SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The purpose of this section is to give detailed information concerning the operation and programming of the 1349A/D. It includes a list of the programming instructions and a section containing a brief explanation of "bit programming". The end of this section contains several programming examples.

WARNING

SHOCK HAZARD

Before operating the instrument, connect the chassis of the display to a safety ground in the system.

3-3. SIGNAL LINE DEFINITIONS.

D0-D15

D0 through D14 are the vector data lines (TTL positive logic). D15 is used as a Vector Memory instruction. When D15 is a "1" then the input data is recognized as a memory command. When D15 is a "0" then all the input data forms the picture.

DISCONNECT SENSE

This line must be grounded to the display chassis when the data lines are active. The internal Performance Verification pattern will be displayed if the 26-pin connector is disconnected.

SYNC

External display refresh synchronization signal line. The line provides an external refresh clock when external sync mode has been selected via a jumper wire on the Vector Memory board.

LXACK

Acknowledge signal line. When low, this line indicates that the Vector Memory has completed the Read or Write operation requested by the user processor.

LDS

Device Select signal line. When low this line enables the Vector Memory to communicate with the user processor (write/read).

LWR

Memory Write signal line. When low, this line indicates that the 16-bit Data Bus contents are to be written into either the current Vector Memory location (D15=0) or into the User Address Pointer (D15=1).

LRD

Memory Read signal line. When low, this line indicates that the contents of the current Vector Memory location (as specified by the User Address Pointer) are to be placed on the 16-bit Data Bus for transmission back to the user processor.

NOTE

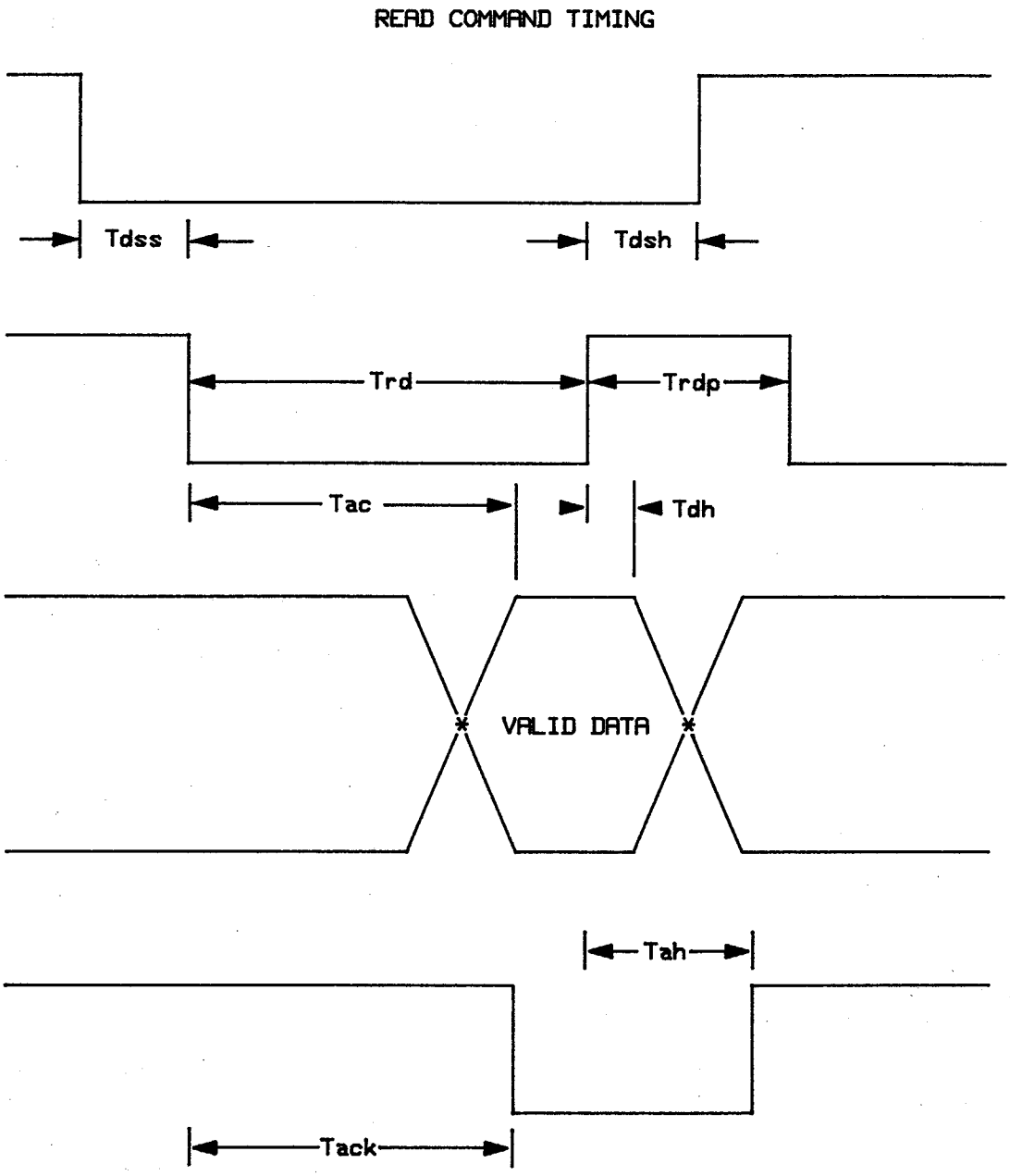
Whenever a Vector Memory location has been either written into or read from by the user processor, the User Address Pointer auto-increments to the next Vector Memory location (address).

3-4. HANDSHAKE TIMING FOR 1349D.

The TTL digital interface to the Vector Memory (1349D) is compatible with most microprocessor peripheral interface adaptor chips (the Motorola ® 6821).

Vector Memory digital interface consists of:

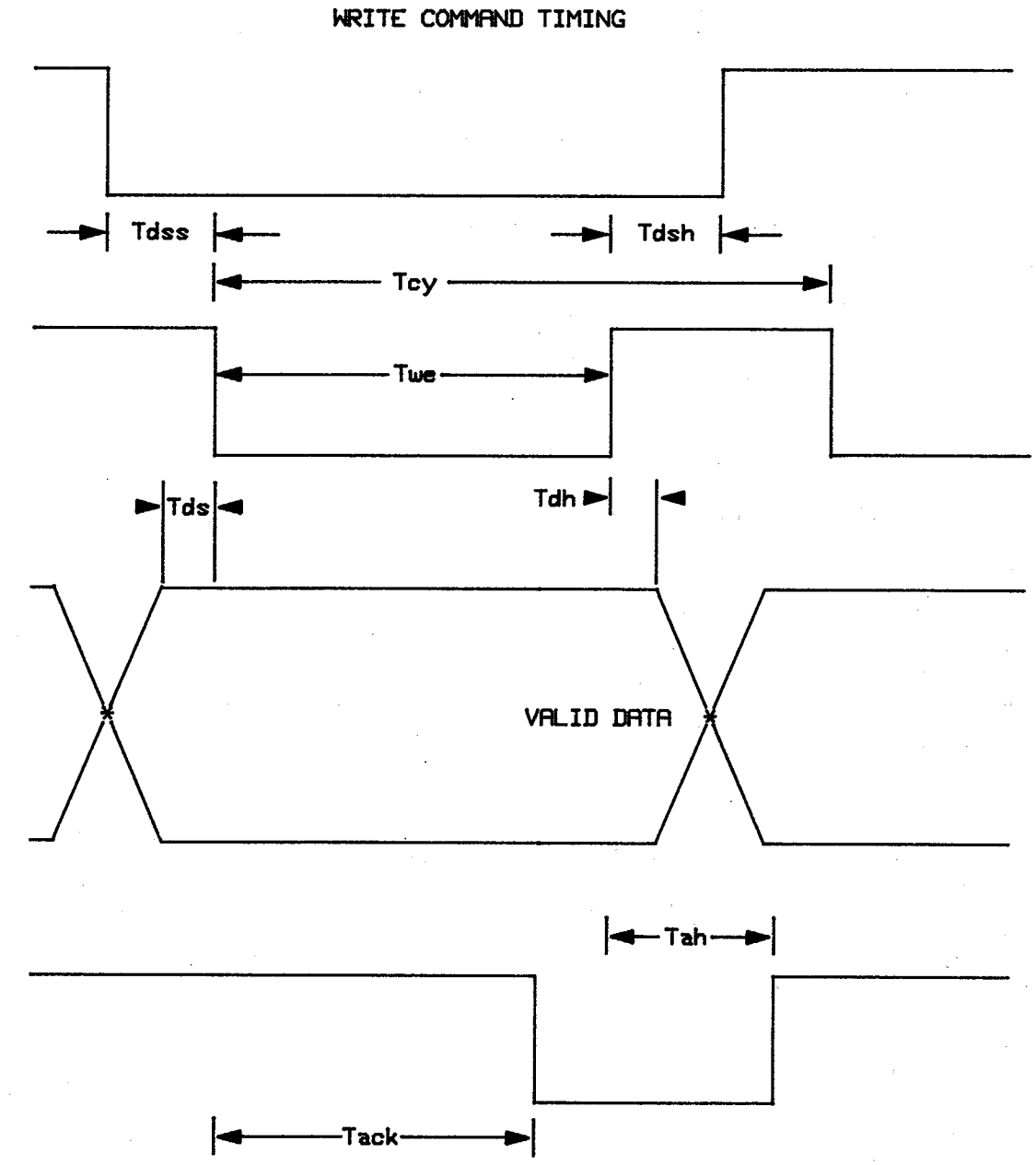
1. A 16-bit bidirectional Data Bus.
2. A Read Signal line LRD (input).
3. A Write signal line LWR (input).
4. A Device Select signal line LDS (input).
5. An Acknowledge signal line LXACK (output).
6. An External display Synchronization signal line SYNC (input use is optional).



Read Command Timing

Tdss — Device Select Setup Time ..... 0 nsec min
Tdsh — Device Select Hold Time ..... 0 nsec min
Trd — Read Pulse Time (ACK not used) 495 nsec min
(ACK used) 760 nsec min
Trdp — Read Precharge Time ..... 25 nsec min
Tac — Read Access Time ..... 760 nsec max
Tdh — Read Data Hold Time ..... 30 nsec min
Tah — Acknowledge Hold Time ..... 40 nsec min
130 nsec max
Tack — Acknowledge Delay Time ..... 455 nsec min
855 nsec max

Figure 3-1. Read Command Timing



Write Command Timing

Tdss — Device Select Setup Time ..... 0 nsec min
Tdsh — Device Select Hold Time ..... 0 nsec min
Tcy — Write Cycle Time ..... 820 nsec min
Twe — Write Command Active Time .. 795 nsec min
Tds — Data In Setup Time ..... 0 nsec max
Tdh — Data In Hold Time ..... 0 nsec min
Tack — acknowledge Delay Time ..... 455 nsec min
855 nsec max
Tah — Acknowledge Hold Time..... 40 nsec min
130 nsec max

Figure 3-2. Write Command Timing

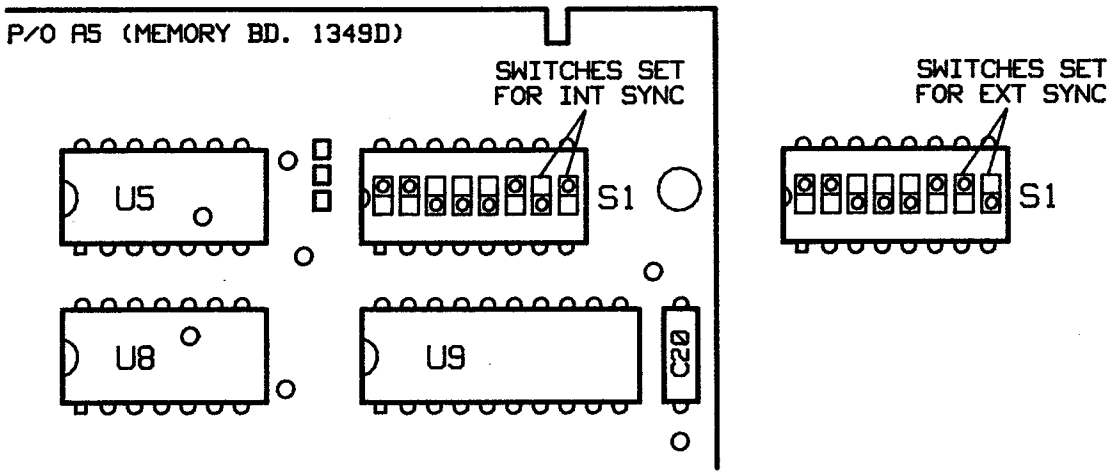


Figure 3-3. Refresh Mode Selection

3-5. PICTURE REFRESH REQUIREMENTS FOR 1349D.

Each time that the picture is redrawn by the 1349D, the display is refreshed. This prevents the phosphor light output from expiring. The refresh sync signal may be provided by either the internal refresh circuit, or an external source. To select the required mode of operation for refresh mode, set the Int/Ext switch (A5S1) on the Memory Board (A5) as shown in figure 3-3.

INTERNAL SYNC. When the jumper is in the Internal position, an on-board oscillator (A5U1) provides sync pulses at approximately a 60 Hz rate. The user processor can send all picture producing data to the Vector Memory at one time. The Vector Memory will then continuously refresh the display screen by redrawing the picture at regular intervals. This reduces overhead time for the user processor.

EXTERNAL SYNC. Sync pulses (TTL) must be supplied from an external source in the user system via the SYNC input signal line. This signal is useful when the display is used in electromagnetic fields which can cause the picture to "swim". Synchronizing the display with the interfering signal can stabilize the picture.

3-6. REFRESH MODES FOR 1349D.

The Vector Memory sends its data to the Vector Processor (VPC) each time the picture is to be drawn on screen. Data is send to the VPC either via synchronous mode or free running mode.

SYNCHRONOUS MODE. In synchronous mode, the Vector Memory waits until a synchronizing pulse occurs before it will begin its next data output cycle to the 1349A/D. Synchronous refresh mode is entered when the Refresh Pointer equals 8191. After sending the contents of address 8191 to the VPC, the Vector Memory waits for the next sync pulse before starting a new refresh cycle at address 0000.

Pictures A and B will be displayed at an even brightness (sync rate = refresh rate) even though picture A requires less drawing time (See Figure 3-4).

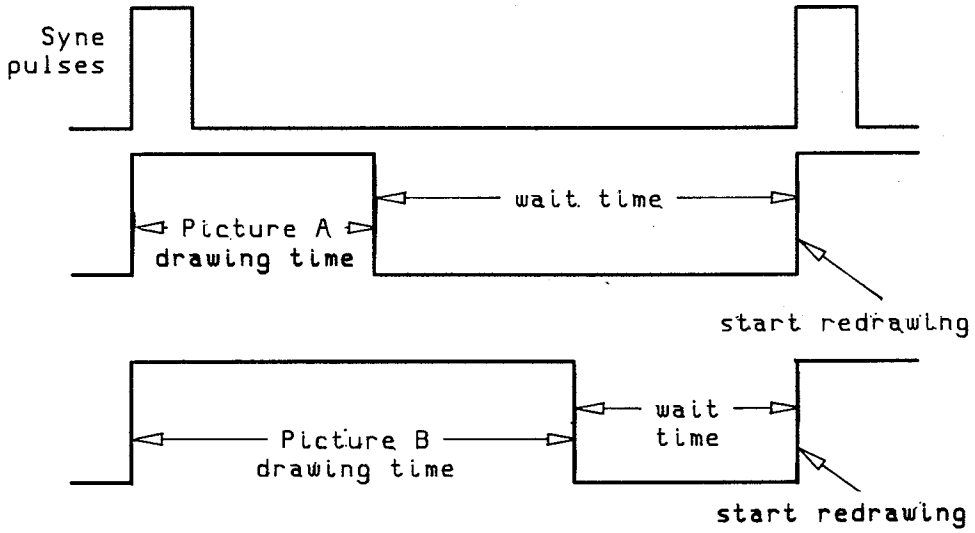


Figure 3-4. Synchronous Refresh Example

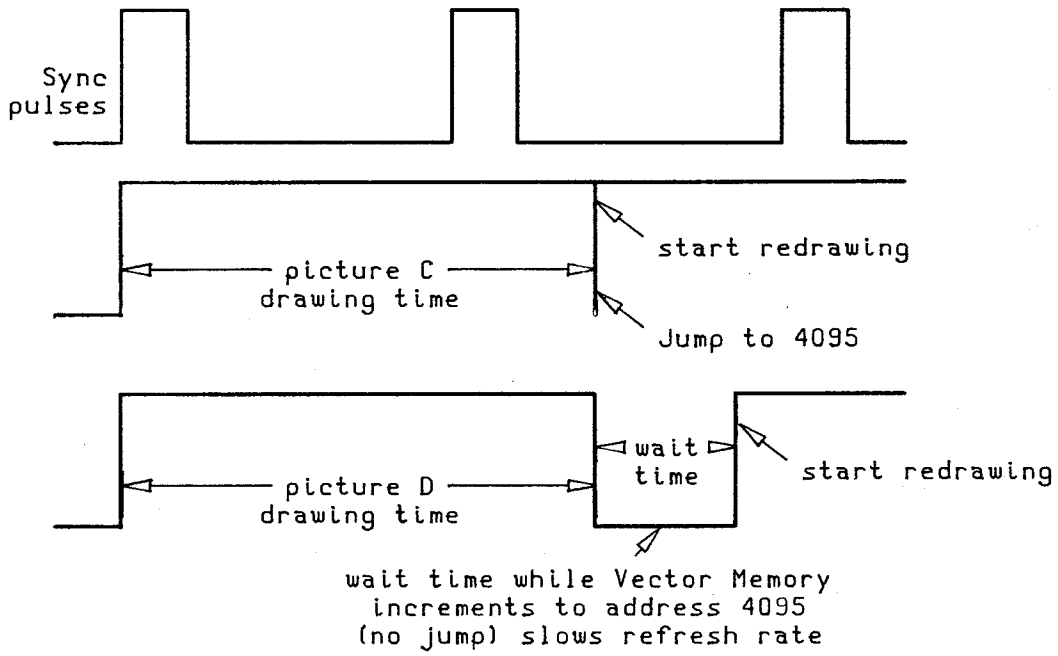


Figure 3-5. Asynchronous Refresh Example

FREE RUNNING MODE. Free Running mode is when the picture cannot be drawn in the time interval between sync pulses. The memory circuit automatically enters this mode whenever a sync edge arrives before the refresh counter reaches its highest address (8191). In this mode, the memory will not wait for a sync edge when it finishes the picture, but will immediately start drawing the picture again.

This sync override feature allows all simple pictures to be displayed at an even brightness (say 60 Hertz refresh rate), and complex pictures to be displayed at a level of brightness that depends only on the time it takes to draw the picture on the display.

3-7. MEMORY INITIALIZATION.

When the Vector Memory is powered up, its contents are in an unknown random state. There are several methods of memory initialization.

One method is to fill the entire memory with "jump to 8191" instructions. The benefit of using this method of initialization is that as the user fills the Vector Memory with picture information, the Vector Memory will always "jump to 8191" after drawing the picture, no matter how many words are used to form the picture. This ensures that the picture will be displayed at the optimum refresh rate.

Another way of initializing the Vector Memory is to write all zeros to all words. This data will be sent to the 1349D, but will draw nothing on screen (effectively a no-op). Each "no-op" will take about one microsecond, thus 8000 "no-ops" (8000 words in Vector Memory) will use up to 8 milliseconds of display time, producing a dimmer picture if in the free running mode.

The Vector Memory can be tested by the user processor as part of power-on self test routine. For example, first write all zeros to all words. Then "chase a one" through memory to check each cell. Also, the User Address Pointer can be checked by writing data sequentially through the memory and then using the Pointer Instruction to move the pointer, and reading the contents of the word selected by the pointer. BE CAREFUL - 11XXXXXXXXXXXXXX (set address pointer) will not be written into the memory and 011XXXXXX1XXXXXX (set condition) is illegal.

3-8. 1349A/D COMMAND SET.

The 1349A/D creates pictures by a technique called random vector plotting. A line is defined by its endpoints in 2048 by 2048 cartesian coordinate system. The origin (0,0) is in the lower lefthand corner. All points are positive reference. The 1349A/D references each vector by starting point, ending point, intensity level, line type, and writing speed. The 1349A/D has the following programming command set.

The 1349A/D recognizes D0-D14 on its input Data Bus as being one of four commands:

Command	Bit 14	Bit 13
1. Set Condition	1	1
2. Plot	0	0
3. Graph	0	1
4. Text	1	0

SET CONDITION.

The Set Condition command controls the intensity level, the line type, and the writing speed of vectors drawn on the CRT.

B14 = 1, B13 = 1: SET CONDITION COMMAND.

With both MSBs (Most Significant Bits) set to one, the 1349A/D is commanded to draw all following vectors according to the configuration commanded until changed by subsequent condition command.

NOTE

A one (1) = TTL high; a zero (0) = TTL low.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	I1	I0	X	L2	L1	L0	0	X	W1	W0	X	X	X

X=DON'T CARE

B6 MUST be zero.

B14=1, B13=1 : Set display configuration according to choices specified for intensity, line type, and writing speed.

I1	I0	Intensity
0	0	Blank
0	1	Dim
1	0	Half Brightness
1	1	Full Brightness

L2	L1	L0	Line Type
0	0	0	Solid Line
0	0	1	Intensify Endpoints (solid line)
0	1	0	Long Dashes
0	1	1	Short Dashes
1	0	1	Dots on endpoints

W1	W0	Writing Speed
1	1	0.19 cm per microsecond
1	0	0.34 cm per microsecond
0	1	0.52 cm per microsecond
0	0	0.69 cm per microsecond

When the line type "solid line with intensified endpoints" is selected, the intensity of the endpoints may vary due to optical illusion. As lines are linked together the intensity of the point where one line ends and the next line starts is a function of the angle separating the lines. The closer the angle is to 180 degrees, the brighter the point. The closer the angle is to zero degrees (absolute), the dimmer the point.

PLOT COMMAND (B14 = 0. B13 = 0).

With both MSBs set to zero, the 1349A/D is commanded to move the display beam to a specific X-Y location each time that a Y coordinate is received. The beam position may be moved with the beam either turned off or turned on. The Plot command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1349A/D. Each time that a Y coordinate is received, the pen status (beam on or off) for the beam movement is established. Also, the X-Y location to be moved to is formed from the last X coordinate received and the current Y coordinate. For example, to draw a vertical line send the 1349A/D: (1) Plot Command - X value; (2) Plot Command - Y1 value (with beam off); (3) Plot Command - Y2 value (with beam on).

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

DATA
MSB LSB

B14=0, B13=0 : Plot Command.

XY
0 = X coordinate (0-2047) as specified by D0 - D10.
1 = Y coordinate (0-2047) as specified by D0 - D10.

PC (Pen Control Bit B11)
0 = Move (draw vector with pen up).
1 = Draw (draw vector with pen down).

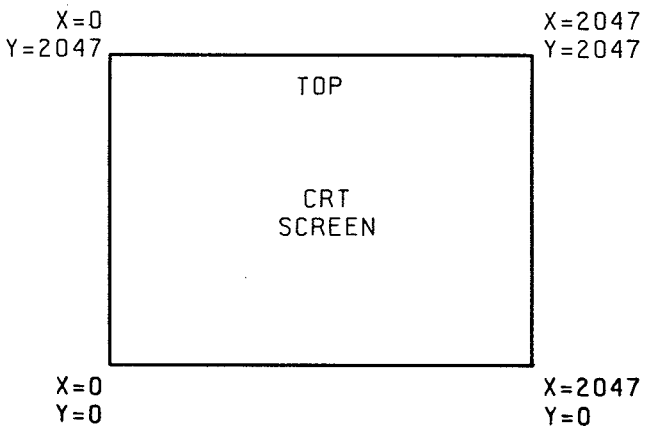


Figure 3-6. Vector Drawing Area

GRAPH COMMAND (B14=0, B13=1).

With the two MSBs set to zero and one respectively, the 1349A/D is commanded to either: (a) set the DELTA-X increment; or (b) move the beam to a specific X-Y location determined by the X increment and the Y coordinate.

The beam position may be moved with the beam either turned off or turned on. Beam status for the beam movement is established each time a Y coordinate graph command is received.

The Graph command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1349A/D.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	1	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

DATA
MSB_____LSB

B14=0, B13=1 : Graph Command.

XY
0 = set automatic DELTA-X increment (as specified by D0-D10) for all subsequent Y coordinate Graph commands received.
1 = Y coordinate (as specified by D0 - D10) to which the beam is to be moved in conjunction with the DELTA-X increment.

PC (Pen Control Bit B11).
0 = Move (draw the vector with beam off).
1 = Draw (draw the vector with beam on).

Example:
To graph, first move the beam to a starting position P1 (Plot Commands: X value; Y value with beam of). Then send the 1349A/D:

1) DELTA-X Graph command.
2) Y1 Graph command with the beam on. This moves the beam to point G1. Note that there is no DELTA-X increment with the first Y Graph command.
3) Y2 Graph command with the beam on. This moves the beam to point G2.
4) Y3 Graph command with the beam on. This moves the beam to point G3.
5) Y4 Graph command with the beam on. This moves the beam to point G4.

This will give a picture as shown below.

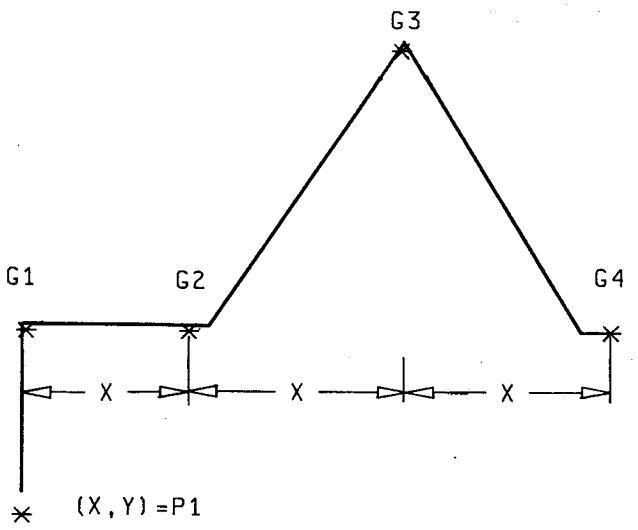


Figure 3-7. Graphing Example

TEXT COMMAND (B14 = 1, B13 = 0):

With the two MSBs set to one and zero respectively, the 1349A/D is commanded to draw all the vectors necessary to produce the character specified.

The 1349A/D automatically provides space to the right of each character for character spacing.

The Text command will draw the characters at the intensity level established by the last Set Condition Command, at the slowest writing speed and in the last line type specified (except dots).

Instead of specifying a character to be drawn, the Text command character code can be replaced by a beam movement control code. These codes that move the beam (with the beam off) are Carriage Return (CR), Line Feed (LF), Inverse Line Feed, Backspace (BS), 1/2 shift up, and 1/2 shift down. The amount and direction of beam movement depends on the character size and orientation specified. Line Feed and Inverse Line Feed provide automatic spacing between lines of text (spacing = height of one character between lines).

The starting point for non-rotated characters is the lower left-hand corner of the character area. For rotated characters the entire character area is rotated the specified number of degrees (90, 180, or 270) in a counterclockwise direction around the starting point.

When the 1349A/D has finished drawing a character it automatically advances the beam to the starting point for the next character. In this way the 1349A/D functions much like a typewriter when presenting text. The modified ASCII character set for the 1349A/D is shown in table 3-1.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	0	S1	S0	R1	R0	ES	D7	D6	D5	D4	D3	D2	D1	D0

CHARACTER
MSB LSB

B14=1, B13=0 : commands that the 1349A display a text character (specified by D0 - D7)

ES (Establish size of character Bit B8).
0 = use previous size and rotation.
1 = establish new size and rotation according to S1-S0 and R1-R0.

R1	R0	Character Rotation (CCW)
0	0	0 degrees
0	1	90 degrees
1	0	180 degrees
1	1	270 degrees

S1	S0	Size	Width X Height (in addressable points)
0	0	1X	30 X 32
0	1	1.5X	45 X 48
1	0	2X	60 X 64
1	1	2.5X	75 X 80

Example:
1 X character spacing (in addressable points)

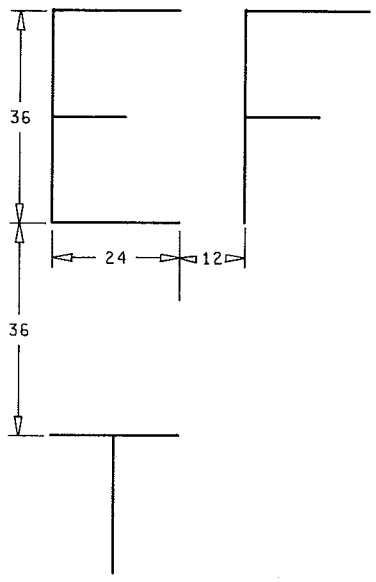


Figure 3-8. Example of Character Spacing

CALCULATING THE STARTING POINT FOR TEXT.

If we wish to display the characters "1349A" in the center of the display, proceed as follows.

Let's choose the 2.5 X (largest) character size. Each character will be 75 X 80 addressable points.

Calculation:

center screen = 1024,1024 (X,Y)

X = 1024 - (2.5 chars. X 75 points/char.)
= 1024 - 188
= 836
Y = 1024 - (0.5 char. X 80 points/char.)
= 1024 - 40
= 984

Send the 1349A/D a Plot X command with X=836. The Octal code to do this is 01504.

Send the 1349A/D a Plot Y command with the beam off and Y=984. The Octal code to do this is 11730.

Then send the Text commands to produce each of the characters.

Table 3-1. 1349A/D Character Set

0		32	Space	64	@	96	‘ NOTE 2
1	HP logo	33	!	65	A	97	a
2	beta	34	”	66	B	98	b
3		35	#	67	C	99	c
4	upper-half tic	36	$	68	D	100	d
5	lower-half tic	37	%	69	E	101	e
6	left-half tic	38	&	70	F	102	f
7	right-half tic	39	’	71	G	103	g
8	back space	40	(	72	H	104	h
9	1/2 shift down	41	)	73	I	105	i
10	line feed	42	*	74	J	106	j
11	inv. line feed	43	+	75	K	107	k
12	1/2 shift up	44	,	76	L	108	l
13	carriage return	45	-	77	M	109	m
14	horizontal tic	46	.	78	N	110	n
15	vertical tic	47	/	79	O	111	o
16	centered *	48	0	80	P	112	p
17	centered o	49	1	81	Q	113	q
18	up arrow	50	2	82	R	114	r
19	left arrow	51	3	83	S	115	s
20	down arrow	52	4	84	T	116	t
21	right arrow	53	5	85	U	117	u
22	square root	54	6	86	V	118	v
23	pi	55	7	87	W	119	w
24	delta	56	8	88	X	120	x
25	mu	57	9	89	Y	121	y
26	° (degree)	58	:	90	Z	122	z
27	ohm	59	;	91	[	123	{
28	rho	60	<	92	\	124	|
29	gamma	61	=	93	]	125	}
30	theta	62	>	94	^	126	box
31	lamda	63	?	95	— NOTE 1	127	shaded triangle

NOTES: 1. 95= Underline character with Auto Back Space
2. 96= Slanted in opposite direction of character 39.

The characters listed below cause wraparound if positioned too close to the edge of the Vector Drawing area. Wraparound appears as vectors drawn completely across the display. This condition can also be caused by vectors drawn outside the screen area.

Character Number	Character	Character Number	Character
1	HP Logo	41	)
2	beta	44	, (comma)
4	upper-half tic	59	; (semicolon)
5	lower-half tic	91	[
6	left-half tic	93	]
7	right-half tic	95	_ (underline)
14	horizontal tic	103	g
15	vertical tic	106	j
16	centered *	112	p
17	centered o	113	q
25	mu	121	y
26	° (degree)	123	{
28	rho	125	}
40	(		

3-9. VECTOR DRAWING EXAMPLES.

Example 1.

To draw a square on the display, use the following procedure.

a. Send the 1349A/D a Set Condition command to configure display brightness, line type, and writing rate.

b. Send the 1349A/D a Plot X1 command.

c. Send the 1349A/D a Plot Y1 command with the beam off. This moves the beam to the starting point of the square.

d. Send the 1349A/D a Plot Y2 command with the beam on. This moves the beam to the X1,Y2 point shown in the diagram below (draws vector "1").

e. Send the 1349A/D a Plot X2 command, then a Plot Y2 (beam on) command. This moves the beam to X2,Y2 (draws vector "2").

f. Send the 1349A/D a Plot Y1 command with the beam on. This moves the beam to X2,Y1 (draws vector "3").

g. Send the 1349A/D a Plot X1 command, then a Plot Y1 (beam on) command. This moves the beam back to the starting point (draws vector "4").

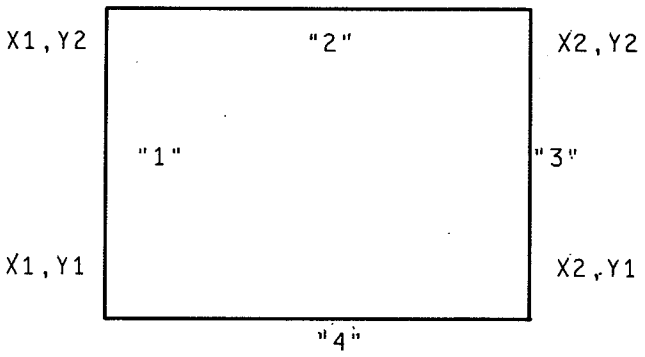


Figure 3-9. Drawing a Square on the Display

Example 2.

To draw two horizontal lines on the display, modify steps "d" and "f" in example 1 so that the 1349A/D receives the Plot Y command with beam off instead of beam on.

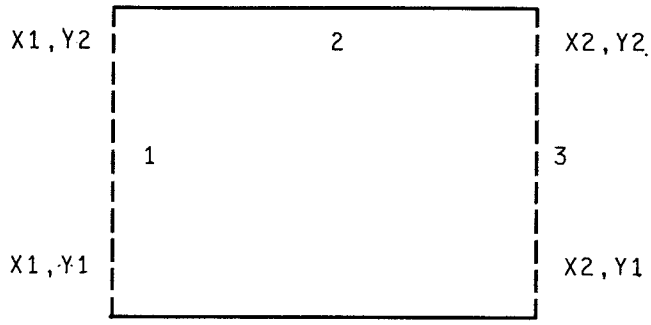


Figure 3-10. Drawing two horizontal lines on the Display

3-10. PROGRAMMING THE 1349D.

In the case of the 1349D, all commands from the user processor go to the Vector Memory as either a write operation or a read operation.

3-11. WRITE OPERATION.

The Write Operation allows the 16 bits on the data bus to be written into either the Vector Memory or the Address Pointer. A Vector Memory word can be either a Picture Data Word or an Internal Jump Word.

PICTURE DATA WORD. When bit M15 is set low, the other 15 data bits (M14-M0) must conform to the 1349A/D commands covered earlier in this section under Data Bit Definitions for 1349A/D commands.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
0	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

(See 1349A/D Commands).

When the display is refreshed, this data is sent from the Memory Board to the VPC for vector/character generation. If internal sync mode is selected, display refresh is accomplished without attention from the user processor once the picture has been loaded into Vector Memory. The write operation is controlled by the handshake sequence as presented in figure 3-2.

INTERNAL JUMPWORD. When M15 is high and M14 is low, then data bits M12 through M0 designate the address of the next word in Vector Memory that will be sent to the VPC. This allows the Memory to skip blocks of picture data on each pass through its address range when it is refreshing the display. Certain data in Memory is effectively suppressed until the user processor wants that data to be displayed. Refer to paragraph 3-14 for an example of using the Jump Instruction. When needed, a suppressed block of data can be added to the picture by changing only the Vector Memory Word that contains the internal jump code. An internal jump does not affect the User Pointer Address.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	0	X	X	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

X= DON'T CARE

M15=1, M14=0: Internal Jump to vector address specified by A11 through A0 during refresh.

POINTER INSTRUCTION. When bits M15 and M14 are both high, then data bits M12 through M0 designate the address to which the User Address Pointer will move. The value in the pointer register specifies the next address in Vector Memory that will be written into (or read from) by the user processor. The pointer increments to the next Vector Memory address after each read or write operation commanded by the user processor.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	1	X	X	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

X= DON'T CARE

Set pointer register to the Vector Memory address value specified by A11 through A0.

NOTE

The address is placed in the User Address Pointer, not the Vector Memory.

3-12. READ OPERATION.

The Address Pointer value specifies the word to be read from Vector Memory. The pointer increments with each Write or Read operation to the Vector Memory. Positioning of the Address Pointer to a specific location can also be accomplished via a write operation and the pointer instruction. This allows a selected word to be read from Vector Memory. The read operation is controlled by the handshake sequence as presented in figure 3-1.

3-13. PROGRAMMING SUMMARY.

A programming summary for the 1349A/D instruction set and commands is given in table 3-2.

Table 3-2. Truth Table for 1349A/D Instructions and Commands

BIT NUMBER M15	M14	M13	1349A/D INSTRUCTION OR COMMAND
0	0	0	PLOT
0	0	1	GRAPH
0	1	0	TEXT
0	1	1	SET CONDITION
1	0	0	INTERNAL JUMP
1	0	1	INTERNAL JUMP
1	1	0	SET POINTER
1	1	1	SET POINTER

3-14. USING THE JUMP INSTRUCTION.

The Internal Jump instruction resides in the Vector Memory. When it is encountered in the course of refreshing the 1349A/D it is not sent to the VPC. Instead, it causes the Vector Memory to do an absolute jump to a new location. The Vector Memory then resumes sending data to the VPC. This allows the user to store pictures in the Vector Memory but not display them until ready (by jumping past them). See the example below.

VECTOR MEMORY

Address	Contents
0000	Jump to 1002
0001 to 1000	Picture A
1001	Jump to 1002
1002 to 2002	Picture B
2003	Jump to 2062
2004 to 2060	Graticule A
2061	Jump to 2062
2062 to 2147	Graticule B
2148	Jump to 8191
2149 to 2255	Set of labels
2256	Jump to 8191
2257 to 8190	Unused Memory
8191	No-Op

By putting jump instructions around each block of data, it allows the user to turn parts of the complete picture on or off by writing only one or two words to the Vector Memory. Picture A might be used as a standard to compare against picture B which is being updated in real time. For this application, picture A can be turned on whenever it is needed by changing the contents of address 0000 to be "Jump to 0001".

NOTE

Vector Memory location 0000 is the first location sent to the 1349A/D in each refresh cycle. The Vector Memory then auto-increments to location 0001, 0002, etc.

3-15. OPTIMIZING PICTURE QUALITY

Due to differing conditions of ambient light when the 1349A/D is displaying pictures, the programmer may have to experiment with the Intensity and Writing Speed parameters of the Set Condition command.

For example, in an environment of high ambient light, the 1349A/D should be set to the highest brightness level and slowest writing speed.

3-16. OCTAL AND HEXADECIMAL RANGES FOR 1349A/D COMMANDS.

1349A/D Command	Octal Range	Hexadecimal Range
Plot		
X	00000 - 07777	0000 - 0FFF
Y (beam off)	10000 - 13777	1000 - 17FF
Y (beam on)	14000 - 17777	1800 - 1FFF
Graph		
Set DELTA-X	20000 - 27777	2000 - 2FFF
Y (beam off)	30000 - 33777	3000 - 37FF
Y (beam on)	34000 - 37777	3800 - 3FFF
Text	40000 - 57777	4000 - 5FFF
Set Condition	60000 - 77777	6000 - 7FFF
Internal Jump	100000 - 120000	8000 - A000
Set Pointer	140000 - 160000	C000 - E000

3-17. OPERATING CONSIDERATIONS FOR THE 1349A.

Model 1349A is not equipped with the Vector Memory Board.

3-18. SIGNAL LINE DEFINITIONS.

D0-D15.

D0 through D15 are the vector data lines (TTL positive logic). Bit D15 is used only with the Memory Board.

LDAV

Data Valid Signal Line (active low). Signal from user processor to 1349A. New output data is available on data bus.

LRFD

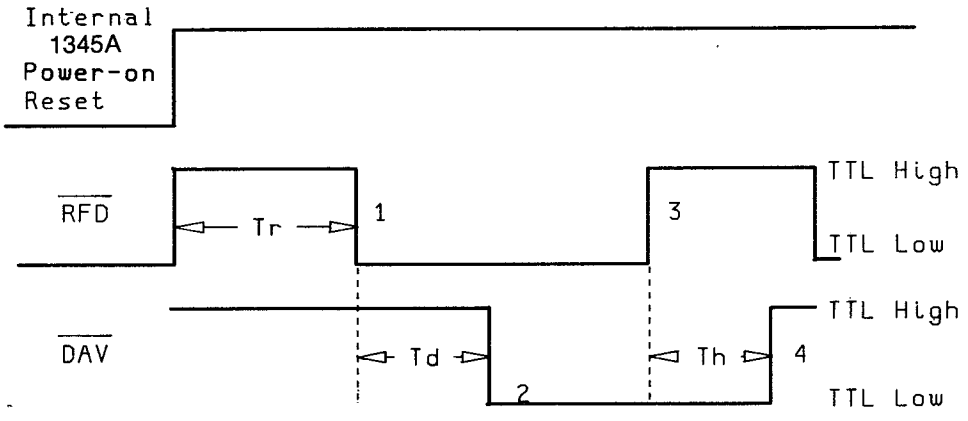
Ready for data signal line (active low). Signal to user processor. 1349A is ready for next data transfer.

DISCONNECT SENSE.

This line must be grounded when above signal lines are active. The internal performance verification pattern will be displayed if this line in not grounded.

3-19. HANDSHAKE TIMING FOR 1349A.

$\overline{RFD}$ and $\overline{DAV}$ (Ready For Data, Data Valid) Handshake.



Tr - Ready Time (1349A Power-on delay) ..... 400 nsec min
100 usec max
(assume $\overline{DAV}$ is high at Power-on)

Td - Data Valid Delay Time (after $\overline{RFD}$ goes low) ..... 0 nsec min

Th - Data Valid Hold Time (after $\overline{RFD}$ goes high) ..... 0 nsec min