PS 390 PERIPHERALS

REFERENCE MANUAL

EVANS & SUTHERLAND

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PREFACE

With the introduction of the PS 390, Evans & Sutherland is marketing a new LC Peripheral Set to replace the standard PS 300 peripherals in some applications. This manual addresses the functionality of those new peripherals.

This version of the *PS 390 Peripherals Reference* manual is intended to be used as a supplement to the *PS 300 Document Set* (specifically Volumes 1 and 5). The hardware changes incorporated into the new LC Peripherals for the PS 390 should be transparent to the user. The exceptions are noted in this manual.

Section One briefly introduces the PS 390 Peripherals

Section Two covers the Peripheral Multiplexer.

Section Three deals with the PS 390 Keyboards.

Section Four is a description of the Function Button Array.

Section Five is a description of the Control Dials.

Section Six introduces and describes the Data Tablets.

Section Seven covers the Optical Mouse.

Section Eight briefly introduces the Raster Display.

Please let us know if this material meets your needs. We welcome your comment and your corrections (if any) concerning this manual. A Reader Comment Form is included with this manual for your convenience.

RELATED DOCUMENTS

Other documents which may relate to the operation of the PS 390 Peripherals are:

PS 300 Document Set

The PS 390 Release Notes

The GTCO Data Tablet Users Manual

CONTENTS

FIGURES

TABLES

Table 2. Pin Assignments for the PS 300 Peripherals Multiplexer

Designation	*Connector*	*Pinout*
32-Key Buttons Dials Keyboard	RJ-11 90 degree PC Mount	1...+12 VDC 2...Ground 3...RS-422 OUT B 4...RS-422 IN B 5...RS-422 IN A 6...RS-422 OUT A 7...Ground 8...+12 VDC
Data Tablet Mouse	7-Pin Micro DIN (Hosiden)	1...Signal & Power Ground 2...Rec. Data from Device 3...Xmit Data to Device 4...-12 VDC for RS-232C 5...+5 VDC 6...+12 VDC 7...Device Present Shell - Chassis Ground
Graphics Controller	Amphenol 25 Pin D 117-DBMM-25SA (Military Socket including locking screw assembly)	1...Chassis Ground 2...Transmitted Data 3...Received Data 7...Signal Ground Other Pins not used

Table 3. Pin Assignments for the LC Peripherals Multiplexer

Designation	*Connector*	*Pinout*
32-Key Buttons Dials	DuPont 68290-101 (2 rows of 4 pins)	1...+5 VDC 2...Ground 3...Device Present 4...Unused 5...+12 VDC 6...-12 VDC 7...TX Data. 8...RX Data E.S.D. Shield-Chassis Ground
Keyboard	5 Pin DIN (5 contacts at 180 Degree Socket)	1...Signal Ground 2...Data In 3...Data Out 4...Signal Ground 5...+5 VDC Shell - Chassis Ground
Data Tablet Mouse	7-Pin Micro DIN (Hosiden)	1...Signal & Power Ground 2...Rec. Data from Device 3...Xmit Data to Device 4...-12 VDC for RS-232C 5...+5 VDC 6...+12 VDC 7...Device Present Shell - Chassis Ground
Graphics Controller	Amphenol 25 Pin D 117-DBMM-25SA (Military Socket including locking screw assembly)	1...Chassis Ground 2...Transmitted Data 3...Received Data 7...Signal Ground Other Pins not used

2.1 FUNCTIONAL CHARACTERISTICS

The Peripheral Multiplexer or MUX consists of a circuit card to which six input ports and one output port in addition to the input power port are connected. The six input ports support the following peripheral devices:

- The Keyboard
- The Control Dials
- A 32-Key Function Button Array
- A Data Tablet
- Spare Port for a Mouse or other device
- A Light Pen (Not Supported)

The function of the MUX is to receive input data from the peripheral devices and to multiplex the data onto an RS-232C output port to the PS 390, and to accept the data from the terminal controller and de-multiplex it to the various peripheral devices which are connected to it.

2.1.1 PS 300 Peripheral Set Device Addressing

The MUX has five active input ports on the front of the box, 1 output port on the rear of the box and 3 power connectors on the rear of the box. Device addressing assigns numbers to the ports. When one faces the front of the box the leftmost connector is a 7-Pin Micro DIN. It is for connection of a mouse when one is used. This port is addressed as port x'B4'. The next three connectors toward the right are RJ-11 connectors. The leftmost of these connectors is for the 32-Key Lighted Function Buttons and is addressed as port x'B3'. The next connector is for the control dials and is addressed as port x'B2'. The rightmost RJ-11 connector is for the keyboard and is addressed as port x'B1'. The 7-Pin Micro DIN connector at the right of the front panel is for the data tablet and is addressed as port x'B6'. When control messages are sent to the MUX box itself, they are addressed to port x'B0'.

2.1.2 LC Peripheral Set Device Addressing

The MUX has five active input ports on the front of the box, 1 output port on the rear of the box and 3 power connectors on the rear of the box. Device addressing assigns numbers to the ports. When one faces the front of the box the leftmost connector is a 7-Pin Micro DIN. It is for connection of a mouse when one is used. This port is addressed as port x'B4'. The next two connectors toward the right are ''Latch-N-Lock'' connectors. The leftmost of these connectors is for the 32-Key Lighted Function Buttons and is addressed as port x'B3'. The rightmost one of these DuPont connectors is for the control dials and is addressed as port x'B2'. The five-pin DIN connector is for the keyboard and is addressed as port x'B1'. The 7-Pin Micro DIN connector at the right of the front panel is for the data tablet and is addressed as port x'B6'. When control messages are sent to the MUX box itself, they are addressed to port x'B0'. These addresses are used for software compatibility with previous systems.

2.1.3 Light Pen

The PS 390 does not presently support the use of a Light Pen. A connector has been provided on the Peripheral Multiplexer to accommodate one in the future. At present, however, a Light Pen is not planned for the PS 390.

2.2 TRANSMISSION CHARACTERISTICS

2.2.1 Multiplexing and De-Multiplexing

When peripheral data is received from an input port, the MUX queues the data to the output port for transmission to the host. If the last byte sent is from the same input device, then the MUX sends just that queued byte unless it is in the range of x'B0' to x'BF'. In that case it prefixes the queued byte with another byte with the value of x'B7'. If the data is from a different input device, then the MUX prefixes that byte only with the address of the device port, i.e., a value in the range of x'B0' to x'B6'. The MUX does not send another device port address until the source of the n+1st data byte differs from the source of the nth data byte.

When data is received from the host or terminal controller, the MUX sends the data byte received to the last addressed peripheral device until it receives a new port address in the range x'B0' through x'B6'. It then sends all subsequently received data to that address until it receives a new address.

2.2.2 Flow Control

The flow of data to the peripheral devices is shut down when the MUX sends the sequence x'B030' to the PS 390. This sequence is the equivalent of ''XOFF'' in asynchronous protocols and is used to protect against the overrun of MUX buffers. When the MUX resumes receiving data from the PS 390, it sends the sequence x'B040'. This sequence is the equivalent to ''XON'' in asynchronous protocols.

2.2.3 Data Framing and Transmission Rates

The data sent to and from the MUX is asynchronous data with each byte containing eight data bits without parity plus one start bit and one stop bit. The data transmission rate of the MUX to and from the PS 390 is 19,200 baud. The transmission rates between the various peripherals and the MUX are shown in Table 4.

Table 4. Peripheral Device Transmission Rates

Device	*Baud Rate*
Keyboard Port x'B1' with Standard Keyboard	1200 Baud
" " with Dual Function Keyboard	9600 Baud
Control Dials Port x'B2'	9600 Baud
32 Func. Buttons Port x'B3'	9600 Baud
Mouse Port x'B4'	9600 Baud
Data Tablet Port x'B6'	9600 Baud

2.3 DIAGNOSTIC LOOPBACK

The MUX will respond with the sequence x'B060' whenever it receives the sequence x'B0B9' from the PS 390. This response informs the PS 390 that the MUX is powered on and working, (meaning that it will recognize commands and respond to them).

3. THE PS 390 KEYBOARDS

The PS 390 can use three different keyboards:

1. The standard PS 390 Keyboard is a DEC VT220-style keyboard with a few minor modifications.
2. The Dual Function Switchable Keyboard which is a 5085 Model 2 look-alike keyboard.
3. The PS 300 Keyboards: E&S #204201-100 with LEDs and E&S #204201-101 without LEDs.

The PS 300 keyboard has its own peripheral multiplexer to accommodate it. PS 300 keyboard operation is described in detail in the PS 300 Document Set Volumes 1 & 5.

The VT220 look-alike keyboard and the Dual Function Switchable keyboard must plug into the peripheral multiplexer which supports the LC peripheral set. Both keyboards meet safety and EMI/ESD qualifications. Neither of the keyboards have LEDs for labeling of the function keys. Figure 5 shows the PS 390 DEC VT220-style keyboard.

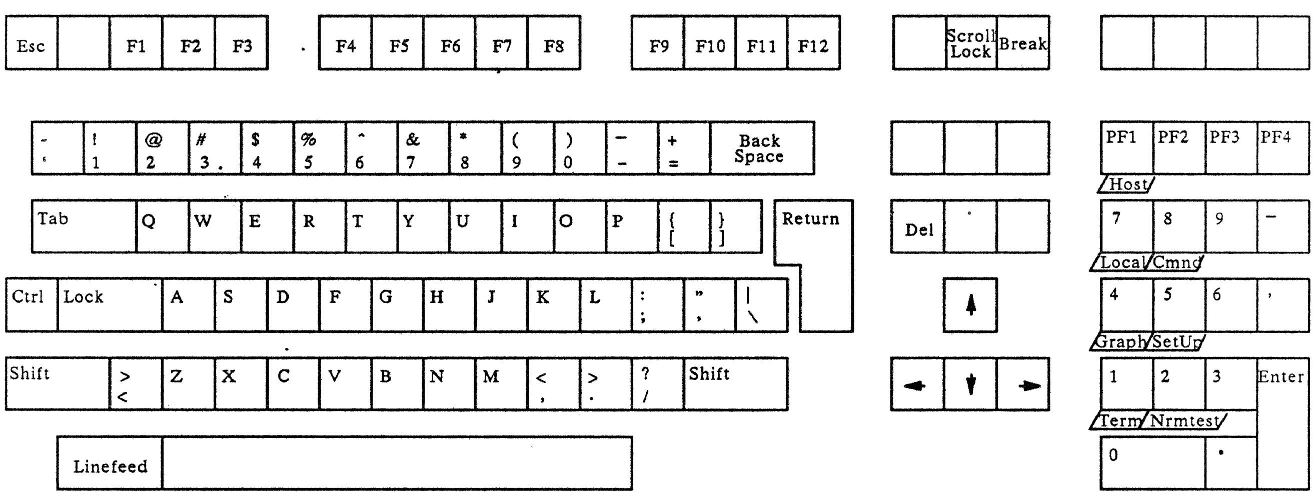

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Figure 5. The PS 390 DEC VT220-Style Keyboard

The PS 390 Keyboards main function is the generation and transmission of ASCII displayable characters, ASCII control characters, and PS 390 system sequences.

The Dual Function Switchable keyboard is also capable of having its output data stream interpreted as EBCDIC data (which is its principal mode of operation). These data are transmitted serially to the peripheral multiplexer. The transmitted data specifies displayed characters, commands, menu/table selections, etc.

The only operator controls located on the keyboard are the 95 keys used for data input.

The assembled keyboard measures 21.1 inches (53.6 cm) long by 8.25 inches (20.9 cm) deep. The keyboard stands 3.5 inches (8.9 cm) high on four rubber feet.

3.1 INTERFACE CABLE

The Interface Cable is a 5-conductor, flexible cable with a shielded DIN plug which connects the PS 390 Keyboard to the front of the Peripheral Multiplexer. The cable may be stretched to permit many different work station arrangements.

3.2 KEYBOARD OPERATION

The PS 390 Keyboard allows the operator to input ASCII characters and other sequences to the Joint Control Processor by means of a typewriter-like keyboard. Keyboard operation is discussed in detail in the following paragraphs.

3.2.1 Data Entry

The PS 390 Keyboard features a layout that makes data entry fast and easy. All keys are momentary-closure devices.

The keys fall into eight general categories:

1.Keyboard Function Control

2.Alphabetic

3.Standard Numeric

4.Special Character

5.Terminal Function

6.PS 390 Function

7.Numeric/Application Mode

8.PS 390 Device Control

The Keyboard Function Control keys are used to modify the codes produced by other keys. In this way, characters are defined as uppercase, lowercase, control, etc. No codes are transmitted when these keys are depressed individually or in combination with each other.

The Alphabetic, Standard Numeric, Special Character, and Terminal Function keys all generate standard ASCII characters. Depressing any of these keys alone or in combination with SHIFT and/or CTRL causes 7-bit character codes or control codes to be transmitted from the keyboard to the Joint Control Processor.

The PS 390 Function, Numeric Keypad/Application Mode and Device Control keys are system-oriented. Depressing any of these keys alone or in combination with SHIFT and/or CTRL causes special two-byte PS 390 system sequences to be generated and transmitted to the JCP.

The following is a detail description with figures of the eight general key categories.

3.2.2 Keyboard Function Control Keys

The Keyboard Function Control keys (shown in gray in Figure 6) are un-encoded, local controls. No codes are transmitted when these keys are struck individually or in combination with each other.

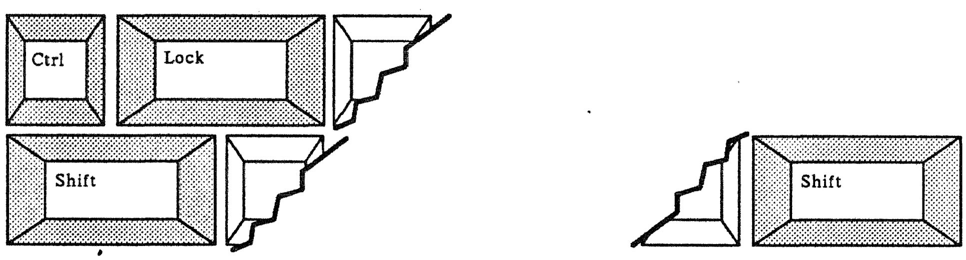


Figure 6. Keyboard Function Control Keys

The Keyboard Function Control keys are used to modify the codes transmitted by other keys, as follows.

When either SHIFT key is depressed simultaneously with a displayable character key, the uppercase code for that key is generated. If the key does not have an uppercase function, the SHIFT key is ignored. For example, striking the A key causes the code B'01100001' for the character **a** to be transmitted; the sequence **SHIFT A** causes the code B'01000001 for the character A to be transmitted. Note that bit 6 is forced low to define an uppercase character.

When CTRL is depressed simultaneously with one of keys A–Z (uppercase only), the space bar, or the Special Character keys, [,], \, or ?, an ASCII control code is generated. For example, the **CTRL Z** keyboard sequence causes the code B'00011010' to be generated. Note that the only difference between this code and that for **Z** (B'01011010') is that bit 7 is forced low to define the control code.

When the SHIFT and CTRL keys are depressed simultaneously, the CTRL function is selected in most cases. The only exceptions occur with the - and / keys. **SHIFT CTRL** - causes the control character **RS** (B'00011110') to be transmitted. **SHIFT CTRL** \ causes the control character **US** (B'00011111') to be transmitted. The auto-repeat feature is enabled on all keys except: F1 through F12, SETUP, GRAPH, HOST, CMMD, LOCAL, TERM, LOCK, CTRL, SHIFT (both keys), RETURN, and all numeric pad keys. When any other key is held down, repeated character transmission occurs. The rate is 15 ±2 Hz.

Depressing the SHIFT LOCK key enables the "shift lock" function. This is a shift operation that applies to all keys. Depressing either of the two shift keys causes the "shift lock" mode to be disabled.

3.2.3 Alphabetic Keys

The Alphabetic Keys (shown in gray in Figure 7) are used to produce uppercase and lowercase ASCII displayable character codes and ASCII control codes. Tables 5 and 6 show the code and character produced when each key is struck alone, with the SHIFT key, or with the CTRL key.

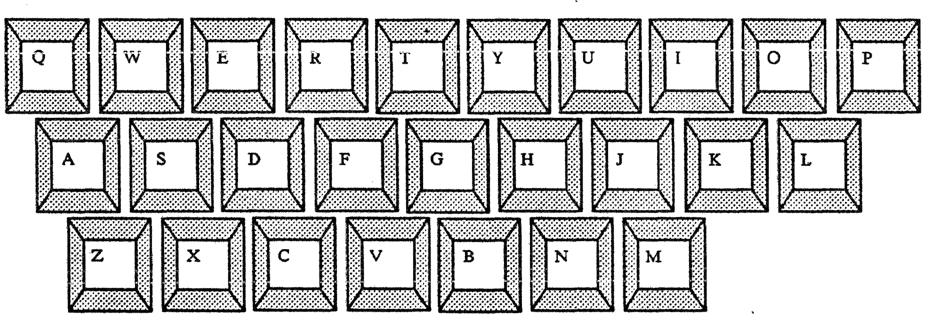


Figure 7. Keyboard Alphabetic Keys

Table 5. Alphabetic Key Codes

Key Label	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
	Code	*Char*	*Code*	*Char*	*Code*	*Char*
A	X'61' 97	a	X'41' 65	A	X'01' 1	SOH
B	X'62' 98	b	X'42' 66	B	X'02' 2	STX
C	X'63' 99	c	X'43' 67	C	X'03' 3	ETX
D	X'64' 100	d	X'44' 68	D	X'04' 4	EOT
E	X'65' 101	e	X'45' 69	E	X'45' 5	ENQ
F	X'66' 102	f	X'46' 70	F	X'06' 6	ACK
G	X'67' 103	g	X'47' 71	G	X'07' 7	BEL
H	X'68' 104	h	X'48' 72	H	X'08' 8	BS
I	X'69' 105	i	X'49' 73	I	X'09' 9	HT
J	X'6A' 106	j	X'4A' 74	J	X'0A' 10	LF
K	X'6B' 107	k	X'4B' 75	K	X'0B' 11	VT
L	X'6C' 108	l	X'4C' 76	L	X'0C' 12	FF
M	X'6D' 109	m	X'4D' 77	M	X'0D' 13	CR
N	X'6E' 110	n	X'4E' 78	N	X'0E' 14	SO

(Continued on Next Page)

Table 5. Alphabetic Key Codes – Continued

Key Label	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
	Code	*Char*	*Code*	*Char*	*Code*	*Char*
O	X'6F' 111	o	X'4F' 79	O	X'0F' 15	SI
P	X'70' 112	p	X'50' 80	P	X'10' 16	DLE
Q	X'71' 113	q	X'51' 81	Q	X'11' 17	DC1
R	X'72' 114	r	X'52' 82	R	X'12' 18	DC2
S	X'73' 115	s	X'53' 83	S	X'13' 19	DC3
T	X'74' 116	t	X'54' 84	T	X'14' 20	DC4
U	X'75' 117	u	X'55' 85	U	X'15' 21	NAK
V	X'76' 118	v	X'56' 86	V	X'16' 22	SYN
W	X'77' 119	w	X'57' 87	W	X'17' 23	ETB
X	X'78' 120	x	X'58' 88	X	X'18' 24	CAN
Y	X'79' 121	y	X'59' 89	Y	X'19' 25	EM
Z	X'7A' 122	z	X'5A' 90	Z	X'1A' 26	SUB

3.2.4 Standard Numeric Keys

The shiftable Standard Numeric keys (shown in gray in Figure 8) are similar to the shiftable numeric/symbol keys that appear on a typewriter; they generate ASCII displayable numbers and symbols. The CTRL key is ignored when used with these keys. Table 6 shows the code and character produced when each key is struck alone, with the SHIFT key, or with the CTRL key.

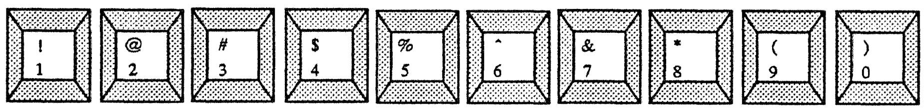


Figure 8. Keyboard Standard Numeric Keys

Table 6. Standard Numeric Key Codes

Key Label	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
	Code	*Char*	*Code*	*Char*	*Code*	*Char*
0	X'30' 48	0	X'29' 41	)	X'30' 48	0
1	X'31' 49	1	X'21' 33	!	X'31' 49	1
2	X'32' 50	2	X'40' 64	@	X'32' 50	2
3	X'33' 51	3	X'23' 35	#	X'33' 51	3
4	X'34' 52	4	X'24' 36	$	X'34' 52	4
5	X'35' 53	5	X'25' 37	%	X'35' 53	5
6	X'36' 54	6	X'5E' 94	∧	X'36' 54	6
7	X'37' 55	7	X'26' 38	&	X'37' 55	7
8	X'38' 56	8	X'2A' 42	*	X'38' 56	8
9	X'39' 57	9	X'28' 40	(	X'39' 57	9

3.2.5 Special Character Keys

The shiftable Special Character keys (shown in gray in Figure 9) are used to produce both ASCII displayable characters and ASCII control characters. Table 7 shows the codes and characters produced when these keys are activated alone, with the SHIFT key, and with the CTRL key. Note the varying response given to the CTRL key; in some instances, the unshifted key character is produced. In other cases, a control character is generated.

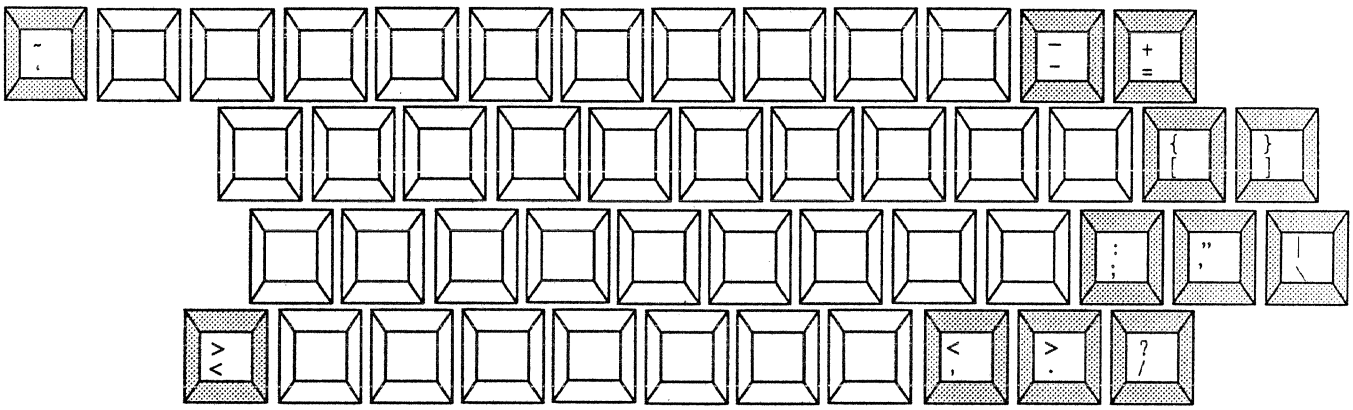


Figure 9. Keyboard Special Character Keys

Table 7. Special Character Key Codes

Key Label	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
	Code	*Char*	*Code*	*Char*	*Code*	*Char*
_ -	X'2D' 45	- (minus)	X'5F' 95	_ (underline)	X'2D' 45	- (minus)
+ =	X'3D' 61	=	X'2B' 43	+	X'3D' 61	=
~ `	X'60' 96	~	X'7E' 126	`	X'1E' 30	RS
{ [	X'5B' 91	[	X'7B' 123	{	X'1B' 27	ESC
}]	X'5D' 93	]	X'7D' 125	}	X'1D' 29	GS
| \	X'5C' 92	\	X'7C' 124	|	X'1C' 28	FS
: ;	X'3B' 59	;	X'3A' 58	:	X'3B' 59	;
" '	X'27' 39	'	X'22' 34	"	X'27' 39	'
< ,	X'2C' 44	,	X'3C' 60	<	X'2C' 44	,
> .	X'2E' 46	.	X'3E' 62	>	X'2E' 46	.
? /	X'2F' 47	/	X'3F' 63	?	X'1F' 31	US
> <	X'2C' 44	<	X'2E' 46	>	X'2C' 44	<

3.2.6 Terminal Function Keys

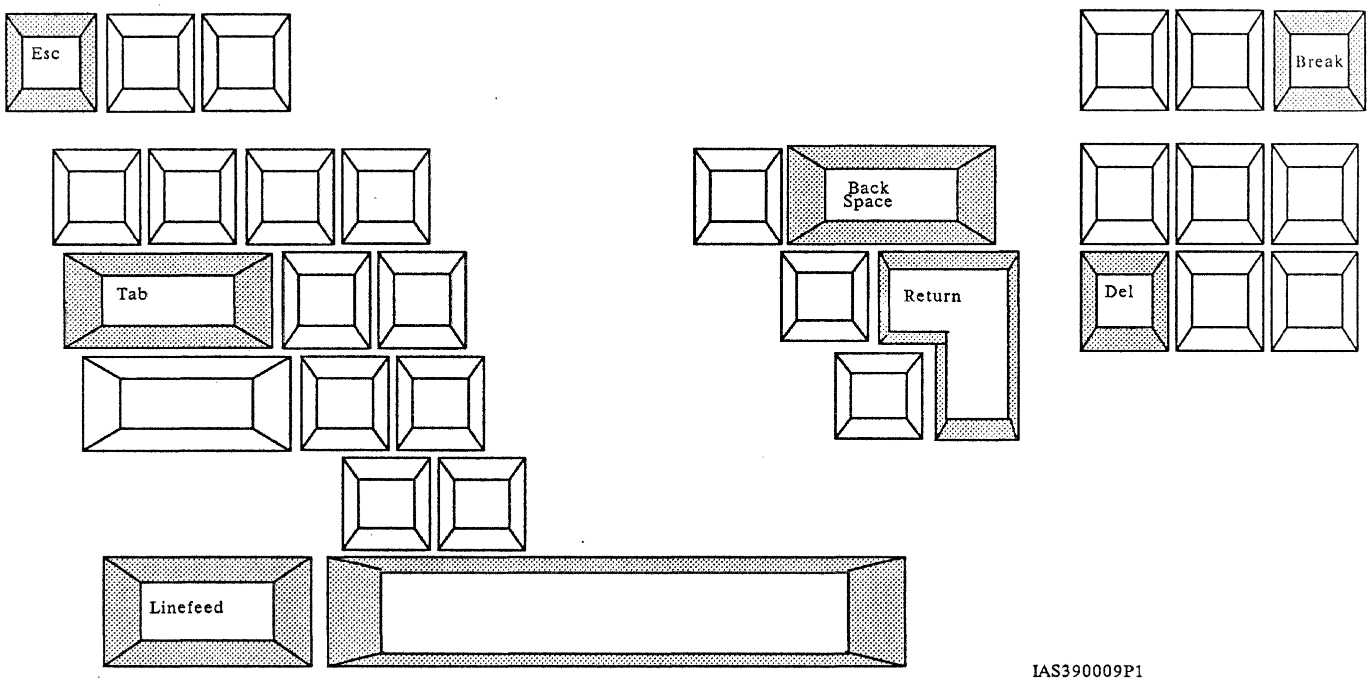


Figure 10. Keyboard Terminal Function Keys

The Terminal Function keys (shown in gray in Figure 10) produce codes used by a typical video display terminal. These keys enable an operator to generate any commonly used terminal control character with a single keystroke. (The codes produced by these keys are identical to those generated by the conventional two-key control sequences described in Table 8.)

Note that the SHIFT and CTRL keys have no effect on the codes produced by the Terminal Function keys, except for the **CTRL Space Bar** sequence that generates an ASCII **NUL** character.

Table 8 Terminal Function Key Codes lists the codes and characters generated by the Terminal Function keys.

Table 8. Terminal Function Key Codes

Key Label	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
	Code	*Char*	*Code*	*Char*	*Code*	*Char*
BREAK	X'A0' 160		X'A0' 160		X'A0' 160	
BACK SPACE	X'08' 8	BS	X'08' 8	BS	X'08' 8	BS
DEL	X'7F' 127	DEL	X'7F' 127	DEL	X'7F' 127	DEL
RETURN	X'0D' 13	CR	X'0D' 13	CR	X'0D' 13	CR
LINE FEED	X'0A' 10	LF	X'0A' 10	LF	X'0A' 10	LF
ESC	X'1B' 27	ESC	X'1B' 27	ESC	X'1B' 27	ESC
TAB	X'09' 9	HT	X'09' 9	HT	X'09' 9	HT
(none; space bar)	X'20' 32	(space)	X'20' 32	(space)	X'00' 0	NUL

3.2.7 PS 390 Function Keys

The PS 390 Function keys (shown in gray in Figure 11) are used to transmit special 2-byte system sequences. Table 9 shows the codes for these keys.

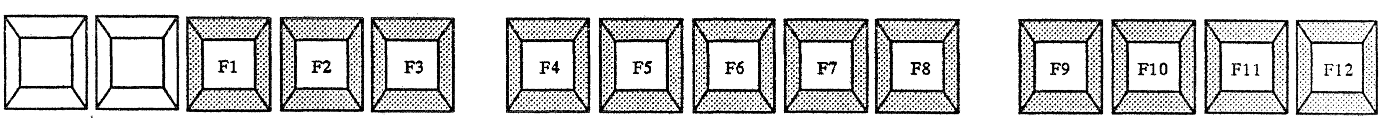


Figure 11. Keyboard PS 390 Function Keys

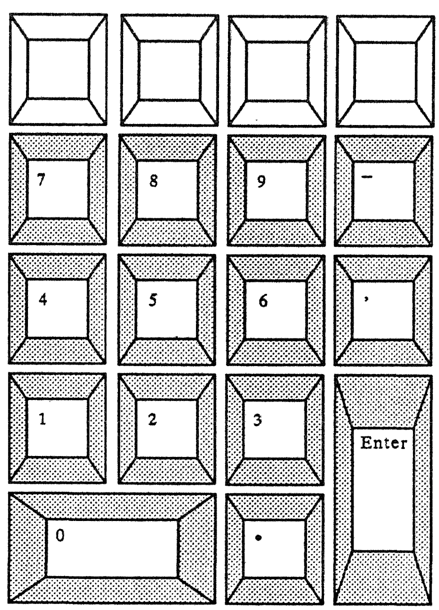
Table 9. PS 390 Function Key Codes

Key Label	*Key Alone Code*	*Key+SHIFT Code*	*Key+CTRL Code*
F1	X'1661	X'1641'	X'1601'
F2	X'1662	X'1642'	X'1602'
F3	X'1663'	X'1643'	X'1603'
F4	X'1664'	X'1644'	X'1604'
F5-	X'1665'	X'1645'	X'1605'
F6	X'1666'	X'1646'	X'1606'
F7	X'1667'	X'1647'	X'1607'
F8	X'1668'	X'1648'	X'1608'
F9	X'1669'	X'1649'	X'1609'
F10	X'166A'	X'164A'	X'160A'
F11	X'166B'	X'164B'	X'160B'
F12	X'166C'	X'164C'	X'160C'

3.2.8 Numeric/Application Mode Keys

The Numeric/Application Mode keys (shown in gray in Figure 12) generate special 2-byte PS 390 system sequences similar to those produced by the PS 390 Function keys.

Figure 12. Keyboard Numeric/Application Mode Keys



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Note that neither SHIFT nor CTRL affects the ENTER key, and that no codes are modified by the CTRL key.

Any code generated by a Numeric/Application Mode key may be duplicated by entering CTRL SHIFT V, followed by the appropriate displayable character or control character.

Table 10 illustrates the codes and characters produced by the Numeric/Application Mode keys.

Table 10. Numeric/Application Mode Key Codes

Key	*Key Alone*		*Key+SHIFT*		*Key+CTRL*	
Label	*Code*	*Char*	*Code*	*Char*	*Code*	*Char*
0	X'1630'		X'1629'	·	X'1630'	
1	X'1631'		X'1621'		X'1631'	
2	X'1632'		X'1640'		X'1632'	
3	X'1633'		X'1623'		X'1633'	
4	X'1634'		X'1624'		X'1634'	
5	X'1635'		X'1625'		X'1635'	
6	X'1636'		X'165E'		X'1636'	
7	X'1637'		X'1626'		X'1637'	
8	X'1638'		X'162A'		X'1638'	
9	X'1639'		X'1628'		X'1639'	
.	X'162E'	.	X'163E'	>	X'162E'	.
,	X'162C'	,	X'163C'	<	X'162C'	,
-	X'162D'	(minus) -	X'165F'	(underline) _	X'162D'	-
ENTER	X'160D'	CR	X'160D'	CR	X'160D'	CR

3.2.9 PS 390 Device Control Keys

The Device Control keys (shown in gray in Figure 13) generate two-byte sequences similar to those described in Sections 3.2.7 and 3.2.8. The codes produced by these keys are modified by SHIFT and CTRL as shown in Table 11.

Any code generated by a Device Control key may also be produced by entering CTRL SHIFT V, followed by the appropriate displayable character or control character.

Figure 13. Keyboard Device Control Keys

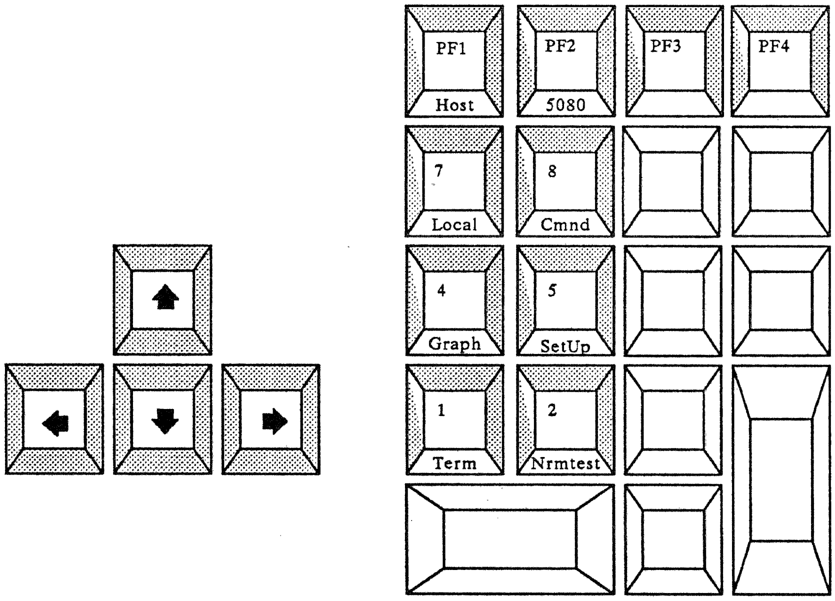


Table 11. PS 390 Device Control Key Codes

Key Label	*Key Alone Code*	*Key+SHIFT Code*	*Key+CTRL Code*
1 TERM	X'1673'	X'1653'	X'1613'
2 NRMTST	X'1632'	X'1640'	X'1644'
4 GRAPH	X'1634'	X'1624'	X'1670'
5 SET UP	X'1635'	X'1625'	X'166F'
7 LOCAL	X'1637'	X'1626'	X'1652'
8 CMND	X'1638'	X'162A'	X'1612'
←	X'1677'	X'1657'	X'1617'
→	X'1678'	X'1658'	X'1618'
↑	X'1679'	X'1659'	X'1619'
↓	X'167A'	X'165A'	X'161A'
PF1 HOST	X'A9'	X'A9'	X'1672'
PF2 5080	X'AA'	X'AA'	X'AA'
PF3	X'AB'	X'AB'	X'AB'
PF4	X'AC'	X'AC'	X'AC'

The Cursor Up key becomes Scroll Up when shifted.
The Cursor Down key becomes Scroll Down when shifted.

3.3 COMMUNICATIONS INTERFACE

The keyboard communicates with the JCP through the Peripheral Multiplexer using a RS-232C line receiver and line driver. The keyboard operates at 1200 baud.

3.4 DUAL FUNCTION SWITCHABLE KEYBOARD

Unique features and IBM key codes for the Dual Function Switchable keyboard will be described as they become available.

4. THE 32 KEY LIGHTED FUNCTION BUTTONS

The 32–Key Lighted Function Buttons (hereafter called the Buttons) consists of an array of 32 lighted function keys arranged in a 6x6 matrix without the key at each of the four corners being present. The Joint Control Processor sends the message to the Buttons box that lights the keys which are candidates to be selected to invoke specific program functions. The same message also turns off some of the lights which are already on. This cues the operator of the station to know that he may select one of the lighted keys by depressing the key. Upon depression, the Buttons box sends a message to the Joint Control Processor which indicates that a specific key has been depressed. The software can then take action(s) based upon the key selection.

4.1 LIGHT CONTROL

For the purpose of turning the lights of the Buttons box on or off, the lights are logically grouped into eight groups of four lights each. The lights of the box are then turned on and of respectively by sending a message consisting of one to eight bytes to it. The four more–significant bits of each byte contain the identification number for a four–light group; the four less–significant bits contain a mask which turns on (if the corresponding bit is set) or off (if the bit is clear) the light. This is shown in Figure 14 where the Group Number is binary 0000 through 0111 and Light Mask 1's and 0's turn lights on and off.

7	6	5	4	3	2	1	0
Group				Mask			

Figure 14. Function Button Light Control Message Byte

The Function Button Light Groups are defined in Table 12.

Table 12. Function Button Light Groups

Group Number	*Description*
b'0000'	Group for lights 1 → 4
b'0001'	Group for lights 5 → 8
b'0010'	Group for lights 9 → 12
b'0011'	Group for lights 13 → 16
b'0100'	Group for lights 17 → 20
b'0101'	Group for lights 21 → 24
b'0110'	Group for lights 25 → 28
b'0111'	Group for lights 29 → 32

Any byte or combination of bytes may be sent in a message, depending on which of the lights must be turned on or turned off. Turning all lights on, turning all lights off or changing the state of at least one byte of each of the eight groups would require an eight-byte message to be sent. Changing the state of one to four lights in a single four-light group would require only a one-byte message to be sent.

4.2 REPORTING SELECTIONS

The Buttons box reports that a key has been depressed simply by sending a single byte to the Joint Control Processor. The value of the byte is given by adding the hexadecimal value of the key number to the hexadecimal value x'3F'. Thus the first sixteen keys are numbered x'40' to x'4F' and the second group of sixteen keys are numbered x'50' to x'5F'. Only one key depression per message is reported.

4.3 SELF-TEST COMMAND AND REPORT

The Buttons box includes a self-test command and report that is used for diagnostics and optionally for initialization confidence tests. The command is a single byte: x'80'. The response is a four-byte sequence as shown in Table 13.

Table 13. Function Box Self Test Responses

Byte 1	64H, Hardware ID for the Button Box.
Byte 2	xxH, where xx is the firmware revision level. This should begin with 01H.
Byte 3	00H if ROM and RAM test successful and 3EH if ROM or RAM test failed, (RAM and ROM refer to processor chip), or 3DH if key down on Self Test (3E supersedes 3D)
Byte 4	00H on successful test, or xxH, where xx is code of keydown at Self Test.

4.4 TRANSMISSION CHARACTERISTICS

The data sent to and from the Buttons box is asynchronous data with each byte containing eight data bits without parity plus one start bit and one stop bit. The data transmission rate of the Buttons box is 9600 baud.

5. THE CONTROL DIALS

5.1 FUNCTIONAL CHARACTERISTICS

The Control Dials (hereafter called the Dials) consists of an array of 8 shaft encoders arranged in a 2 column x 4 row design with the number 1 dial being the upper left–hand dial and the number 5 dial being the upper right–hand dial when the Dials are situated in the vertical orientation. When the Dials are situated in the horizontal orientation, the number 1 dial is the lower left–hand dial and the number 5 dial is the upper left–hand dial. The Dials report to the Joint Control Processor the number of counts rotated between sampling intervals. The Joint Control Processor may specify the number of counts to be accumulated between sampling intervals and may set a sampling time for all the dials.

5.1.1 Dial Responses to the Host

The Dials output relative delta values only; i.e., each dial's position is reported in terms of its last sample location. The data format used to report the count is:

Byte Number	*Description*
1	Control V = '00010110'
2	Byte = '00000nnn', Where nnn is a binary number 000 thru 111 (0 thru 7 decimal which specifies the dial.)
3	Most significant byte of a 16-bit signed integer (sign indicates direction).
4	Least significant byte of the 16-bit signed integer (two's complement notation).

5.1.2 Commands to the Dials from the Host

There are two commands to which the Dials box must respond. The first is in the same format as the response message except that the second byte is '100xxnnn' and no sign is legal on the 16-bit integer. It specifies the delta value which must be accumulated before the delta count is reported to the host, i.e., how many counts between reports.

The second command is formatted as follows and applies a sampling time to all the dials:

Byte Number	*Description*
1	Control V = '00010110'
2	Control Byte = '1x1xxxxx', (x=don't care)
3	Reserved unused byte.
4	Time count in binary, Where x'05' = 60 samples/second Where x'0A' = 30 samples/second Where x'1E' = 10 samples/second

This time indicates how often the dials box wakes up to see if sufficient counts have been accumulated on any dial to respond to the processor.

5.2 TRANSMISSION CHARACTERISTICS

The data sent to and from the Dials box is asynchronous data with each byte containing eight data bits without parity plus one start bit and one stop bit. The data transmission rate of the Dials box will be 9600 baud.

6. THE DATA TABLET

There are two data tablets available for use with the LC Peripheral Set. They are the 6" x 6" and the 12" x 12" tablets with a four-button cursors. Both are alike except for their active areas and both provide digitizing and picking functions for the PS 390.

The tablets use +12 VDC @ 300 mA max. The power is provided by the multiplexer on the 7-pin Micro DIN connector provided.

The Data Tablets transform graphic information into digital data suitable for transmission to the Joint Control Processor (JCP). The data tablets use a stylus or a four button cursor to identify coordinates. Touching the pen-like stylus to any position on the data tablet transforms the coordinates of that position into their digital equivalents. The cursor contains a crosshair sight that permits the user to enter data with precise accuracy.

6.1 DATA TABLET MICROPROCESSOR

The data tablet's microprocessor is an 8-bit Intel 8035. The microprocessor outputs two control signals that are used to gate the X pulse and the Y pulse to the data tablet. The microprocessor also controls communications with the host processor that is located on the JCP card.

6.2 OPERATING MODES

Data tablet modes and the sampling rates may be controlled externally under program control or internally by switches on the logic card. The positions of the internal switch determine the power-up mode and sampling rate. The following operating modes are available:

- Point Mode
  - Pressing the stylus on the tablet or pressing a button on the cursor outputs one X, Y coordinate pair (sample) in the appropriate format.
- Stream Mode
  - X, Y coordinate pairs (samples) are generated continuously at theselected sampling rate when the stylus or cursor is near the active area of the tablet. Pressing the stylus to the tablet or depressing a button on the cursor puts the flag character (F) bit in the output string.

- Switched Stream Mode
  - Pressing the stylus or a button on the cursor continuously outputs X, Y coordinate pairs at the selected sampling rate until the stylus is lifted or the button is released.

The data tablet has a six-position switch that sets the mode of operation and the rate at which the coordinate data are output to the processor. The Mode and Rate Controls on the data tablet are mounted on SW 2. Positions 1 and 2 are mode switches and Positions 3, 4, and 5 are rate switches. Switch 6 is not used. The system reset switch is mounted externally at the rear of the lower frame.

Both the mode and the sampling rate may be changed under program control from the PS 390 by sending the data tablet an ASCII character.

6.3 POWER REQUIREMENTS

The data tablet is shipped with a connector that mates with the power input connector located at the rear of the data tablet. The pin assignments that apply to this connector are shown in Table 14.

Table 14. Data Tablet Pin Assignments

Pin #	Function
1	Ground
2	Transmit data (From Device)
3	Receive data (To Device)
4	-12 VDC
5	+ 5 VDC
6	+12 VDC
7	Device Present (Connected to Pin 1)
Shell	Protective Ground (ESD Shield)

6.4 DATA TABLET/PS 390 INTERFACE

The data tablet communicates with the PS 390 via an RS-232 asynchronous cable. Each character is transmitted as a complete self-contained message consisting of an ASCII data character with even or odd parity (POE) preceded by a start bit and followed by one or two stop bits, depending on the strap option selected (HCB). The bit polarity of the transmitted data is low level mark, high level space in the following format:

Start Bit	*Seven Data Bits*	*Parity*	*Stop*	**Stop**

6.4.1 Binary Data Format (Switch 1, Position 7 ON)

The binary formatted RS-232 interface is a five byte count output. Binary format is as follows:

Binary Format								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	P	1	F3	F2	F1	F0	0	0
2	P	0	X5	X4	X3	X2	X1	X0
3	P	0	X11	X10	X9	X8	X7	X6
4	P	0	Y5	Y4	Y3	Y2	Y1	Y0
5	P	0	Y11	Y10	Y9	Y8	Y7	Y6

6.4.2 Remote Control via RS-232

The data tablet is a stand-alone microprocessor-driven device that can be remotely programmed. The Joint Control Processor controls remote operation of the data tablet. The following conditions must exist for remote control of the data tablet:

- All internal mode and rate controls (SW 2) must be inactive or in the OFF condition.
- Data going to the data tablet must be at the same baud rate as the data transmitted from the data tablet.
- Data tablet command data must be input on J1 Pin 3 with a bit polarity of low level mark, high level space.
- One of the binary data transmission codes shown in Table 15 must be selected.

Table 15. Binary Data Transmission Codes

Mode	*Binary Rate*	*Uppercase* ASCII Character
Stop	-	S
Point	-	P
Switched Stream	2	@
	4	A
	10	B
	20	C
	35	D
	70	E
Stream	141	F
	141	G
	2	H
	4	I
	10	J
	20	K
	35	L
	70	M
	141	N
	141	

Note: Rate is calculated as coordinate pairs per second at 19,200 baud. All other rates are dependent on baud rates.

6.4.3 RS-232 Unit Switch Settings & Strap Options for 600 Series PROMs

Data tablets are shipped with a standard setting from the factory. The following sections describe strap and switch settings for non-standard strap and switch settings. Refer to the GTCO Users Manual, for all switch and strap locations.

Switch 1 (Format/Calibration) This nine-position switch controls the output data format as shown in Table 16.

Table 16. RS-232 Switch Settings

Position	*Effect*
1	Do not adjust–Factory Set
2	Do not adjust–Factory Set
3	Do not adjust–Factory Set
4	Do not adjust–Factory Set
5	Do not adjust–Factory Set
6	Not Used
7	ON–Serial Binary Output (No CRLF transmitted when in Serial Binary (Position 8) *OFF-ASCII BCD Output
8	*ON-Carriage Return Line Feed (CRLF). This adds line feed to the end of output data format. OFF-Carriage Return (CR) only.
9	*ON–English (0.005" Resolution) OFF–Metric (0.1 mm Resolution)

* Factory settings.

Note

Switches 1 through 5 are factory set calibration switches. They should not be changed unless the tablet portion of the device is changed. Refer to the GTCO User's Manual.

Switch 2 (Mode/Rate) This six-position switch controls the sampling mode (Point, Switch Stream, or Continuous Stream) and the sampling rate (X–Y coordinate pairs per second). The switch is factory set in the Continuous Stream Mode at 200 samples per second. To operate under program control, set all internal position switches to OFF.

The PS 390 Data Tablet operates at 9600 baud, sending 105 serial binary samples per second. Due to the limitations of serial baud rate transmit time, the maximum sampling rate is automatically limited to the sampling rates shown in Table 17.

Table 17. Data Tablet Sampling Rates

Baud Rate	*Serial ASCII BCD*	*Serial Binary*
Maximum Sampling Rate		
28800	85	166
19200	68	141
9600	46	105
4800	28	65
2400	16	37
1200	9	20
300	2	5

Switch 7 and Pluggable Program Strap BA (Baud Rate) Both Switch 7 and the Pluggable Strap BA must be set to select the desired baud rate. One of the ten positions on Switch 7 must be set to ON and the blue pluggable strap must be over the center pin and the A pin (or over the center pin and the B pin). Only one position on Switch 7 may be on at a time. The baud rate is factory set with Position 2 ON on Switch 7 and pluggable strap BA over Pin B and the center pin. Table 18 shows the baud rates that may be selected.

Table 18. Baud Rate Selection

Switch 7 (Position ON)	*Blue Pluggable Strap BA*	
	Strap A	*Strap B*
1	19200	19200
2*	28880	9600*
3	14400	4800
4	7200	2400
5	3600	1200
6	1800	600
7	900	300
8	450	150
9	225	75
10	112.5	–

* Factory setting.

POE Strap (Parity) Polarity can be odd or even and is controlled by a wire jumper soldered into the two points on the circuit card labeled POE. The RS-232 Data Tablet is shipped with no strap and in the even parity mode.

HCB Strap (Stop Bits) There may be one or two stop bits transmitted. The number of stop bits transmitted is controlled by a wire jumper soldered into the two points on the card labeled HCB. The RS-232 unit is shipped with a strap and transmits one bit.

7. THE OPTICAL MOUSE

The Optical Mouse transforms position information into a digital form acceptable to the Joint Control Processor (JCP). The optical mouse uses a three-button mouse unit in conjunction with a reflective pad to provide x and y-axis position information. The cursor (an X) moves around on the screen in response to movement of the mouse across the pad.

The mouse uses red and infrared LEDs reflecting off the pad to provide directional information to the control logic in the mouse. This movement is then translated into absolute x and y position information similar to that provided by a PS 390 Data Tablet. The data is transmitted serially to the PS 390 through the peripheral multiplexer.

7.1 OPERATING MODES

The mouse emulates the MM Series Delta Data Protocol. This is a 3-byte format that defines change in mouse position as delta movement in X and Y. The mouse also operates in Exponential Scaling Mode. This means that the faster the mouse is moved across the pad, the larger the data increments will be. This allows a single move across the pad to produce a complete movement of the cursor across the screen.

7.2 PS 390 RUNTIME OPERATION

The PS 390 contains one system function to interface the mouse to an application. It is called MOUSEIN, and is an instance of F:mouse. They are instances of the same functions that are used by TABLETIN and TABLETOUT. The mouse is connected to the mouse port of the multiplexer or to Port D on the Data Concentrator. The MOUSEIN function is already connected to the pick_location just the same as TABLETIN.

The MOUSEIN function instance has the same outputs as TABLETIN. There are 4 inputs to the Mouse function.

1. String – Data from the Mouse
2. Integer – Counts full scale
3. String – Output queues enable/disable message
4. Vec2d – New cursor position

Input 1 is a string of data from the Mouse in the format shown in Table 18.

Input 2 is an integer specifying the number of counts to map to a cursor movement across the screen. The default is 2200.

Input 3 is a string of up to eight characters (characters in strings longer than eight are ignored) consisting of either T or F. This is a positional indication of the enable or disable of a particular output. For example, the string 'TTTFFT' would enable outputs 1, 2, 3, and 6; the string 'TTFFFFF' would enable output from 1 and 2 only.

Note:

> Only the F is checked for. Therefore 'XXFFyyy' would be the same as 'TTFFTTT'. The default is 'TTTTTTTT'.

Input 4 is a 2–D vector that will position the cursor on the screen at the point specified. the value should be in the range of –1.0 to 1.0. The default is 0.0.0.0.

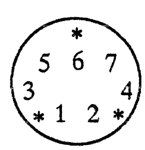
The runtime will support the use of both the tablet and the mouse on the same system. A special "Y" power connector will be required if both are to be used on a data concentrator since there is only one 9–pin D power connection.

7.3 MOUSE/PS 300 INTERFACE

There are two versions of the mouse. One is for use with the Data Concentrator and the other is for use with the Peripheral Multiplexer. The pin assignments on the data concentrator version are identical to the data tablet. The pinouts for the MUX version are as follows:

Pin #	Function
1	Ground
2	Transmit data (From Mouse)
3	Receive data (To Mouse)
4	-12 VDC
5	Not Used
6	+12 VDC
7	Device Present (Connected to Pin 1)
Shell	Protective Ground (ESD Shield)

With the connector of the mouse cable facing you the pins are numbered according to the diagram below: (* = connector key)



7.3.1 Baud Rate

The mouse is configured to run at 9600 Baud over the serial asynchronous interface.

7.3.2 Data Format

The data format consists of 3 bytes which are assigned as follows:

Table 19. Mouse Data Format

	MSB 7	6	5	4	3	2	1	LSB 0
Byte 1	1	0	0	Sign X	Sign Y	Left	Center	Right
Byte 2	0	X_6	X_5	X_4	X_3	X_2	X_1	X_0
Byte 3	0	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0

The bit positions Left, Center, and Right indicate the status of the three buttons on the Mouse. A one in the postions indicates that the button is down.

8. THE RASTER DISPLAY

The Raster Display or Monitor for the PS 390 is the FIMI 2054. The monitor is part of the PS 390 hardware and is technically not part of the peripheral set. However a brief introduction to its features may be useful.

The PS 390 can use either a FIMI 2054 or a DEC VR290 for displaying its raster images. The FIMI Monitor has a 20 inch viewing area while the DEC monitor offers a 19 inch viewing area. Both monitors operate with AC 110/200 VAC, 60/50 Hz and a nominal power consumption of 150 watts. They have the following features:

Contrast	Lets the user adjust the video display to a suitable intensity.
Brightness	Lets the user adjust the background intensity to compensate for ambient room light.
Degauss	Permits the user to clear color picture distortion caused by external magnetic interference.
Power On/Off	Turns the monitor on and off. The monitor should be turned off at the end of the workday to extend its life.
Tilt Lock	Locks or unlocks the tilting mechanism to allow or prevent movement; swivel operation is not affected.

These adjustment devices are located on the lower right–hand side of the monitor.

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