector current from the curves) will be conservative for smaller inductive loads. For further information on second breakdown, consult RCA "Silicon Power Circuits Manual" Form No. (SP-50) and SMA-30, "Second Breakdown in Transistors Under Conditions of Cut-off."

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPES 2N3878 & 2N3879

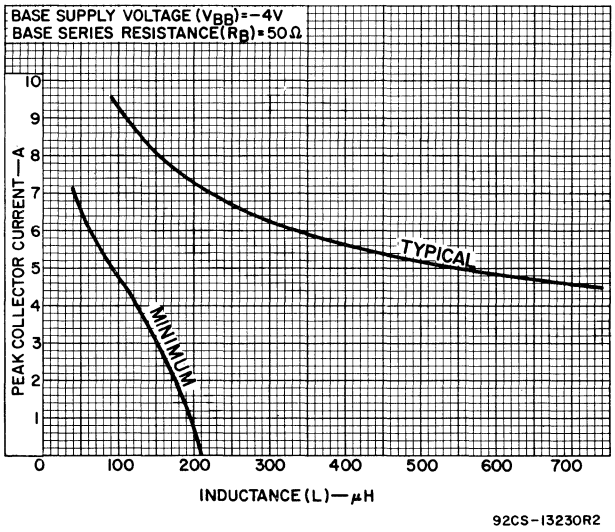


Fig. 8

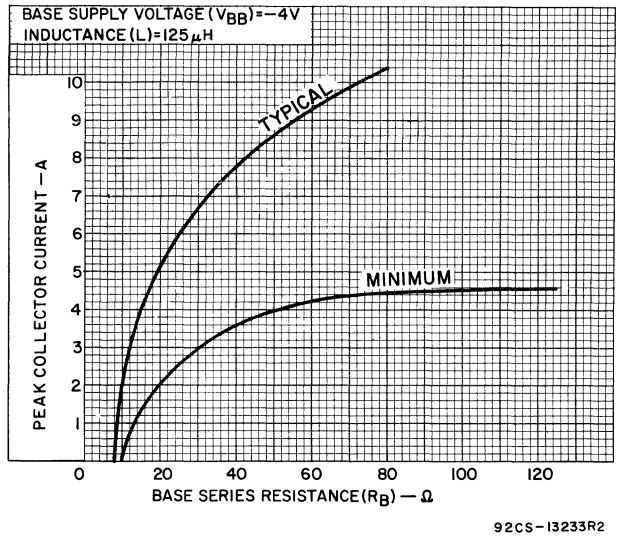


Fig. 9

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPES 2N3878 & 2N3879

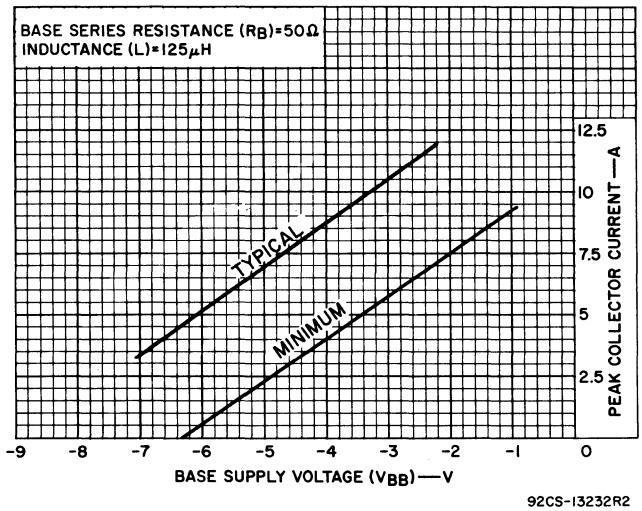


Fig. 10

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS
FOR TYPE 2N5202

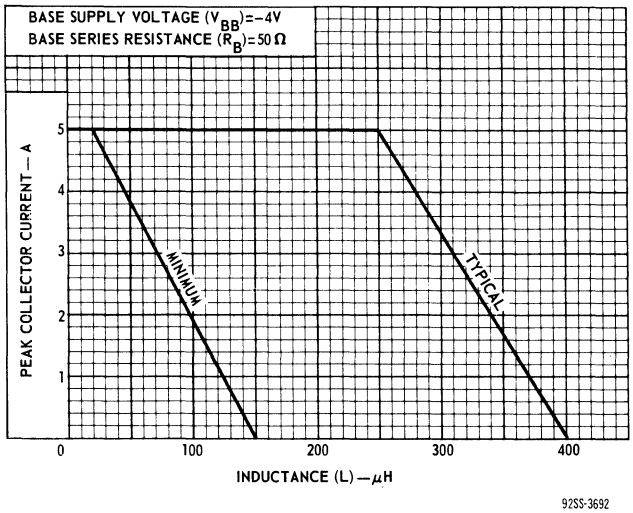


Fig. 11

REVERSE-BIAS, SECOND-BREAKDOWN CHARACTERISTICS FOR TYPE 2N5202

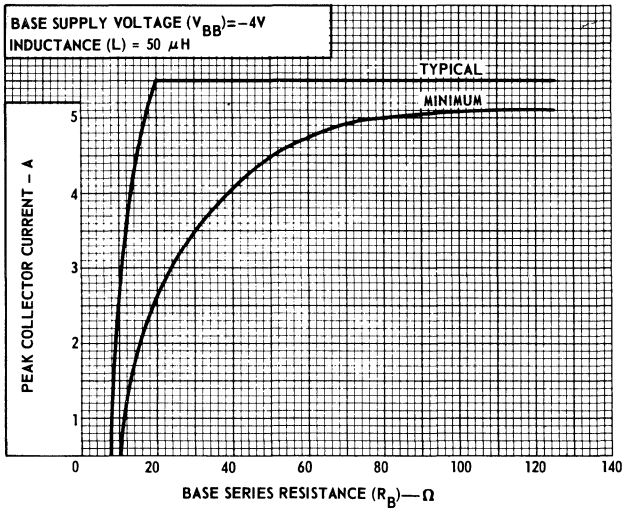


Fig. 12

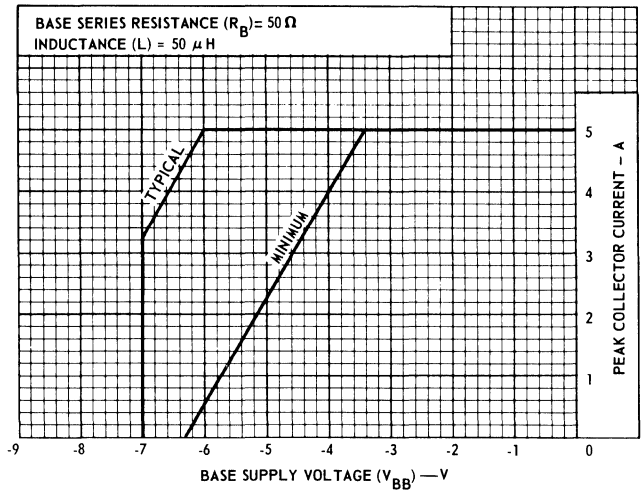


Fig. 13

TYPICAL DC BETA FOR TYPES 2N3878 & 2N3879

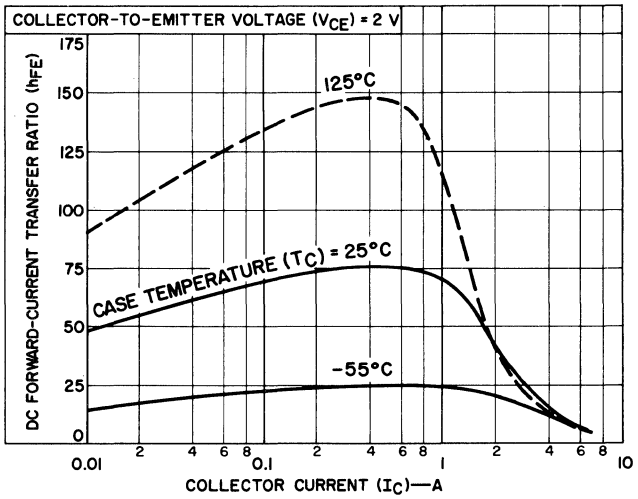


Fig. 14

TYPICAL DC BETA FOR TYPES 2N3878 & 2N3879

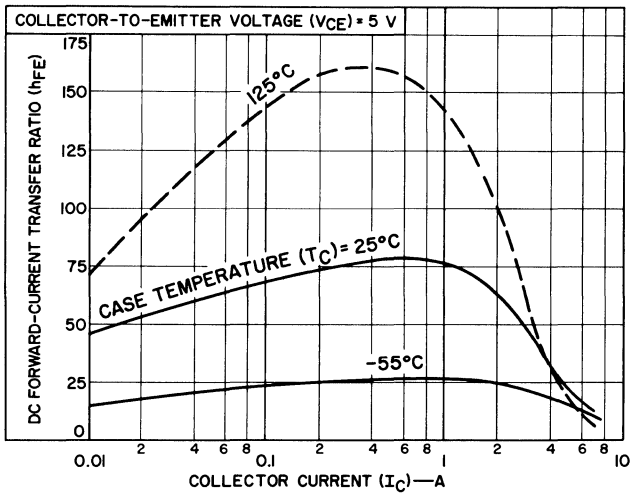


Fig. 15

TYPICAL DC BETA FOR TYPE 2N5202

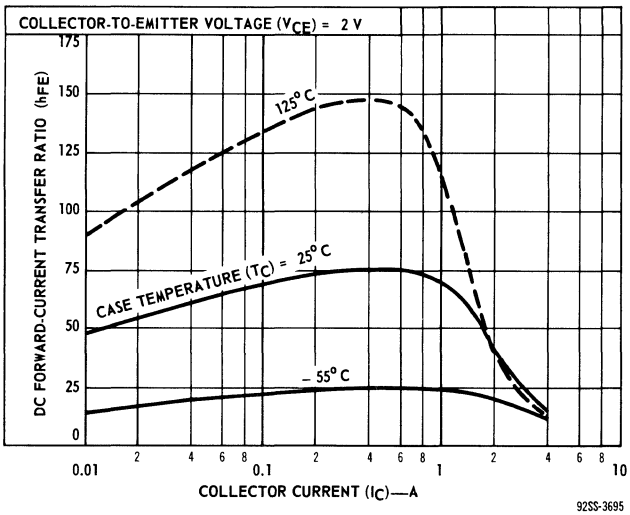


Fig. 16

TYPICAL DC BETA FOR TYPE 2N5202

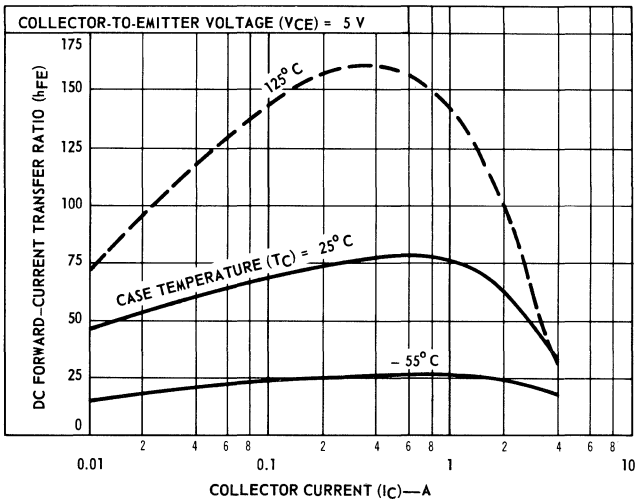


Fig. 17

TYPICAL INPUT CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 2N5202

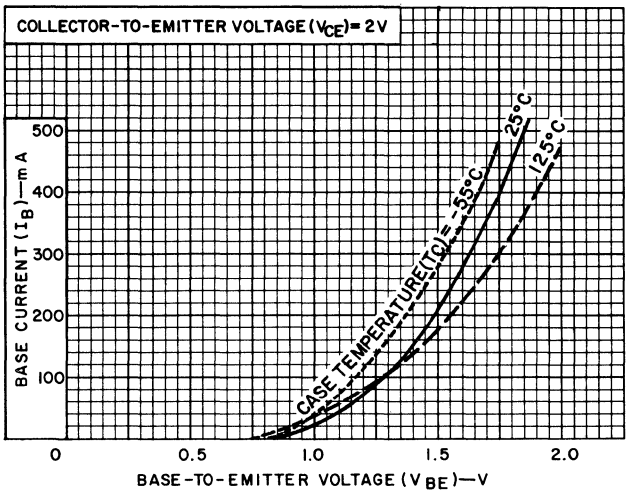


Fig. 18

TYPICAL OUTPUT CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 2N5202

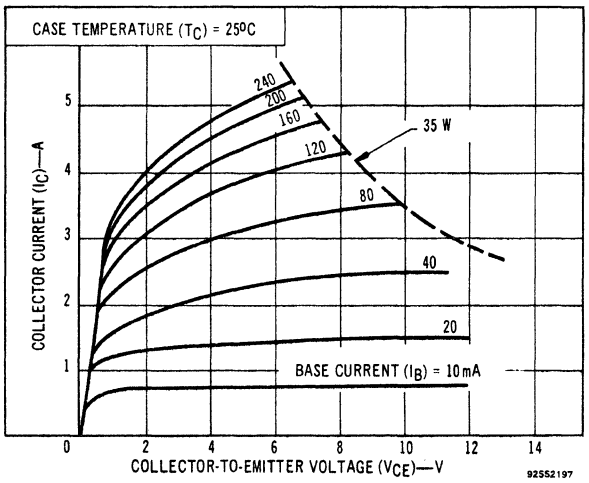


Fig. 19

TYPICAL TRANSFER CHARACTERISTICS FOR TYPES 2N3878, 2N3879, & 2N5202

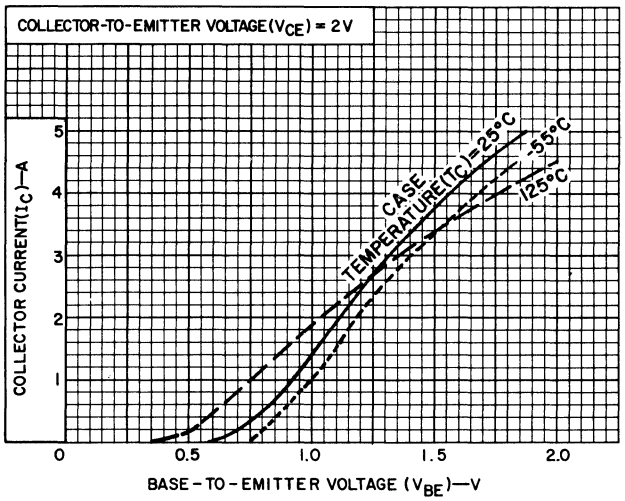


Fig. 20

TYPICAL GAIN-BANDWIDTH PRODUCT FOR TYPES 2N3878, 2N3879, & 2N5202

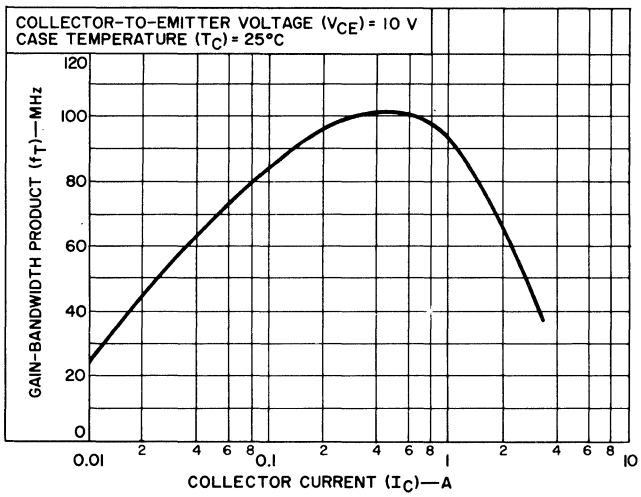


Fig. 21

TYPICAL SATURATION VOLTAGE CHARACTERISTICS FOR TYPES 2N3878 & 2N3879

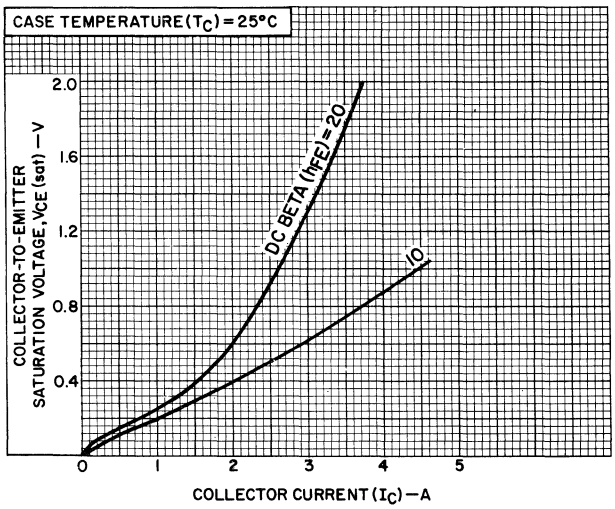


Fig. 22

TYPICAL SATURATION VOLTAGE CHARACTERISTICS FOR TYPE 2N5202

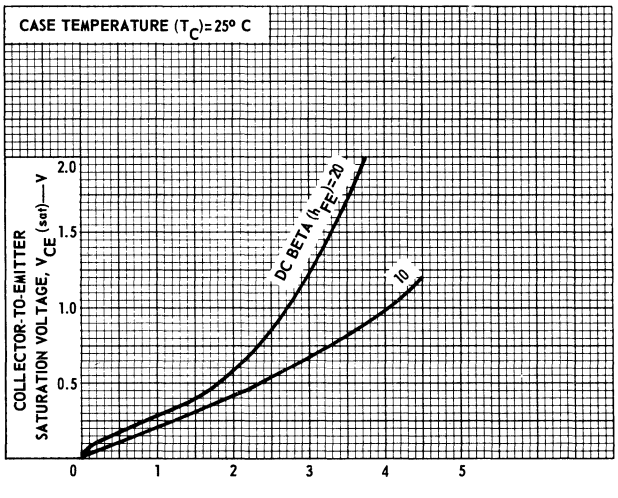
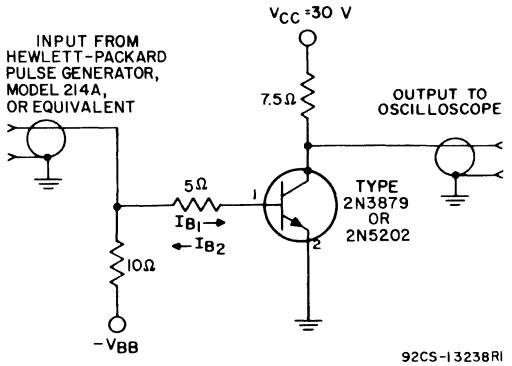


Fig. 23

CIRCUIT USED TO MEASURE SWITCHING TIMES FOR TYPES 2N3879 & 2N5202



INPUT PULSE:

Pulse rep. rate = 1,000 pulses/s
Pulse width = 20 μs

Fig. 24

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES (TEST CIRCUIT SHOWN IN FIG.24)

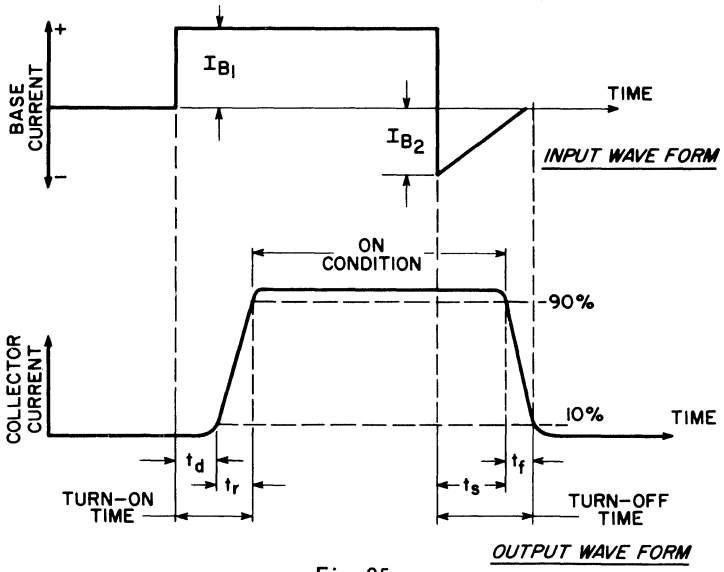


Fig. 25

92CS-12874

TYPICAL TURN-ON TIME FOR TYPES 2N3879 & 2N5202

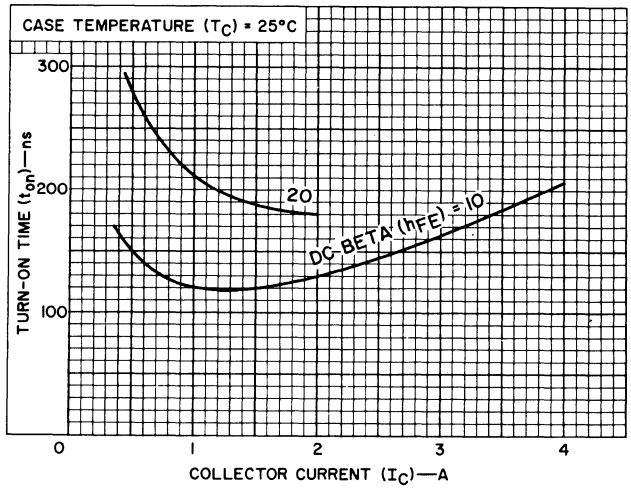


Fig. 26

TYPICAL STORAGE-TIME FOR TYPES 2N3879 & 2N5202

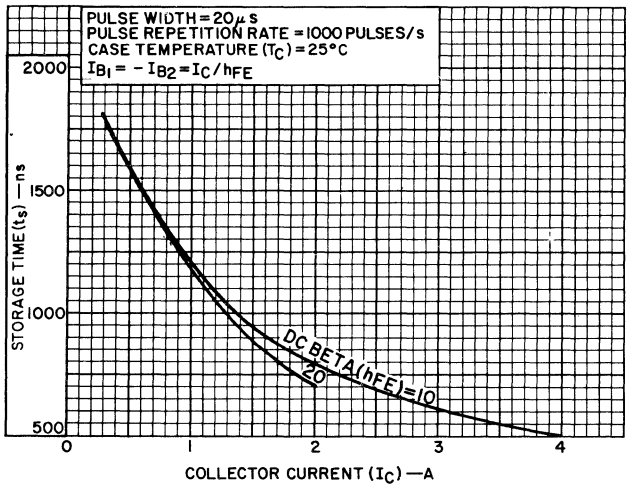


Fig. 27

TYPICAL FALL-TIME FOR TYPES 2N3879 & 2N5202

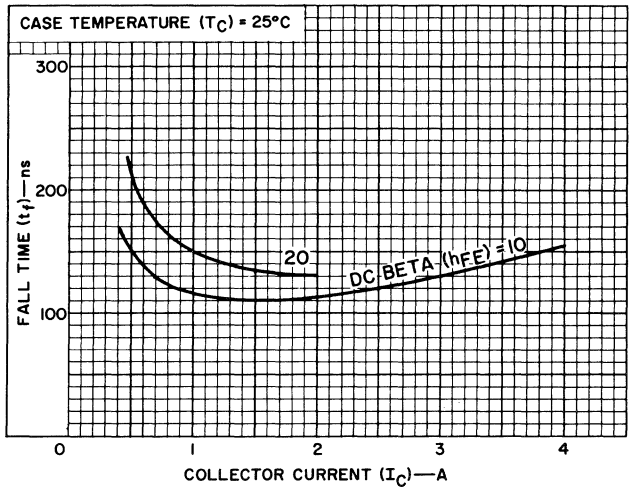


Fig. 28

SUGGESTED HARDWARE FOR MOUNTING TYPES 2N3878, 2N3879, & 2N5202

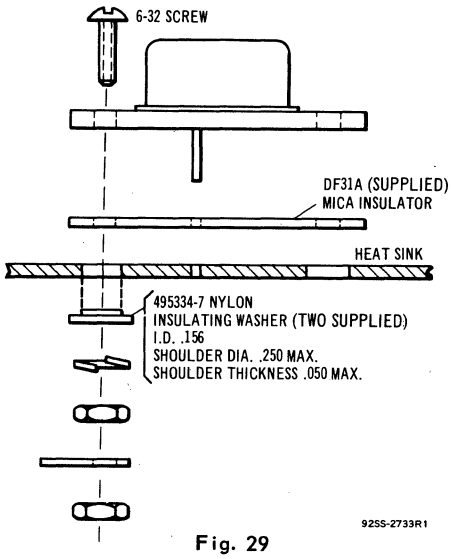
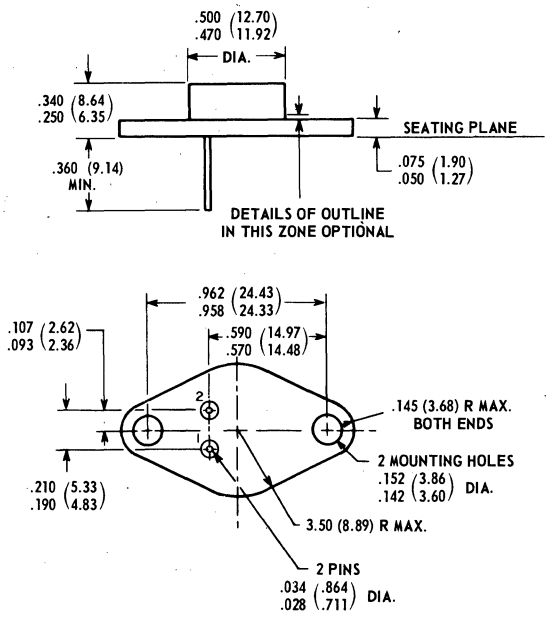


Fig. 29

DIMENSIONAL OUTLINE FOR TYPES 2N3878, 2N3879, & 2N5202

JEDEC TO-66

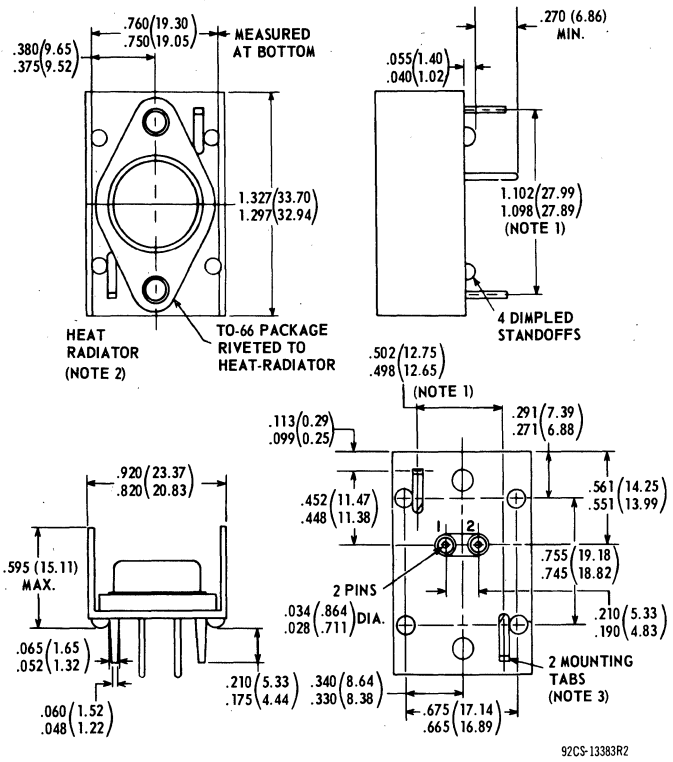


Dimensions in Inches and Millimeters

NOTE: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

DIMENSIONAL OUTLINE FOR TYPE 40375

JEDEC TO-66 WITH HEAT-RADIATOR



Dimensions in Inches and Millimeters

NOTE: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 1: Measured at bottom of heat-radiator.

Note 2: 0.035" C.R.S., tin plated.

Note 3: Recommended hole size for printed-circuit board is 0.070" dia.

TERMINAL CONNECTIONS

FOR TYPES 2N3878, 2N3879, 2N5202, & 40375

Pin 1 - Base
Pin 2 - Emitter
Flange, Case - Collector (For 2N3878, 2N3879, & 2N5202)
Heat Radiator - Collector (For 40375)