

TEKTRONIX®

**018-0067-02
DISPLAY
MULTIPLEXER**

**For use with TEKTRONIX
4010 Series Terminals**

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077
070-1992-00

Serial Number _____

First Printing Sept. 1975



WARRANTY

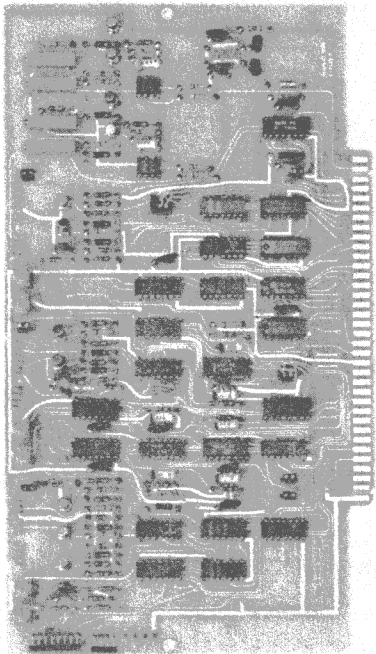
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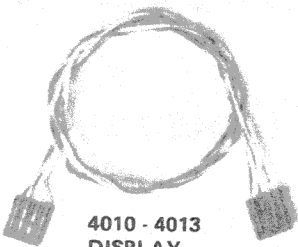


**MULTIPLEXER
CARD**

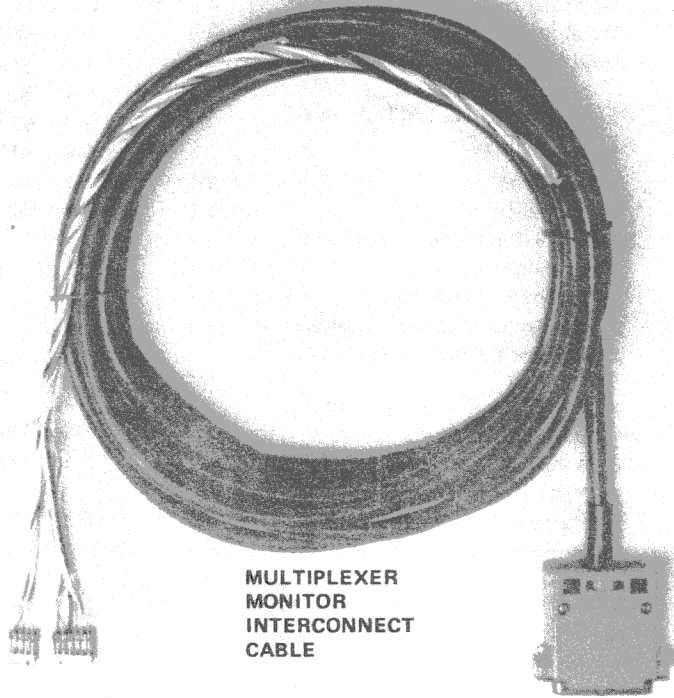
**4014 - 4015
CARD
INTERCONNECT
CABLE**



**Z AXIS
JUMPER
STRAP**



**4010 - 4013
DISPLAY
CONTROL
CABLE**



**MULTIPLEXER
MONITOR
INTERCONNECT
CABLE**

1992-01

Fig. 1-1. 018-0067-02 Display Multiplexer.

Section 1

DESCRIPTION

Introduction

The Display Multiplexer (hereafter called the Multiplexer) is a circuit card which installs in a 4010-Series Terminal (4010, 4012, 4013, 4014, or 4015) to permit one, two, or three Display Monitors to be controlled by the Terminal. The Display Monitors can be Tektronix type 603, 611, or 613 Monitors. Up to four Multiplexer cards may be installed in a Terminal to control a maximum of twelve Display Monitors.

A connector on the Multiplexer card also permits control of the Terminal display if the Terminal is equipped with a writing, copy making and erase interrupt cable. The interrupt cable is not required on 4014 and 4015 Terminals. 4010 and 4010-1 Terminals which have a 670-1734-00 Motherboard must be specially modified (Modification Kit No. 040-0646-01) if control of the Terminal Display is desired.

Program instructions control the Multiplexer card, causing any combination of monitors and the Terminal display to write, erase or make copies (if connected to copying units).

INSTALLATION INFORMATION

The actual installation of the Multiplexer is described in Section 3 of this manual. The following paragraphs contain information concerning operational characteristics of the Multiplexer.

Installation of the Multiplexer card consists of the following:

- a. Select the appropriate strap options on the Multiplexer card.
- b. Connect the Terminal Display Control cable (if required) to the Multiplexer card.
- c. Connect the Monitor/Multiplexer cable(s) to the Multiplexer card.
- d. Install the Multiplexer card in the Terminal.

The monitor connection includes X and Y deflection signals for controlling the position of the monitor writing beam. The X and Y outputs (from the Multiplexer card) are adjustable between 1 and 10 volts for full screen deflection and must be adjusted to match the sensitivity of the monitor(s). However, the three X outputs from the Multiplexer are equal to each other, as are the three Y outputs. The higher voltage range (e.g., 10 V) full-screen deflection voltage will provide better signal-to-noise ratio in noisy environments.

If Monitors with different full-screen sensitivity are connected to the same Terminal, one of the following methods can be used:

- a. Use separate Multiplexer cards, connecting monitors with similar sensitivity to the same card.
- b. Connect the monitors to the same card and modify the input sensitivity of the monitor(s). The input sensitivity can be changed by installing a variable attenuator (Tektronix Part No. 011-0111-02) in series with the monitor input. The input sensitivity can also be changed by changing straps and/or resistors in the Monitor Attenuator circuit (refer to the appropriate monitor manual for details).

Some monitors (such as the Tektronix 613) have a BUSY strap option which causes a low BUSY signal to occur in response to any beam movement. Busy is then applied to the line which controls the BUSY signal in the Multiplexer. When used with the Multiplexer, this function must be disabled in the monitor so that beam movement does not place a low on the Multiplexer BUSY line. The Multiplexer BUSY line should only be enabled by a BUSY from the monitor during an erase (or hard copy operation if the monitor enables BUSY while copying). See the appropriate monitor Service manual for additional details.

Monitor Identification. Monitor identification is essential for programming, and assures expedient installation of cables. This identification is based on the Multiplexer card output port connections. A Multiplexer card is identified by the number 0, 1, 2, or 3 (selected by the CARD SELECT strap on the Multiplexer card). In addition, the three pairs of output connections are identified as A, B, and C for a specific card. Therefore, a monitor connected to the B output of card 3 becomes Monitor 3B.

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Two or more Multiplexer cards can be strapped for the same address. In this case, duplicate monitor numbers could result. For example, if two Multiplexer cards are strapped for address 3, there may be two monitors identified as 3A. In such a case it is recommended that one monitor be identified as 3A and the other as 3AA.

Specifications

The Multiplexer electrical specifications are listed in Table 1-1.

TABLE 1-1
Electrical Specifications

Characteristics	Performance
X and Y Input Signals	Designed to accept +5 to -5 V for bottom-left and top-right display positions (respectively) on horizontally-oriented display.
X and Y Output Signal ($V_{TR} - V_{BL}$) ¹	Adjustable within a range of 1 to 10 V. The larger values (10 V) provide the best signal-to-noise ratios.
Signal Polarity	Positive-going for upward and right deflection.
Voltage (V_{BL})	Adjustable from -1.65 to +0.8 V with full scale deflection window set for 1 V; Adjustable from -13.5 to +8.0 V with full scale deflection window set for 10 V.
Trace Shift— accompanying change in number of Monitors driven	$\pm 1.0\%$ of full screen display (≥ 1.4 mm on 611 Monitor).
Impedance Requirement of driven circuit	Any value between 10 k and 1 M Ω .
Z Output Signals	TTL 50 Ω line driver; nominal 45 mA source.
MAKE COPY and ERASE Signals	Signal lines will withstand +25 V; low drive signal will sink 25 mA with a minimum level of +0.6 V.
Signal Duration	
ERASE	7 ms $\pm 20\%$

¹ V_{TR} = Deflection voltage at top right Display position.
 V_{BL} = Deflection voltage at bottom left Display position.

TABLE 1-1 (cont)

Characteristics	Performance
MAKE COPY	$> 866 \mu s$
CURSOR Pulse Width	Adjustable from 70 to 450 ns
WRITE THRU Pulse Width	Adjustable from 80 to 500 ns.
Deflection Shift—due to temperature drift (from 25°C over Operating Range)	With X and Y inputs grounded, X and Y output drift will be $\leq \pm 1.0\%$ of full scale deflection voltage.
Power Requirements	
+5 V	400 mA (max.)
+15 V	25 mA (max.)
-15 V	25 mA (max.)

The Multiplexer environmental specifications are the same as the standard 4010-Series Terminals.

Mechanical. The Multiplexer card is designed to fit the 4010 through 4015 minibus connector and card guides. The Multiplexer/Monitor interconnect cable has harmonica connectors which connect to the Multiplexer card and a 25-pin Cannon connector for the monitor connection.

Accessories

The following is a list of the items which are normally shipped with the Multiplexer card.

Instruction Manual	070-1992-00
20' Multiplexer/Monitor Interconnect Cable	012-0662-00
4010-4013 Terminal Display Control Cable	012-0407-00
4010-4013 Z Axis Jumper Strap	175-1753-00
4014/4015 Card Interconnect Cable	175-1752-00

Optional accessories which can be ordered for use with the Multiplexer are as follows:

50' Multiplexer/Monitor Interconnect Cable	012-0663-00
Variable Attenuator	011-0111-02
4010 Terminal Display Control Modification	040-0646-00

Section 2

PROGRAMMING

Programming Instructions

Programming the Multiplexer consists of sending the following Multiplexer Control Sequence to the Terminal:

- Terminal Arming Command,
- Multiplexer Card Select Command, and
- Multiplexer Control Command.

These commands must be sent without interceding characters. The Multiplexer Card Select command and the Multiplexer Control command are suppressed in most other circuits of the Terminal.

Terminal Arming Command. This permits the Multiplexer to accept commands, and always consists of the ASCII character ESC.

Multiplexer Card Select Command. This arms the Multiplexer card and consists of the ASCII 0, 1, 2, or 3. Recognition by a Multiplexer card is dependent on the positioning of the CARD SELECT straps. Refer to Strap Options (Section 3) for a description of the straps and settings.

Multiplexer Control Command. This command is accepted by the Multiplexer card (when selected). The command contains the necessary information to control the Terminal display and the attached monitors. Only bits 1 thru 4 are used by the Multiplexer card to control operation. The remaining bits (5 thru 8) may be either true or false. The bits (and their associated functions) are explained in Table 2-1.

TABLE 2-1

**Multiplexer Control
Command Description**

Bits								Configuration
8	7	6	5	4	3	2	1	
X	X	X	X	0	0	0	0	Disable Terminal Display and all monitors
X	X	X	X	0	0	0	1	Enable Terminal Display only
X	X	X	X	0	0	1	0	Enable Monitor A only
X	X	X	X	0	0	1	1	Enable Terminal Display and Monitor A
X	X	X	X	0	1	0	0	Enable Monitor B only
X	X	X	X	0	1	0	1	Enable Terminal Display and Monitor B
X	X	X	X	0	1	1	0	Monitors A and B only
X	X	X	X	0	1	1	1	Terminal Display Monitors A and B

TABLE 2-1 (cont)

Bits								Configuration
8	7	6	5	4	3	2	1	
X	X	X	X	1	0	0	0	Monitor C only
X	X	X	X	1	0	0	1	Terminal Display and Monitor C
X	X	X	X	1	0	1	0	Monitors A and C
X	X	X	X	1	0	1	1	Terminal Display Monitors A, and C
X	X	X	X	1	1	0	0	Monitors B and C
X	X	X	X	1	1	0	1	Terminal Display, Monitor B and Monitor C
X	X	X	X	1	1	1	0	Monitor A, B and C
X	X	X	X	1	1	1	1	Terminal Display, Monitor A, B and C

X = don't care

Special Programming Considerations

When operating a 4014 or 4015 Terminal in Graph mode with VECTOR RETARD strap IN the programmer must compensate for timing limitations at the higher data transfer rates (2400, 4800 and 9600 Baud). The programmer should allow at least 10 ms between vectors.

At 9600 Baud this can be accomplished by sending 12 characters for each vector address (the four address bytes followed by 8 SYNC or NUL characters). At 4800 Baud at least six characters are required and at 2400 Baud at least three characters are required.

Faster graphic rates can be obtained by sending fewer characters after short vectors. A half-screen vector (at 9600 Baud) requires only 5 ms to complete, therefore only six characters would be required before transmitting the next address. Shorter vectors require proportionally less time to complete before transmitting the next address.

If even faster graphics are required and small gaps can be tolerated between vectors (on the remote display monitors) the VECTOR RETARD strap should be placed in the OUT position and normal 4014/4015 vector timing observed.

Programming Examples

Example 1: Assume that a monitor is connected to the B output of Multiplexer card 0 and no other monitors or Multiplexer cards are installed, and the Terminal display is

under Multiplexer control. It is desired to write on the Terminal display screen without writing on the monitor. The following Multiplexer Control command sequence must be sent:

- Terminal Arming ASCII ESC
- Multiplexer Card ASCII 0
- Multiplexer Control Any of the ASCII characters which have bit 3 false (bit 3 false disables Monitor B). Example: ASCII 1.

Explanation: The ESC and 0 select Multiplexer card 0. The ASCII 1 disables the monitor and enables the terminal display. Any information sent to the terminal will be displayed. In order to again enable the monitor a new command must be sent to the Multiplexer to enable the monitor (bit 3 true).

NOTE

The bit configuration for the various Monitor/Terminal configurations is shown in Table 2-1. The corresponding ASCII characters are shown in Table 2-2. Any of the ASCII characters with the proper bit configuration can be used as the Multiplexer Command byte. It is recommended that the customer (or programmer) select one column of ASCII characters (e.g., '0' thru '?') to be used. This simplifies coding and helps to eliminate confusion.

TABLE 2-2

Multiplexer Control Commands

Bit 4 Monitor C Control	Bit 3 Monitor B Control	Bit 2 Monitor A Control	Bit 1 Terminal Display	Decimal Equiv. (Bits 1—4)	ASCII Character							
					NUL	DLE	SP	Ø	@	P	`	p
0	0	0	0	00	NUL	DLE	SP	Ø	@	P	`	p
0	0	0	1	01	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	02	STX	DC2	"	2	B	R	b	r
0	0	1	1	03	ETX	DC3	#	3	C	S	c	s
0	1	0	0	04	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	05	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	06	ACK	SYN	&	6	F	V	f	v
0	1	1	1	07	BEL	ETB	'	7	G	W	g	w
1	0	0	0	08	BS	CAN	(	8	H	X	h	x
1	0	0	1	09	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

1 = ON

0 = OFF

Bits 5-8 are "don't care" bits and can be 0 or 1.

ENCODING EXAMPLE: Locate the desired Terminal/Monitor configuration on the chart. Follow this line to the right to find the equivalent ASCII command character. Suppose it is desired to enable the Terminal Display, and Monitor A, with Monitors B and C disabled. Any of the following characters will perform the desired function: 'ETX', 'DC3', '#', '3', 'C', 'S', 'c', or 's'.

Example 2: Assume that the Terminal has Multiplexer cards 0 and 1 with three monitors connected to each card. It is desired to erase Monitor 1B only. The following command sequences are required.

ESC 00 (ASCII) Selects Multiplexer Card 0 and disables the Terminal display and all attached monitors.

ESC 14 (ASCII) Selects Multiplexer card 1 and disables all Monitors except Monitor B.

ESC FF (ASCII) Erase command to Monitor B

Any additional commands issued to the Terminal will only be acted on by the Monitor B until another command

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sequence is sent to the Multiplexer which restores the Terminal and attached monitors to enabled condition.

The Terminal will go Busy during the erase time if the BUSY signal is available from Monitor B and the BUSY B strap is IN. If the BUSY signal is not available or is not selected on the Multiplexer card, the appropriate delay must be inserted (by software control) to allow the monitor to complete the erase operation before more information

is sent to the screen. The following command sequences will restore the Terminal and attached monitors to initial status condition:

- ESC 0 ? (ASCII) Selects Multiplexer card 0 and enables the Terminal display and all attached monitors.
- ESC 1 ? (ASCII) Selects Multiplexer Card 1 and enables all attached monitors.

Section 3

INSTALLATION/OPERATION

General

This section is divided into two basic areas; installation and operation. The installation section contains the information necessary to install the Multiplexer in the Terminal, connect the cables, and select the desired strap options. The operation section contains the basic Multiplexer/Terminal operating characteristics and information.

INSTALLATION DETAILS

Perform the following steps to install the Display Multiplexer in the Terminal and connect the Display Monitor(s).

1. Turn off ac power to the Terminal and disconnect the line cord from the power source. Remove the front cover from the pedestal.

WARNING

Dangerous voltages are contained within the Terminal when connected to a power source. Servicing should be done by a qualified technician.

2. Select the strap options on the Multiplexer card. The strap options are described in Table 3-1.

3. Install the card in a minibus connector in the pedestal. (A motherboard extender, Tektronix Part No. 018-0069-00 may be necessary to install the card in the pedestal.)

4. Feed the exposed wires (on the harmonica end) of the Monitor/Terminal interconnect cable into the pedestal through the slot in the back. Secure the cable by placing a cable clamp on the cables outer insulation and secure the clamp to the sill at the lower edge of the access slot.

5. Connect the ground lug from the cable to one of the spade lugs above the access slot.

NOTE

On some early versions of Terminals there may not be enough spade lugs to connect the cable ground when four Multiplexer cards are installed in the Terminal. The ground lugs should be connected if possible. A modification kit is available to add additional lugs, if needed.

6. Connect the Multiplexer/Monitor cable harmonica connectors to J400 and J401 (for Monitor A), J402 and J403 (for Monitor B), and J404 and J405 (for Monitor C).

7. If Multiplexer Control of the Terminal display is desired, make the following cable connections.

4010 Remove the jumpers between J35 and J36 on the Terminal Motherboard. Connect the Display Control cable between J35 (in the Terminal) and J406 on the Multiplexer card. On 4010 Terminals with 670-1734-00 Motherboards, a 040-0646-00 Modification kit is required.

4012, 4013 Remove the plug from J33 on the Terminal Motherboard and connect it to J406 on the Multiplexer card.

4014, 4015 Connect the 4014/4015 Card Interconnect cable from J141 on the Terminal Display card to J411 on the Multiplexer card. For Multiplexer control of MAKE COPY commands from the keyboard or computer (ESC ETB) to the Terminal screen, the wire must be removed from J125-3 (on the Terminal motherboard) and connected to J140-4 (on the Display Control card).

NOTE

If additional Multiplexer cards are installed in the Terminal, cables must be connected between the cards. These cables are connected between J410 of the first card to J411 of the second card (4014, 4015).

TABLE 3-1

Multiplexer Card Strap Options

Strap	Positions	Function
<p>CARD SELECT</p> <p>BIT 1 0/1</p> <p>BIT 2 0/1</p>		<p>Determines which character (0, 1, 2, or 3) can select the card.</p> <p>B_2B_1 = Card number (in binary format).</p> <p>B_2 = bit 2, and B_1 = bit 1.</p> <p>Therefore, if $B_2 = 1$ and $B_1 = 0$, the card address is set to 2.</p>
<p>BUSY</p> <p>A IN/OUT</p>		<p>IN permits Monitor A (if enabled) to cause a busy signal at the Terminal during the monitor's erase cycle. Will also cause the Terminal to go busy if power is removed from the monitor.</p> <p>OUT prevents the monitor from causing a busy condition in the Terminal.</p>
<p>B</p>	<p>IN/OUT</p>	<p>Same as Monitor A BUSY strap, except pertains to Monitor B.</p>
<p>C</p>	<p>IN/OUT</p>	<p>Same as Monitor A BUSY strap, except pertains to Monitor C.</p>
<p>WRITE THRU</p>	<p>IN/OUT</p>	<p>IN permits the Multiplexer to route the Write Thru Z Axis pulses through separate pulse width control circuitry for each monitor. In the 4010 — 4013 Terminals, this strap must be OUT unless the Fast Vector option is installed.</p> <p style="text-align: center;">NOTE</p> <p style="text-align: center;"><i>If the strap is OUT (and the Fast Vector option is installed), the Terminal WRITE THRU INTENSITY adjustment will control all monitors as well as the Terminal display. The Multiplexer Write Thru Intensity control is disabled.</i></p> <p>If the Multiplexer card is installed in a 4014 or 4015, the strap has no effect on the monitors or Terminal display. When operating with a 4014 or 4015, the strap can be in either position.</p>
<p>Z CONTROL</p>	<p>4010/4014</p>	<p>Selects control signal for Write Thru mode and Cursor Z Axis pulse routing within the Multiplexer.</p> <p>When operating the Multiplexer with 4010, 4012, or 4013 Terminals, the strap should be in the 4010 position.</p> <p>When operating the Multiplexer with 4014 or 4015 Terminals, the strap should be set to the 4014 position.</p>

8. Repeat steps 6 and 7 for additional interconnecting cables as required.

9. Connect the Multiplexer/Monitor cables to the Monitors.

10. Replace the pedestal cover and turn on the Terminal and monitor(s) power.

NOTE

If adjustment of the card is required, the cover must be left off and the interlock must be defeated to apply power to the Terminal. Refer to Section 4 (Check and Adjustment Routines) for Multiplexer adjustment procedures.

Strap Options

A complete description of the Multiplexer card strap options is contained in Table 3-1. The Strap Option locations are shown in Fig. 3-1. The recommended strap option settings for the various terminals are as follows:

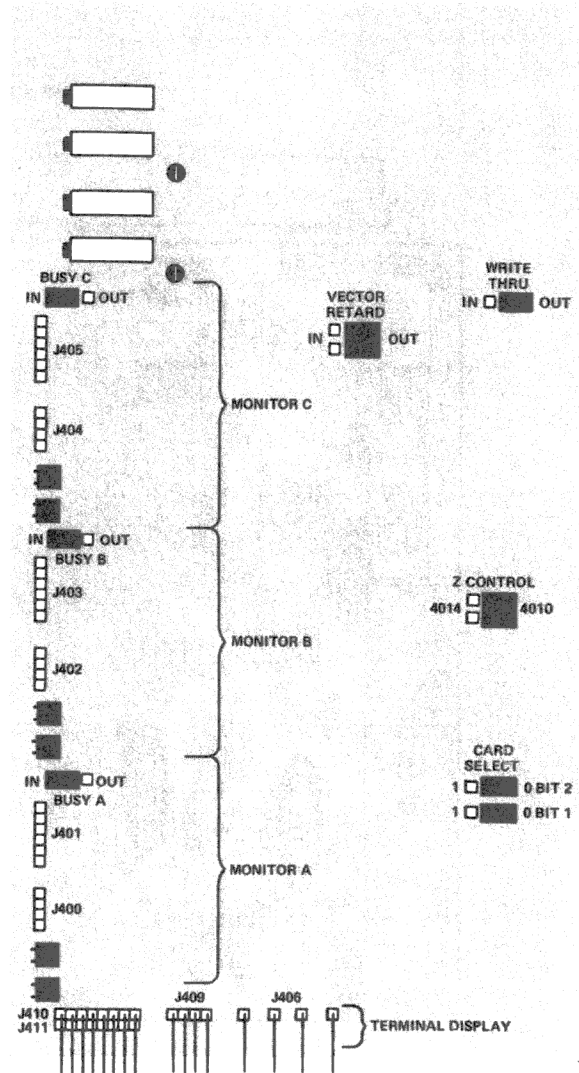
4010 — 4013 Terminal Control Jumper J409 to J410.
 Z Control strap block to 4010 position.
 VECTOR RETARD strap block OUT.
 WRITE THRU strap IN.
 (IN only if the Fast Vector option is installed, otherwise the strap must be set out).

4014, 4015 Terminal Control and Z axis cable from J141 of the Display Control card (in the Terminal) to J411 of the Multiplexer card.
 Z Control strap block to 4014 position.
 VECTOR RETARD strap IN or OUT
 (See strap options section for proper setting.)

Additional Multiplexer cards (2, 3, and 4) will daisy chain off J410 (of board 0) to J411 (of the other boards) to relay Z axis information.

Special Considerations

The following is a list of special modifications, conditions and considerations when using the Multiplexer with the various Terminals, monitors and peripheral equipment.



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Fig. 3-1. Strap Options.

Write-Thru Degradation. Some degradation of the write-thru character quality will be evident when using the 4014 or 4015 terminals with 611 or 613 monitors unless the Terminal Character generator is modified. This modification consists of connecting pin 2 to pin 7 on U171 of the Character Generator card. Write-thru operation is not recommended when using 603 Monitors.

603 Monitor. When using the Multiplexer with a 603 Monitor, the monitor circuitry must be modified as follows:

Remove C116, C136, C316, and C336 (.01 μ F capacitors) from the Monitor's Deflection Amplifier card (see Fig. 3-2 for component locations).

In addition, the Alpha/Graphic focus for the monitor must be adjusted to provide the optimum display quality. Some blurring of the characters and vectors will be present on the monitor display.

1. Adjust the Multiplexer card and monitor(s) for 10 V full-scale deflection window. The monitor's input sensitivity is changed by installing a Variable Input Attenuator (Part No. 011-0111-02) on the monitor, or by changing resistors on the Monitor Attenuator board (see page 3-4 of the Monitor Service manual). All monitors connected to the Multiplexer card must have input sensitivities of 10 V full-screen deflection if this procedure is used.

2. If a 1 V full-scale deflection window is desired, remove resistors R6 and R106 (0.25Ω) from the monitor's Horizontal/Vertical Amplifier board (see Fig. 3-3). Take apart the male Cannon plug housing of the Multiplexer/Monitor Interconnect cable and cut the jumper wires between pins 19, 17, 14, and 3 (leaving the black wire connected to pin 19). Re-assemble the plug.

b. Oscillations are present with a 4601 Hard Copy Unit connected.

1. Set the 4601 for the 5 volts range.

2. Adjust the Multiplexer card for 5 V full-scale deflection window and change the monitor's input sensitivity for 5 V full-scale deflection.

OPERATION

Once the Terminal, Multiplexer, and monitor(s) are connected as a system, operation consists of turning each unit on, selecting remote control (at monitors so equipped), and providing the Terminal Control circuits with information from a computer, from the keyboard, or from an auxiliary device. There are however, some additional points to consider, as detailed in the following paragraphs.

De-energized Monitors

A BUSY strap option is provided for each monitor. If the strap is IN, and the monitor is equipped to send a BUSY signal to the Multiplexer, turning off that monitor may cause the Terminal to become busy and inhibit operation. Placing the strap in the OUT position or removing the interconnecting cable will overcome this. If the monitor has no BUSY signal line (or the monitor BUSY strap on the Multiplexer card is in the OUT position), turning it off will not affect system operation.

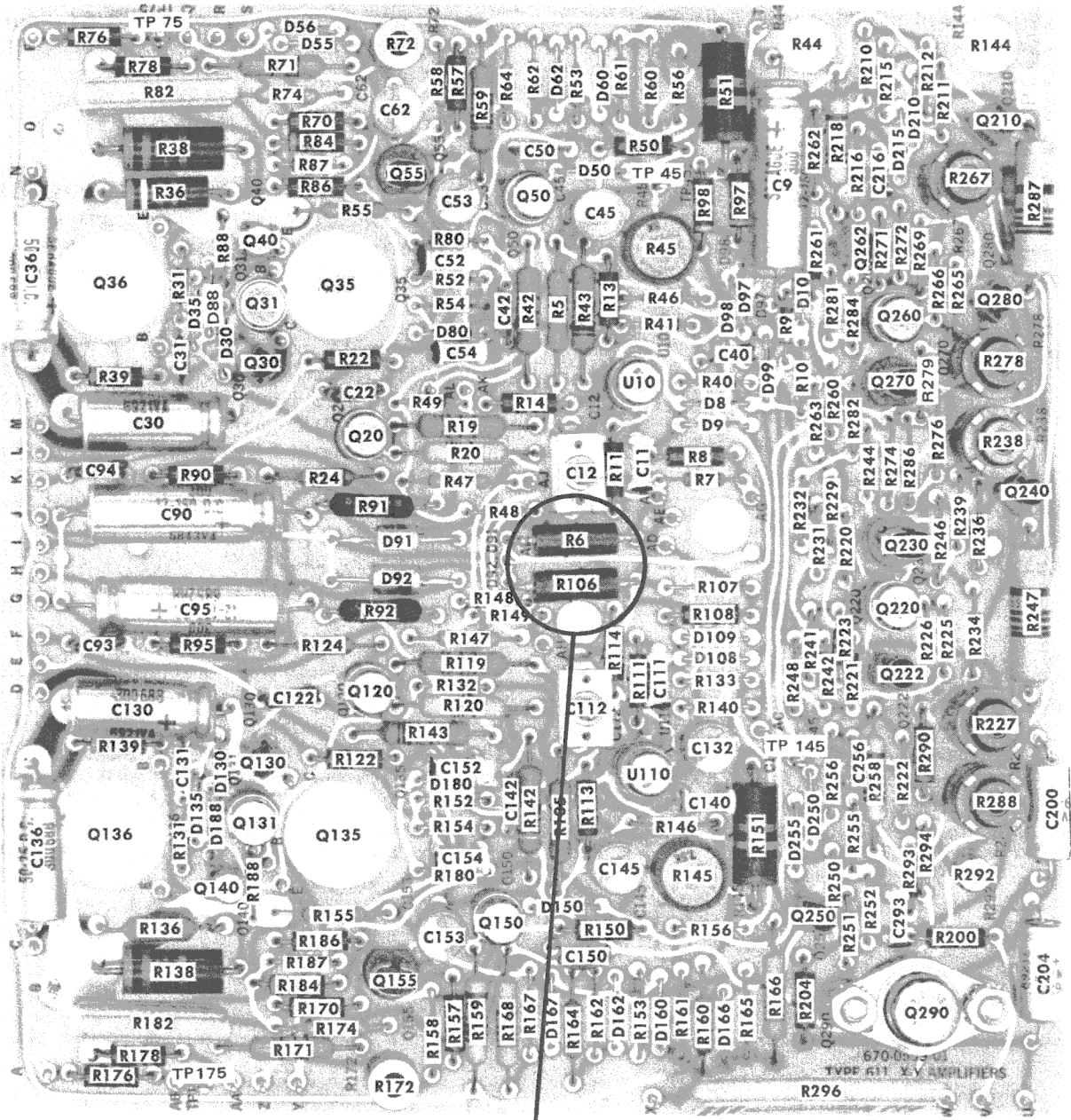
Initial Status

When the Terminal is turned on, or the RESET key is pressed on the keyboard, the system attains an initial status as follows: all monitors and the Terminal display unit accept any writing, copying or erasing commands.

Changes to the initial status can be made only by sending a Multiplexer Control Command sequence to the Terminal. (Refer to Section 2 for explanation of the Multiplexer Control Command sequence.) Once the initial status has been changed, it can be returned to by pressing the RESET key on the keyboard, or by sending another Multiplexer Control Command sequence which specifies the initial status.

Hold Mode

The Terminal will reduce display intensity after 60 to 120 seconds of inactivity. This prolongs the life of the display screen. If the Terminal goes into Hold mode, any enabled monitor (equipped with the Hold mode feature) will go into Hold mode after an additional 60 to 120 second delay. Monitors will also go into Hold mode 60 to 120 seconds after being "disabled" by the Multiplexer. Monitors return to View mode as soon as the Terminal returns active or as soon as the monitor is again enabled.



RESISTORS TO BE REMOVED

(0752) 1993-5

Fig. 3-3. 611 Monitor Modifications.

Section 4 PERFORMANCE CHECK AND ADJUSTMENT

Introduction

Two procedures are provided here, one employs the use of a display monitor to observe the results of checks and adjustments, the second procedure is designed for applications where a monitor is not available. The first procedure is recommended as the Multiplexer card can be adjusted under actual operating conditions. Multiplexer cards which are adjusted using the second procedure may require minor readjustment when the Multiplexer card is connected to a monitor.

Maintenance

Routine servicing of the Multiplexer is not required. It contains no moving parts, and its performance is adequately checked during normal operation. If trouble occurs, it can be pin-pointed by performing the performance checks and adjustments.

SYSTEM PERFORMANCE CHECKS AND ADJUSTMENTS

This procedure assumes the Terminal display is under control of the Multiplexer card. Monitors are assumed to be connected to ports A, B, and C. If only one monitor is available, the monitor control check should be repeated three times, connecting the monitor to a different port each time. Monitor sensitivity is assumed to be 1 V full-screen, with V_{BL} (deflection voltage for bottom-left display position) equal to 0, 0 volts. This is the standard monitor and multiplexer shipping configuration. If other gain and position configurations are desired, omit step 3a of the following procedure.

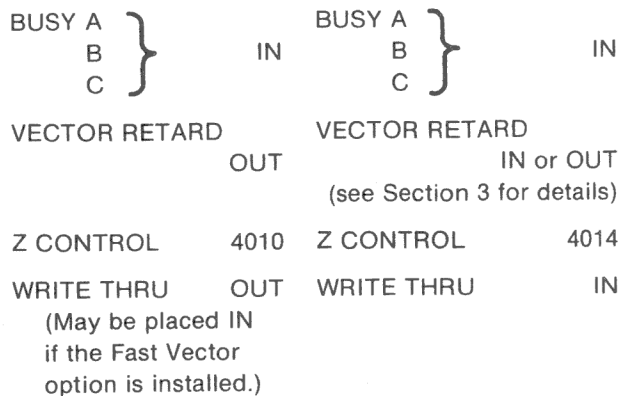
NOTE

Refer to Section 3 for special considerations affecting multiplexer adjustment and/or operation with Tektronix 603 or 611 Monitors.

1. Preliminary Procedure

a. Connect the strap options on the multiplexer card as follows:

4010 — 4013 Terminals	4014 — 4015 Terminals
CARD SELECT BIT 1 1	CARD SELECT BIT 1 1
BIT 2 1	BIT 2 1



- b. Install an extender card in the Terminal motherboard.
- c. Verify that the Terminal power is off and install the Multiplexer card on the extender card.



Do not install or remove the Display Multiplexer card while the Terminal is energized.

- d. Connect the Display Control cable to the Multiplexer card. (Refer to Section 3 for cable connection instructions.)
- e. Connect the monitor(s) to the Multiplexer card.
- f. Connect the Hard Copy Unit(s) to the Terminal and/or monitor(s) if available.
- g. Apply power to the Terminal, monitor(s) and Hard Copy Unit(s).
- h. Set the keyboard LOCAL switch, and enter RESET, PAGE (after about 30 seconds).

Performance Check and Adjustment—018-0067-02

2. Display Unit Control Check

a. Verify that the Alpha Cursor appears at the Home position (top left) on the Terminal display unit.

b. Enter several writing characters from the keyboard and note that they appear on the display.

c. Enter CTRL SHIFT K, CTRL W from the keyboard (make copy command) and note that a copy of the Terminal display is produced by the Hard Copy Unit connected to the Terminal.

d. Press the keyboard PAGE key and verify that the display is erased.

e. Enter CTRL SHIFT K, the numerals 3, followed by Ø from the keyboard. Note that nothing is written on the screen as a result of these entries.

f. Repeat steps a through d and note that the cursor is not being displayed and the writing, copying and erasing commands are ignored by the Terminal Display. Note that pressing the COPY button on the Terminal will cause a copy to be made, regardless of whether or not the Terminal Display has been disabled by the Multiplexer.

3. Monitor Control Check and Adjustment

a. Enter several characters from the keyboard and adjust the monitor(s) so the characters store properly.

b. Press RESET at the keyboard.

c. Place the vertical thumbwheel at its upper limit and place the horizontal thumbwheel at its mid-position.

d. Enter CTRL SHIFT K and CTRL Z from the keyboard. The Cross-hair cursor should appear on the Terminal display and on the monitor(s). (It may be necessary to adjust the Cursor Intensity adjustment on the Multiplexer card and/or the Writing Intensity adjustment on the monitor to bring the non-storing cursor into view on the monitor.)

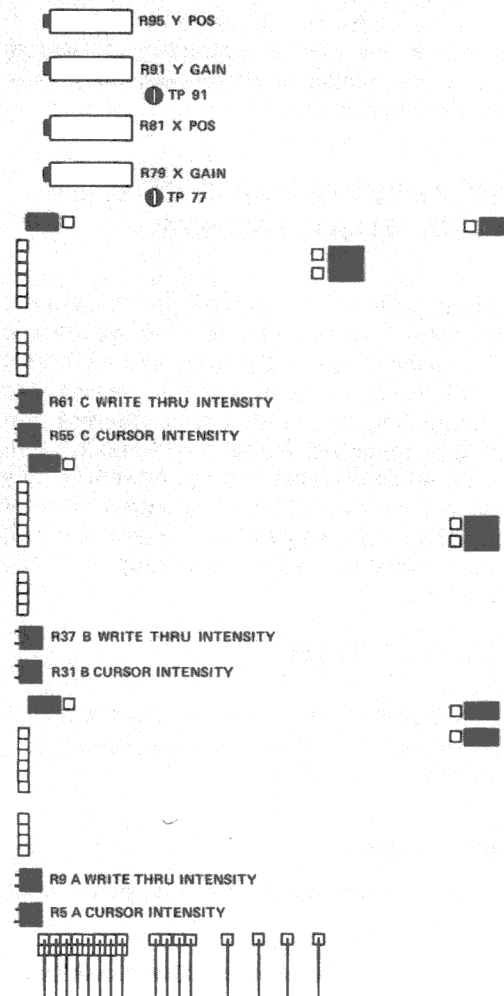
NOTE

The size and position to which the display is adjusted in this procedure is considered optimum. It can be adjusted to suit the customer. The X outputs from the Multiplexer card are identical at all three output ports, as are the Y outputs.

e. Check the Multiplexer X GAIN and POSITION adjustments. The horizontal line (cross-hair) should be approximately centered at the top of the screen. The left end of the line should end (approximately) at the left edge of the monitor's quality display area and the right end should be approximately 1/8 inch to the left of the right edge of the quality display area.

f. Adjust X POS (R82) and X GAIN (R85) on the Multiplexer card to obtain the status specified in step e. (The Multiplexer adjustments are shown in Fig. 4-1.)

g. Check the Multiplexer Y GAIN and POSITION adjustments. The bottom of the vertical line (Cross-hair) should end (approximately) at the bottom of the monitor's quality display area. The vertical line should intercept the horizontal line at the top of the monitor's quality display area (vertical thumbwheel at upper limit).



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Fig. 4-1. Multiplexer Adjustments.

MULTIPLEXER CARD PERFORMANCE CHECK/ADJUSTMENT PROCEDURE

This procedure is designed to be used when the Multiplexer card is adjusted without the availability of Display Monitors. The card is adjusted using an oscilloscope and voltmeter. To perform this check, the Multiplexer need only be inserted into the Terminal motherboard connector (the Display Control cable and monitors are not required). Slight adjustment of the Multiplexer card may be required when the Multiplexer is installed in a system.

h. Adjust the Y POS (R90) and Y GAIN (R93) as necessary to obtain the status specified in step g.

i. Press the PAGE key on the keyboard.

j. Enter several characters from the Terminal keyboard. The characters should be displayed on the Terminal screen and all monitors. The monitor intensity should be adjusted for optimum character quality.

k. Adjust the CURSOR INTENSITY controls on the Multiplexer card so the alpha cursor is visible but does not store. Enter CTRL SHIFT K, CTRL Z to display the graphic cross-hair cursor and verify that it does not store.

l. Enter ESC ETB (CTRL SHIFT K, CTRL W). The Hard Copy Unit(s) connected to the monitor(s) should make a copy of the monitor display.

m. Press ERASE at the monitor(s) and note that the Alpha Cursor disappears from the Terminal screen and all other monitors during the erase operation.

n. Press PAGE at the Terminal keyboard and verify that the monitor(s) and the Terminal display are erased and the Alpha Cursor returns to the Home position.

o. Enter CTRL SHIFT K, the numeral 3 followed by a Ø. Note that the characters are not displayed on the Terminal or the monitor(s).

p. Enter several characters from the keyboard and verify that they are not displayed. Press PAGE and enter CTRL SHIFT K, CTRL W (Make Copy command) and note that the Terminal and monitor(s) do not respond.

4. WRITE THRU Adjustment

The WRITE THRU adjustment procedure is a preliminary setting. Fine tuning of the adjustment will be required to provide optimum operation for the specific mode where Write Thru is being used by the customer (Alpha or Graphics). Initially adjust the WRITE THRU INTENSITY control (R11 for Monitor A) fully clockwise, then turn the adjustment 1/4 turn (90°) counterclockwise. Repeat the adjustment for R41 (Monitor B) and R71 (Monitor C).

This completes the performance checks and adjustments. The following procedure describes the adjustment routines for the Multiplexer card when a monitor is not available.

1. Preliminary Procedure

a. Connect the strap options on the Multiplexer card as follows:

<u>4010 — 4013 Terminals</u>		<u>4014 — 4015 Terminals</u>	
CARD SELECT BIT 1	1	CARD SELECT BIT 1	1
BIT 2	1	BIT 2	1
BUSY A } B } C }	IN	BUSY A } B } C }	IN
VECTOR RETARD	OUT	VECTOR RETARD	IN or OUT (see Section 3 for details)
Z CONTROL	4010	Z CONTROL	4014
WRITE THRU	OUT	WRITE THRU	IN (May be placed IN if the Fast Vector option is installed.)

b. Verify that the Terminal power is off and install an extender card (Tektronix Part No. 670-1739-00) in the Terminal motherboard.

c. Install the Multiplexer card in the extender and apply power to the Terminal. After the Terminal has powered up, set the LOCAL switch (on the keyboard) and press PAGE.

d. Temporarily connect 1 k pull-up resistors from pin 1 of J401, J403 and J405 to +5 volts.

2. Gain and Position Adjustment

a. Place the Terminal in Graph Mode by entering CTRL SHIFT M from the keyboard.

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b. Enter SP (Space) RUBOUT SP @ to address coordinates 31Y, 0X (lower left corner of the display).

c. Adjust R95 (Y POS) to obtain 0 V at TP91.

d. Adjust R81 (X POS) to obtain 0 V at TP77.

e. Enter 7 RUBOUT ? _ to position the beam to 767Y, 1023X (upper right corner of the display).

f. Adjust R79 (X GAIN) for the desired full-scale deflection voltage at TP77.

NOTE

Full-scale deflection can be adjusted from 1 to 10 V. The 10 V full-scale deflection range provides a better signal-to-noise ratio for noisy environments.

g. Adjust R91 (Y GAIN) for the desired full-scale deflection voltage at TP91.

h. Recheck steps b through d to verify the voltages are still zero. If the gain pots are at the extreme ends when the initial voltage settings are made, the voltages may be incorrect. If the voltages are significantly wrong, reset the gain pots for zero volts and repeat steps e, f, and g.

NOTE

For monitors with a 0 volt X and Y reference other than the lower left corner of the screen, use the following procedure to adjust the gain and position:

1. Enter the desired beam reference position (0 volt X and Y) using the appropriate graphic coordinates.

2. Adjust X POS (R81) for 0 V at TP77 and adjust Y POS (R95) for 0 V at TP91.

3. Enter the graphic coordinates for full-scale monitor deflection.

4. Adjust X GAIN (R79) for full-scale voltage at TP79 and adjust Y GAIN (R91) for full-scale voltage at TP91.

3. Monitor Control Check

a. Press the RESET key on the keyboard.

b. Using an oscilloscope, verify high-to-low pulsing signal at J406 pin 3 (Z AXIS 2). It may be necessary to press the SHIFT key on the keyboard to maintain view status on the Terminal.

c. Verify the following TTL levels (or pulses) using an oscilloscope:

J401-5	Positive-going pulses (Z to Monitor A).
J403-5	Positive-going pulses (Z to Monitor B).
J405-5	Positive-going pulses (Z to Monitor C).

J406-1	Negative-going signal (MAKE COPY 2) in response to Make Copy commands (ESC ETB) from the keyboard.
--------	--

J401-2	Negative going MAKE COPY pulses (for Monitors A, B, and C) in response to a Make Copy command from the keyboard.
J403-2	
J405-2	

J406-2	Negative-going pulses (PAGE 2) in response to a Page command from the keyboard.
--------	---

J401-1	Negative-going ERASE pulses (for Monitors A, B, and C) in response to a Page command from the Terminal keyboard.
J403-1	
J405-1	

d. Connect the oscilloscope to pin L of the extender card and verify that pin L goes low if J401-6, J403-6, or J405-6 are grounded.

e. Enter CTRL SHIFT K, the numerals 3 and 0 from the keyboard. Note that the entry has no effect on the display.

f. Verify a high level at J406-3 (Z AXIS 2) and a low level (no pulses present) at J401, J403, and J405-5 (Z for Monitors A, B, and C).

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g. Verify a high level (and no response to MAKE COPY - ESC ETB - commands from the keyboard) on the following pins:

J406-1	(MAKE COPY 2 to the Display)
J401-2	(MAKE COPY to Monitor A)
J403-2	(MAKE COPY to Monitor A)
J405-2	(MAKE COPY to Monitor C)

h. Verify a high level (and no response to PAGE commands from the keyboard) on the following pins:

J406-2	(PAGE 2 to the Display)
J401-1	(ERASE to Monitor A)
J403-1	(ERASE to Monitor B)
J405-1	(ERASE to Monitor C)

i. Adjust the WRITE THRU INTENSITY controls as described in step 4 of the System Performance Check/Adjustment procedure.

j. Remove the 1 k pull-up resistors from J401, J403 and J405 pin 1 to +5 volts.

This completes the Multiplexer card checks and adjustments. It should be noted that slight re-adjustment may be required when the card is installed in the system.

Section 5

CIRCUIT DESCRIPTION

The Display Multiplexer permits the 4010 Series Display Terminals to control one, two, or three remote Display Monitors (Tektronix 603, 611 or 613) as well as the Terminal display. Up to four Multiplexer cards can be installed in a Terminal to control a maximum of 12 monitors. The Multiplexer permits program control of writing, erasing, and making copies on the display and/or monitors.

Fig. 5-1 is a simplified block diagram of the Multiplexer card, the actual schematic diagram of the card is shown at the end of this section.

DETAILED DESCRIPTION

The Multiplexer card contains eight basic functional areas: the Vector Retard, Write Thru, the Display Monitor Select, Multiplexer Control, the Monitor Control (three identical circuits, one for each of the Monitors - A, B and C), X and Y Control circuits, Busy Control, and the Terminal Display Control circuits. The Display Monitor Select and Multiplexer Control logic enables the Monitor Control, which enables the desired Monitor/Terminal operating configuration on receipt of the proper Multiplexer Control command. The Monitor Control logic controls the ERASE, COPY and Z Axis information to each of the attached monitors (A, B, and/or C). The X and Y Control circuits amplify the X and Y signals from the Terminal and provide gain and position adjustments for the signals to the Display Monitors. The Terminal Display Control circuits are used to enable DRBUSY to the Terminal when the monitors are erasing or making copies (Busy Control is enabled by strap option). Vector Retard is used to control Graph mode writing speed and Write Thru provides Multiplexer control of the Z Axis during Write Thru operations. Each of these logic functions is described in greater detail in the following paragraphs.

Card Select

The Card Select circuit consists of a character decoder (U361) and a flip-flop (U265). The circuit is enabled by receipt of an ESC (Escape) from the computer.

If the character following an ESC matches the address selected by the address straps, the decode gate is enabled and the accompanying TSTROBE sets the flip-flop. The

flip-flop output enables the Select Latch (U341) and the next byte (bits 1 thru 4) is loaded into the latch. This byte determines the operating configuration of the Terminal/Display Multiplexer system. Once the byte has been stored, it remains until another Multiplexer Control command sequence is received to change the operating configuration or the Terminal logic is reset (HOME is enabled).

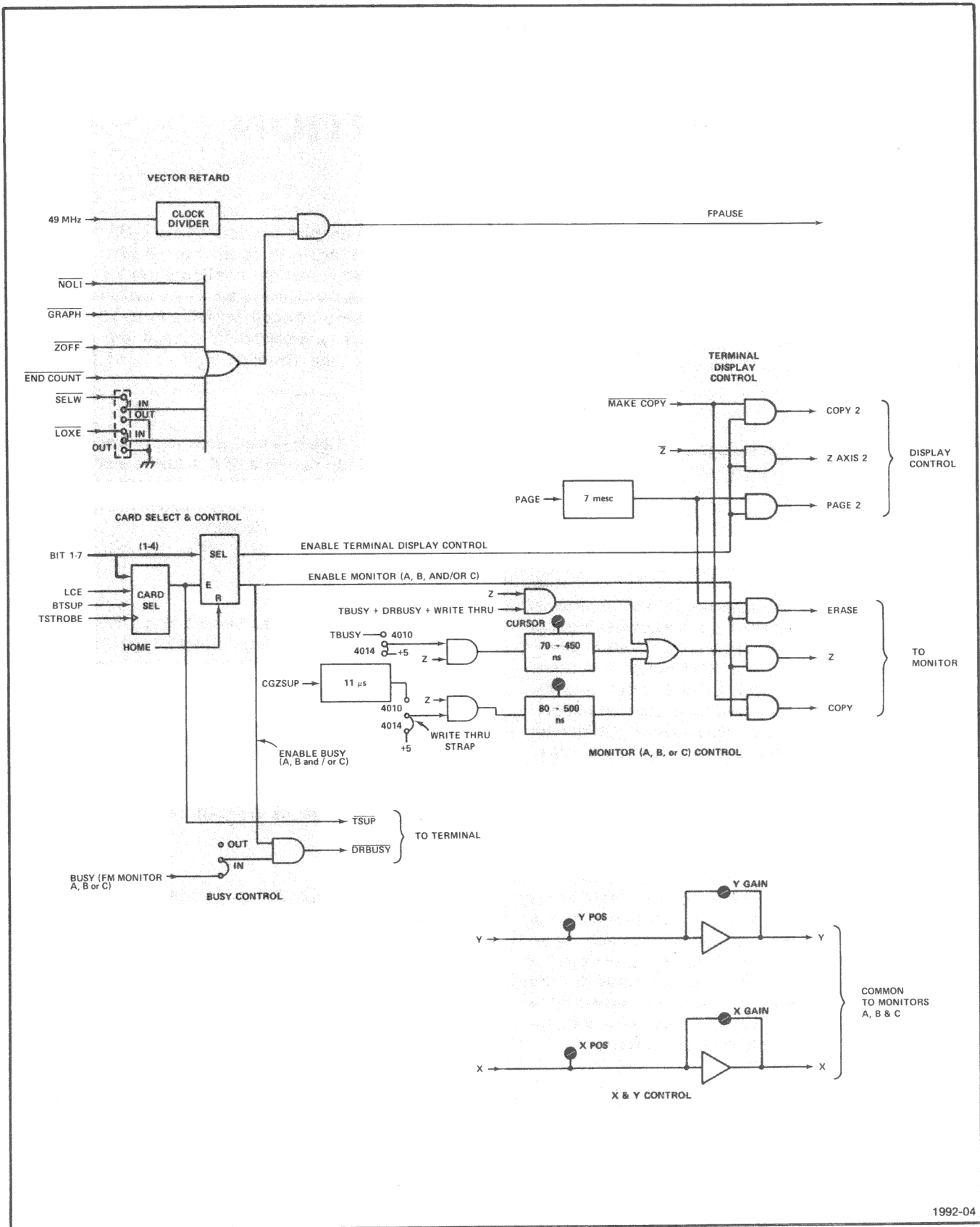
The flip-flop (U265) is also used to control the TSUP line. When the flip-flop sets to 0, a low is placed on the TSUP line. The end of the TSTROBE (which accompanies the Multiplexer Command byte) causes the flip-flop to reset and ends the TSUP signal.

Monitor Control

The four outputs from the Select Latch (U341) are used to control the selection of the monitor(s) and the Terminal display. Note that on initialization of the Terminal, the HOME signal is low, providing a reset for the Select Latches. The low on the outputs of U341 provide an enabling signal to the output gates of the Terminal Control circuits, and each of the Monitor Control circuits (for Monitors A, B, and C). The following description will cover only the Terminal and Monitor A Control circuits as the Monitor B and C circuits are identical to the Monitor A circuits.

Monitor A Control. Z Axis information (writing gun control) from the Terminal is applied to the monitor control logic through U115A. The signal is applied to U245B (WRITE THRU INTENSITY control one-shot), U245A (CURSOR INTENSITY control one-shot) through U215B, and to the Z Axis control gate (U151B).

U151B combines Z Axis signals and U145C sends them to the monitor (if U145C is enabled by U341-13). Only one of the three inputs to U151B receives Z Axis information at a given time. The pin 3 input to U151B is the normal writing signal from the Terminal. Pin 4 receives the Z Axis signal to write the Alpha and Cross-hair cursors. U245A provides an adjustable control (from 70 to 450 ns) so that the Z Axis signal to the monitor can be adjusted independent of the Terminal cursor intensity. The third input (pin 5) receives Z-axis information only when the WRITE THRU strap is set to IN (only used when the Terminal has the Fast Graph



1992-04

Fig. 5-1. Simplified Multiplexer Block Diagram.

option installed), and the Terminal is displaying information in the Write Thru mode. When the WRITE THRU strap is IN, the CGZSUP signal from the terminal is used to retrigger U385A. U385A is set for an 11 ms pulse which provides a constant high to U245B pin 11. (The normal CGZSUP signal from the terminal during Write Thru is of a 10 ms period and retriggers the one-shot to provide a continuing enable to U385A.) This allows the Z Axis information to be controlled by the WRITE THRU INTENSITY control (R9 and U245B), providing independent control of the monitor Write Thru Intensity without affecting the Terminal display.

Two additional signals are provided (to the monitors) by the Monitor Control circuits: an ERASE and a MAKE COPY signal. A MAKE COPY (low) signal from the Terminal (initiated by the computer or the operator) enables U35D (if U161-6 is high). This output is used to turn on Q19 which provides the drive signal for the Hard Copy Unit attached to the monitor. The ERASE signal (low) to the monitor is initiated by a PAGE signal from the Terminal. The PAGE signal triggers a 7 ms one-shot (U385B) and the one-shot output enables U35C if U161-6 is high (Monitor A enabled), providing the ERASE signal to the monitor.

The operation of the Control circuits for Monitors B and C is identical to Monitor A except the controls and logic gates will have different identification numbers.

BUSY Control

If the Display Monitor used with the Terminal is designed to provide a BUSY signal during ERASE or MAKE COPY operation, the BUSY control straps and logic provide control of the Terminal Display logic. If the BUSY strap is IN, a BUSY signal (from Monitor A, B, or C) turns off Q25 (for Monitor A). The Q25 output and the Monitor Select signal (Monitor A enabled) will enable U225B, providing DRBUSY (low) to the Terminal logic. DRBUSY remains enabled (low) until the erase or copy operation is completed by the monitor (monitor removes BUSY signal).

X and Y Control

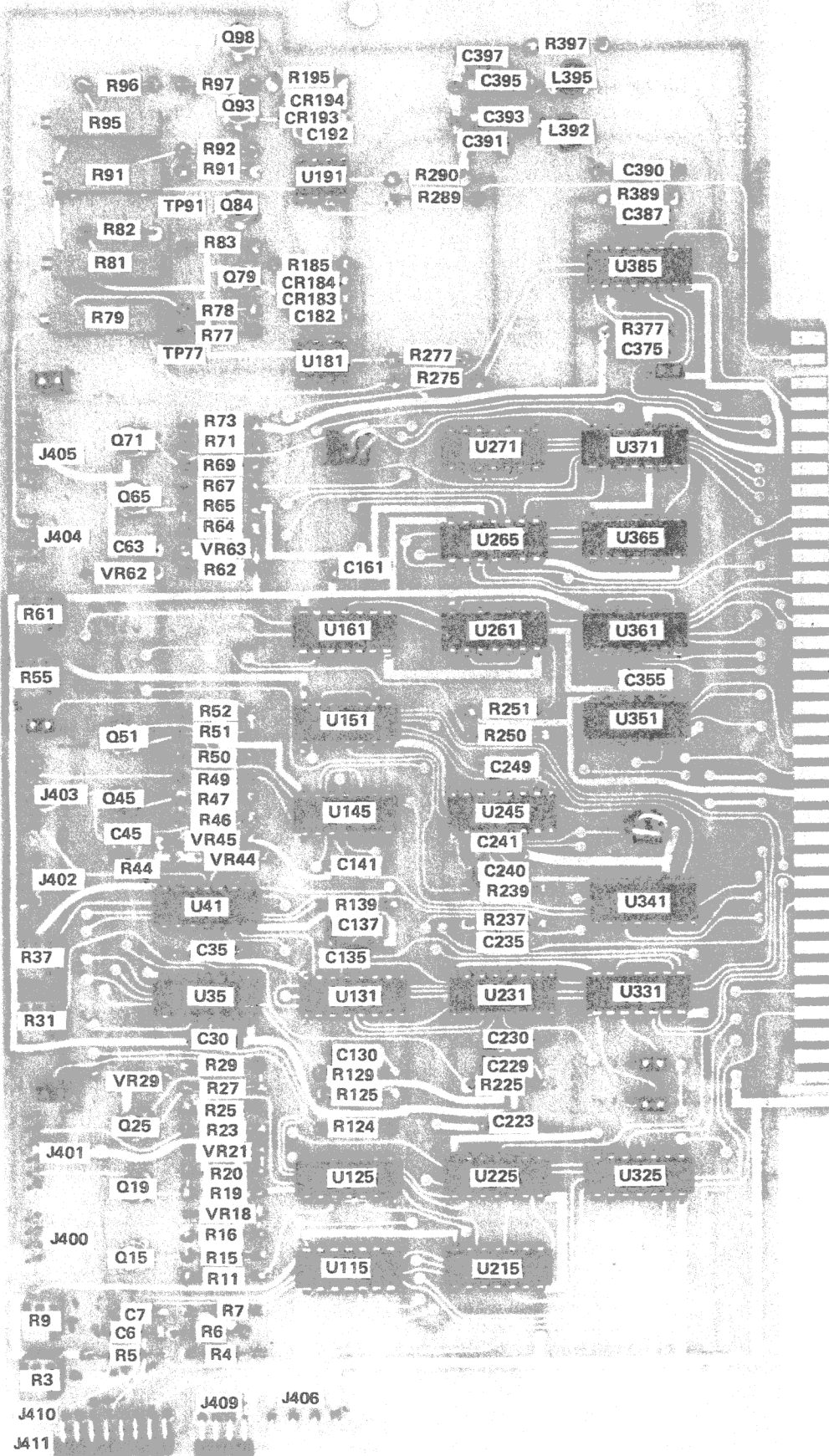
The X and Y Control circuits consist of two amplifier circuits (U191 and U181) which drive the output transistors (Q93/98 and Q79/84 respectively). The amplifiers and their associated adjustments provide for control of the X and Y gain and position to the Display Monitors which are being used with the card. The X and Y deflection signals are common to all monitors connected to the Multiplexer card. The Y GAIN (R91) and X GAIN (R79) adjustments permit the user to adjust the output signal from 1 to 10 volts for full-scale deflection. The 10 volt range is recommended in noisy environments as it provides a better signal-to-noise ratio. The adjustment procedures are described in detail in Section 4 of this manual.

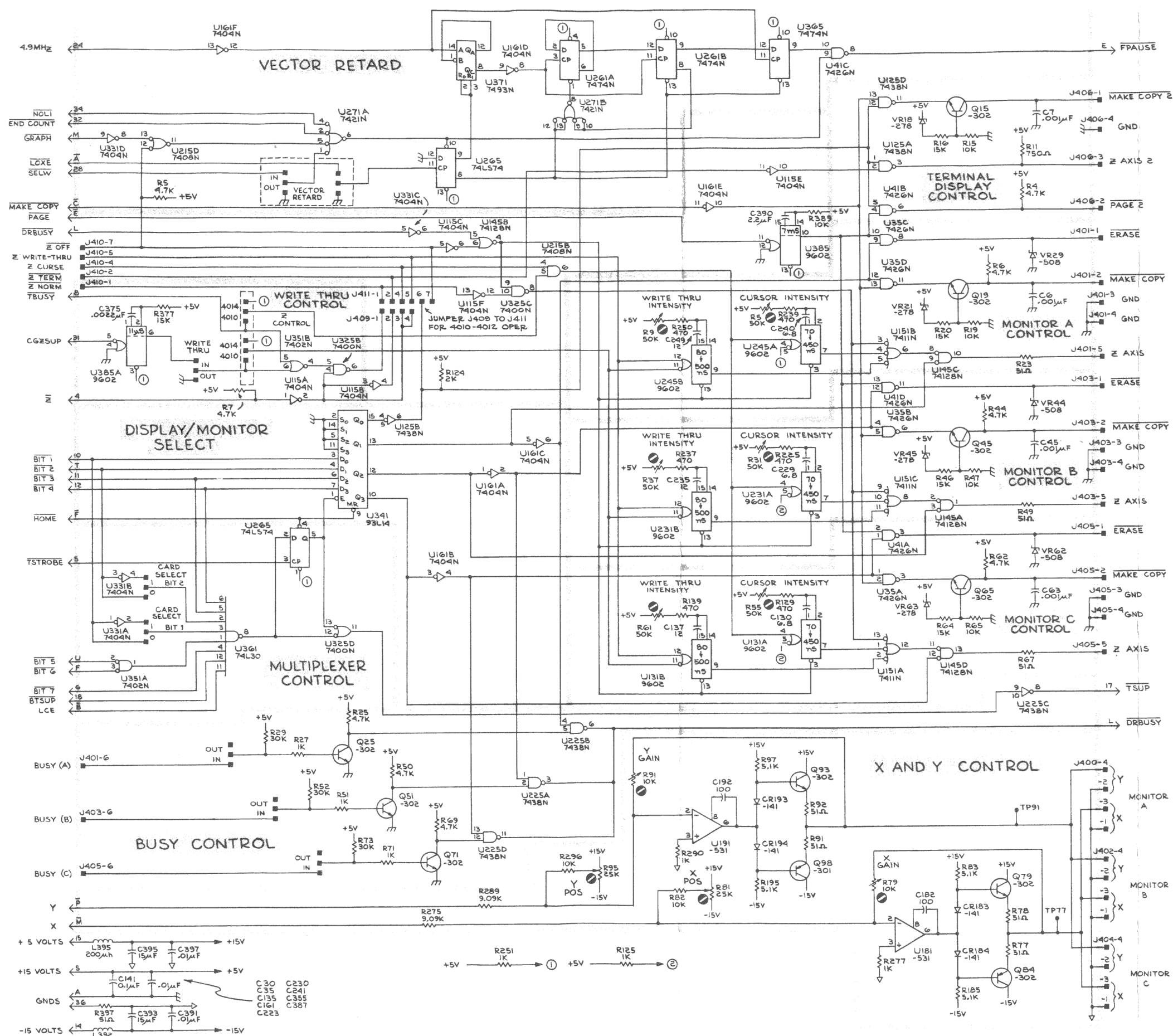
Terminal Display Control

The Terminal Display Control logic performs many of the same functions as the Monitor Control logic. If the Terminal Display Control logic is enabled (U125 pin 6 high), the writing (Z AXIS 2), copying (MAKE COPY 2) and erasing (PAGE 2) of the Terminal display is permitted by the Multiplexer. One major difference between the Monitor Control logic and the Display Control logic is the lack of adjustments in the Display Control logic. All of the display adjustments are contained in the Terminal logic. The Multiplexer simply provides a means for controlling the display when a command is issued to the Terminal. If the Display Control logic is not enabled, writing, copying and erasing will only be acted on by the enabled monitor(s). It is also possible to perform write, erase and copy operations on the Terminal display without writing, copying, or erasing the attached monitor(s).

Vector Retard

The Vector Retard logic is enabled by strap option. The logic consists of a counter (U371), flip-flops U261A, B and U365B. This logic (with U265B) is used to divide the 4.9 MHz clock (from the Terminal bus) and control FPAUSE. FPAUSE is used to slow down the Terminal Vector Generator by a factor of 3. VECTOR RETARD should only be used with 4014 or 4015 Terminals.





O18-0067-02
(FOR USE WITH 4010 THRU 4015)

DISPLAY MULTIPLEXER

REPLACEABLE PARTS LIST

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5      Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
-----*-----
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
-----*-----
Parts of Detail Part
Attaching parts for Parts of Detail Part
-----*-----

```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---*--- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
# NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICON	SEMICONDUCTOR
ADPTR ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
00779	AMP, INC.	P. O. BOX 3608	HARRISBURG, PA 17105
01121	ALLEN-BRADLEY CO.	1201 2ND ST. SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P. O. BOX 5012	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORP.	17070 EAST GALE AVE.	CITY OF INDUSTRY, CA 91745
04713	MOTOROLA, INC., SEMICONDUCTOR PRODUCTS DIV.	5005 E. MCDOWELL RD.	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS ST.	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SAN YSIDRO WAY	SANTA CLARA, CA 95051
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
59730	THOMAS AND BETTS CO., THE	36 BUTLER ST.	ELIZABETH, NJ 07207
71468	ITT CANNON ELECTRIC	666 E. DYER RD.	SANTA ANA, CA 92702
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97077
91418	RADIO MATERIALS CO.	4242 W. BRYN MAWR	CHICAGO, IL 60646

Electrical Parts List

Ckt No.	Tektronix	Serial/Model No.	Name & Description	Mfr	
	Part No.	Eff Dscont		Code	Mfr Part Number
	670-4317-00		CKT BOARD ASSY:DISPLAY MULTIPLEXER	80009	670-4317-00
C6	283-0000-00		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C7	283-0000-00		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C30	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C35	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C45	283-0000-00		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C63	283-0000-00		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C130	281-0572-00		CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000COH0689D
C135	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C137	281-0505-00		CAP.,FXD,CER DI:12PF,+/-1.2PF,500V	72982	301-012COG0120K
C141	283-0023-00		CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX10421201RO
C161	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C182	281-0523-00		CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C192	281-0523-00		CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C223	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C229	281-0572-00		CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000COH0689D
C230	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C235	281-0505-00		CAP.,FXD,CER DI:12PF,+/-1.2PF,500V	72982	301-012COG0120K
C240	281-0572-00		CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000COH0689D
C241	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C249	281-0505-00		CAP.,FXD,CER DI:12PF,10%,500V	72982	301-012-COG0120K
C355	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C375	283-0028-00		CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	19C606
C387	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C390	290-0136-00		CAP.,FXD,ELCTL:2.2UF,20%,20V	56289	162D225X0020CD2
C391	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C393	290-0135-00		CAP.,FXD,ELCTL:15UF,20%,20V	56289	150D156X0020B2
C395	290-0135-00		CAP.,FXD,ELCTL:15UF,20%,20V	56289	150D156X0020B2
C397	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
CR183	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR184	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR193	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR194	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
L392	108-0598-00		COIL,RF:200UH	80009	108-0598-00
L395	108-0598-00		COIL,RF:200UH	80009	108-0598-00
Q15	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q19	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q25	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q45	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q51	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q65	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q71	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q79	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q84	151-0301-00		TRANSISTOR:SILICON,PNP	04713	2N2907A
Q93	151-0302-00		TRANSISTOR:SILICON,NPN	04713	2N2222A
Q98	151-0301-00		TRANSISTOR:SILICON,PNP	04713	2N2907A
R3	311-1286-00		RES.,VAR,NONWIR:50K OHM,10%,0.5W	73138	62PAS-332-0
R4	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R5	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R7	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R9	311-1286-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.5W	73138	62PAS-332-0
R11	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R15	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R16	316-0153-00		RES., FXD, CMPSN: 15K OHM, 10%, 0.25W	01121	CB1531
R19	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R20	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R23	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R25	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R27	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R29	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R31	311-1286-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.5W	73138	62PAS-332-0
R37	311-1286-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.5W	73138	62PAS-332-0
R44	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R46	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R47	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R49	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R50	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R51	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R52	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R55	311-1286-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.5W	73138	62PAS-332-0
R61	311-1286-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.5W	73138	62PAS-332-0
R62	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R64	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R65	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R67	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R69	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R71	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R73	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R77	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R78	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R79	311-1319-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.75W	01121	4SP103
R81	311-1337-00		RES., VAR, NONWIR: 25K OHM, 10%, 0.50W	02111	43P253
R82	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R83	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R91	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R91	311-1319-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.75W	01121	4SP103
R92	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R95	311-1337-00		RES., VAR, NONWIR: 25K OHM, 10%, 0.50W	02111	43P253
R96	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R97	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R124	315-0202-00		RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R125	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R129	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R139	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R185	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R195	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R225	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R237	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R239	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R250	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R251	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R275	321-0285-00		RES., FXD, FILM: 9.09K OHM, 1%, 0.125W	75042	CEAT0-9091F
R277	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr	
	Part No.	Eff	Dscont			Code	Mfr Part Number
R289	321-0285-00				RES., FXD, FILM:9.09K OHM, 1%, 0.125W	75042	CEATO-9091F
R290	315-0102-00				RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
R377	315-0153-00				RES., FXD, CMPSN:15K OHM, 5%, 0.25W	01121	CB1535
R389	315-0103-00				RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
R397	315-0510-00				RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
U35	156-0112-00				MICROCIRCUIT, DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U41	156-0112-00				MICROCIRCUIT, DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U115	156-0058-00				MICROCIRCUIT, DI:HEX. INVERTER	01295	SN7404N
U125	156-0145-00				MICROCIRCUIT, DI:QUAD 2-INPUT POS NAND BFR	01295	SN7438N
U131	156-0405-00				MICROCIRCUIT, DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
U145	156-0451-00				MICROCIRCUIT, DI:QUAD 2-INPUT NOR BUFFER	01295	SN74128N
U151	156-0163-00				MICROCIRCUIT, DI:TRIPLE 3-INPUT POS AND GATE	18324	N7411A
U161	156-0058-00				MICROCIRCUIT, DI:HEX. INVERTER	01295	SN7404N
U181	156-0511-00				MICROCIRCUIT, LI:OPERATIONAL AMPLIFIER	18324	NE531V
U191	156-0511-00				MICROCIRCUIT, LI:OPERATIONAL AMPLIFIER	18324	NE531V
U215	156-0129-00				MICROCIRCUIT, DI:QUAD 2-INPUT GATE	01295	SN7408N
U225	156-0145-00				MICROCIRCUIT, DI:QUAD 2-INPUT POS NAND BFR	01295	SN7438N
U231	156-0405-00				MICROCIRCUIT, DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
U245	156-0405-00				MICROCIRCUIT, DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
U261	156-0041-00				MICROCIRCUIT, DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U265	156-0388-00				MICROCIRCUIT, DI:DUAL D-TYPE FLIP-FLOP	01295	SN74LS74N
U271	156-0297-00				MICROCIRCUIT, DI:DUAL 4-INPUT AND GATE	18324	N7421A
U325	156-0030-00				MICROCIRCUIT, DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U331	156-0058-00				MICROCIRCUIT, DI:HEX. INVERTER	01295	SN7404N
U341	156-0327-00				MICROCIRCUIT, DI:QUAD LATCH	07263	93L14DC
U351	156-0043-00				MICROCIRCUIT, DI:2-INPUT NOR GATE	80009	156-0043-00
U361	156-0267-00				MICROCIRCUIT, DI:8-INPUT NAND GATE	01295	SN74L30N
U365	156-0041-00				MICROCIRCUIT, DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U371	156-0032-00				MICROCIRCUIT, DI:4-BIT BINARY COUNTER	01295	SN7493AN
U385	156-0405-00				MICROCIRCUIT, DI:DUAL RETRIG MONOSTABLE MV	07263	9602PC
VR18	152-0278-00				SEMICONV DEVICE:ZENER, 0.4W, 3V, 5%	07910	1N4372A
VR21	152-0278-00				SEMICONV DEVICE:ZENER, 0.4W, 3V, 5%	07910	1N4372A
VR29	152-0508-00				SEMICONV DEVICE:ZENER, 0.4W, 12.5V, 5%	80009	152-0508-00
VR44	152-0508-00				SEMICONV DEVICE:ZENER, 0.4W, 12.5V, 5%	80009	152-0508-00
VR45	152-0278-00				SEMICONV DEVICE:ZENER, 0.4W, 3V, 5%	07910	1N4372A
VR62	152-0508-00				SEMICONV DEVICE:ZENER, 0.4W, 12.5V, 5%	80009	152-0508-00
VR63	152-0278-00				SEMICONV DEVICE:ZENER, 0.4W, 3V, 5%	07910	1N4372A

Mechanical Parts List

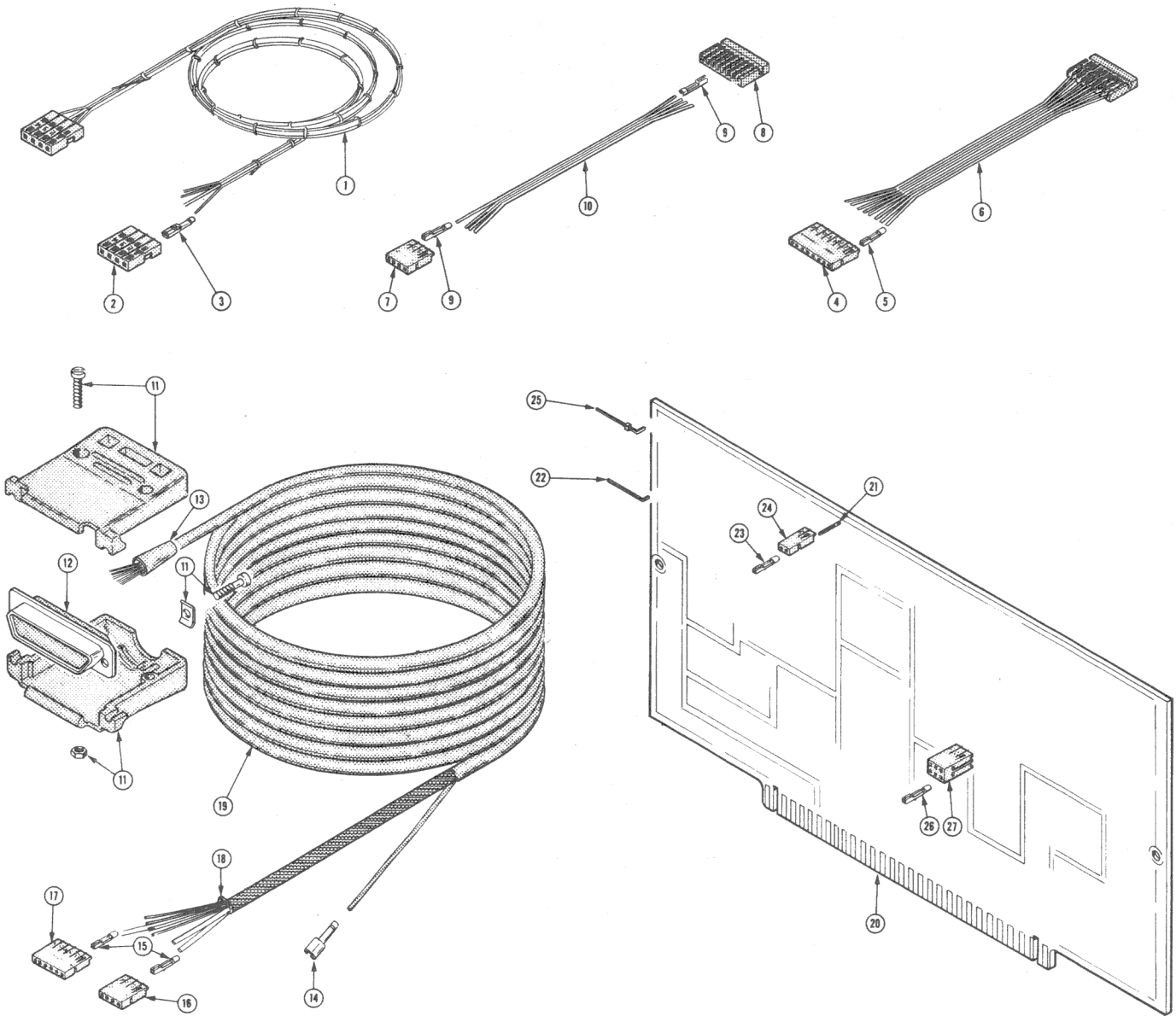


Fig. & Index No.

Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
	018-0067-02			1						CKT BOARD ASSY:DISPLAY MULTIPLEXER	80009	018-0067-02
-1	179-1981-00			1						WIRING HARNESS:MUX	80009	179-1981-00
-2	352-0200-00			2						CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0200-00
-3	131-0621-00			4						CONTACT,ELEC:0.577"L,22-26 AWG WIRE	22526	46231
	131-0622-00			2						CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
	131-0792-00			2						CONTACT,ELEC:0.577"L,18-20 AWG WIRE	22526	46221
	175-1752-00			1						CA ASSY,SP ELEC:8.26 AWG,0.5" L	80009	175-1752-00
-4	352-0166-00			1						CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
	352-0166-01			1						CONN BODY,PL,EL:8 WIRE BROWN	80009	352-0166-01
-5	131-0707-00			16						CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
-6	175-0831-00			FT						WIRE,ELECTRICAL:8 WIRE RIBBON	08261	TEK-175-0831-00
	175-1753-00			1						CA ASSY,SP,ELEC:4.26 AWG,3.5" L	80009	175-1753-00
-7	352-0162-09			1						CONN BODY,PL,EL:4 WIRE WHITE	80009	352-0162-09
-8	352-0166-00			1						CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
-9	131-0707-00			8						CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
-10	175-0827-00			FT						WIRE,ELECTRICAL:4 WIRE RIBBON	08261	TEK-175-0827-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty						Name & Description	Mfr Code	Mfr Part Number
				1	2	3	4	5			
	012-0662-00		1	.	.	.	.	.	CABLE,INTCON:240.0 INCHES LONG	80009	012-0662-00
-11	200-1667-00		1	.	.	.	.	.	SHLD,ELEC CONN:FOR 25 PIN CONN,W/HARDWARE	00779	5091-153-1
-12	131-0570-00		1	.	.	.	.	.	CONNECTOR,RCPT,:25 PIN,MALE	71468	DB25P
-13	200-1104-00		1	.	.	.	.	.	CABLE NIP,ELEC:	80009	200-1104-00
-14	131-1159-00		1	.	.	.	.	.	CONTACT,ELEC:250 FASTEN	00779	60041-2
-15	131-0707-00		7	.	.	.	.	.	CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
	131-0708-00		3	.	.	.	.	.	CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
-16	352-0162-00		1	.	.	.	.	.	CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0162-00
-17	352-0164-00		1	.	.	.	.	.	CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
-18	343-0549-00		1	.	.	.	.	.	STRAP,TIEDOWN:0.091 W X 3.62" L,ZYTEL	59730	TY23M
-19	175-1695-00		FT	.	.	.	.	.	CABLE,SP,ELEC:3-50 OHM COAX,9-26 AWG, 1-22 AWG,20 FEET LONG	80009	175-1695-00
-20	-----		1	.	.	.	.	.	CKT BOARD ASSY:DISPLAY MULTIPLEXER(SEE EPL)		
-21	131-0608-00		12	.	.	.	.	.	CONTACT,ELEC:0.365 INCH LONG	22526	47357
-22	131-0787-00		4	.	.	.	.	.	CONTACT,ELEC:0.64 INCH LONG	22526	47359
	131-0993-00		6	.	.	.	.	.	LINK,TERM.CONNE:2 WIRE BROWN	00779	530153-2
	-----		-	.	.	.	.	.	EACH CONNECTOR INCLUDES:		
-23	131-0707-00		2	.	.	.	.	.	CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
-24	352-0169-00		1	.	.	.	.	.	CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
-25	131-1425-00		8	.	.	.	.	.	CONTACT SET,ELE:R ANGLE,0.150" L	22526	65275-001
	131-1426-00		12	.	.	.	.	.	CONTACT SET,ELE:R ANGLE,0.250L,STRIP OF 36	22526	65275-004
	131-1848-00		1	.	.	.	.	.	LINK,TERM.CONNE:2,26 AWG,1.25 L	80009	131-1848-00
-26	131-0707-00		4	.	.	.	.	.	CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
-27	352-0177-00		1	.	.	.	.	.	CONN BODY,PL,EL:6 WIRE,DBL ROW BLACK	80009	352-0177-00

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 nsec into 50 Ω .	107 - Risetime less than 3.0 nsec into 50 Ω .
108	PG 501 - 5 V output pulse; 3.5 nsec Risetime.	108 - 10 V output pulse; 1 nsec Risetime.
111	PG 501 - Risetime less than 3.5 nsec; 8 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger Pulse delay.
114	PG 501 - ± 5 V output.	114 - ± 10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 5 V dc Offset; short proof output. Has ± 5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 10 V output. Short proof output.
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output.
111	PG 502 - Risetime less than 1 nsec; 10 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger pulse delay.
114	PG 502 - ± 5 V output.	114 - ± 10 V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 5 V output. Short proof output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 10 V output. Short proof output.
2101	PG 502 - Does not have Paired, Delayed, Undelayed and output locked mode; ± 5 V output.	2101 - Paired, Delayed, Undelayed and output locked on mode; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude, 60 V output.	106 - Positive and Negative-going trigger output signal, 50 nsec and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B, 191	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	180A - Marker outputs, 5 sec to 1 μ s. Sinewave available at 5, 10, and 50 MHz. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be stacked.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000, plus 10 MHz sinewave.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	2901 - Marker outputs, 5 sec to 0.1 μ s. Sinewave available at 5, 10, and 50 ns. Separate trigger pulses, from 5 sec to 0.1 μ s. Multiple time-marks can be stacked.