SATURN DISPLAY SET

VOLUME 1

INSTRUCTION MANUAL

Available from NASA to NASA offices, NASA centers, and NASA contractors only.

TP 1203
Volume 1 of 3

INSTRUCTION MANUAL

SATURN DISPLAY SET

2110559-501
THRU
2110559-505

(RADIO CORPORATION OF AMERICA)
49671
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Instruction Manual, Cardomatic Automatic Multiple Switch (Card Reader, RCA Part No. 2184764-2)	
Instruction Manual, Dual High Voltage Power Supply (RCA Part No. 2184590-1)	2 December 1964
Instruction Manual Dual High Voltage Power Supply (RCA Part No. 2184591-1)	23 December 1964
Instruction Manual, Operational Amplifier (RCA 2184073-1)	24 July 1964
Instruction Manual, Regulated Power Supply (RCA Part No. 2184570-1)	
Instruction Manual, Regulated Power Supply (RCA Part No. 2184570-2)	
Instruction Manual, Voltage Reference Power Supply (RCA Part No. 2183389-1)	
Instruction Manual, Photoelectric Keyboard (RCA Part No. 2185411-1)	4 September 1964

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INTRODUCTION

The information in this instruction manual pertains to the RCA Saturn Display Set (RCA 2110559-501 through -505). The manual comprises a multi-volume set, the contents of which are as follows:

VOLUME 1

a. Chapter 1 contains a general description of the equipment and its purpose, the physical and functional characteristics, and other pertinent data.

b. Chapter 2 describes and illustrates the display set installation considerations.

c. Chapter 3 lists and illustrates all operating controls and indicators. Chapter 3 also contains normal and emergency operating instructions.

d. Chapter 4 describes the principles of operation of the equipment.

e. Chapter 5 contains instructions required for maintenance of the equipment.

VOLUME 2

f. Chapter 6 contains the functional, power distribution, schematic, and cabling diagrams of the equipment.

VOLUME 3

g. Chapter 7 contains the applicable manuals for the following commercial equipment:

Card Reader (RCA Part No. 2184764-2)	Form No. SP360	Hickok Electrical Instrument Company
Dual High Voltage Power Supply (RCA Part No. 2184590-1)	Model 5417	Transval Electronics Corporation
Dual High Voltage Power Supply (RCA Part No. 2184591-1)	Model 5418	Transval Electronics Corporation
Operational Amplifier (RCA Part No. 2184073-1)	Model 9587	Burr-Brown Research Corporation
Regulated Power Supply (RCA Part No. 2184570-1)	Model LA 200-03BM-1456-1	Lambda Electronics Corporation
Regulated Power Supply (RCA Part No. 2184570-2)	Model LA 15-08BM-1457-1	Lambda Electronics Corporation
Voltage Reference Power Supply (RCA Part No. 2183389-1)	Model 2092	Viking Industries Incorporated
Photoelectric Keyboard (RCA Part No. 2185411-1)	Model PK-144	Invac Corporation

CHAPTER 1
GENERAL INFORMATION

INTRODUCTION

This chapter contains the physical description, purpose, and functional operation of the display set equipment. Figures and tables provide information regarding the location of major components and technical quick reference data pertaining equipment and signal characteristics.

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CHAPTER 1

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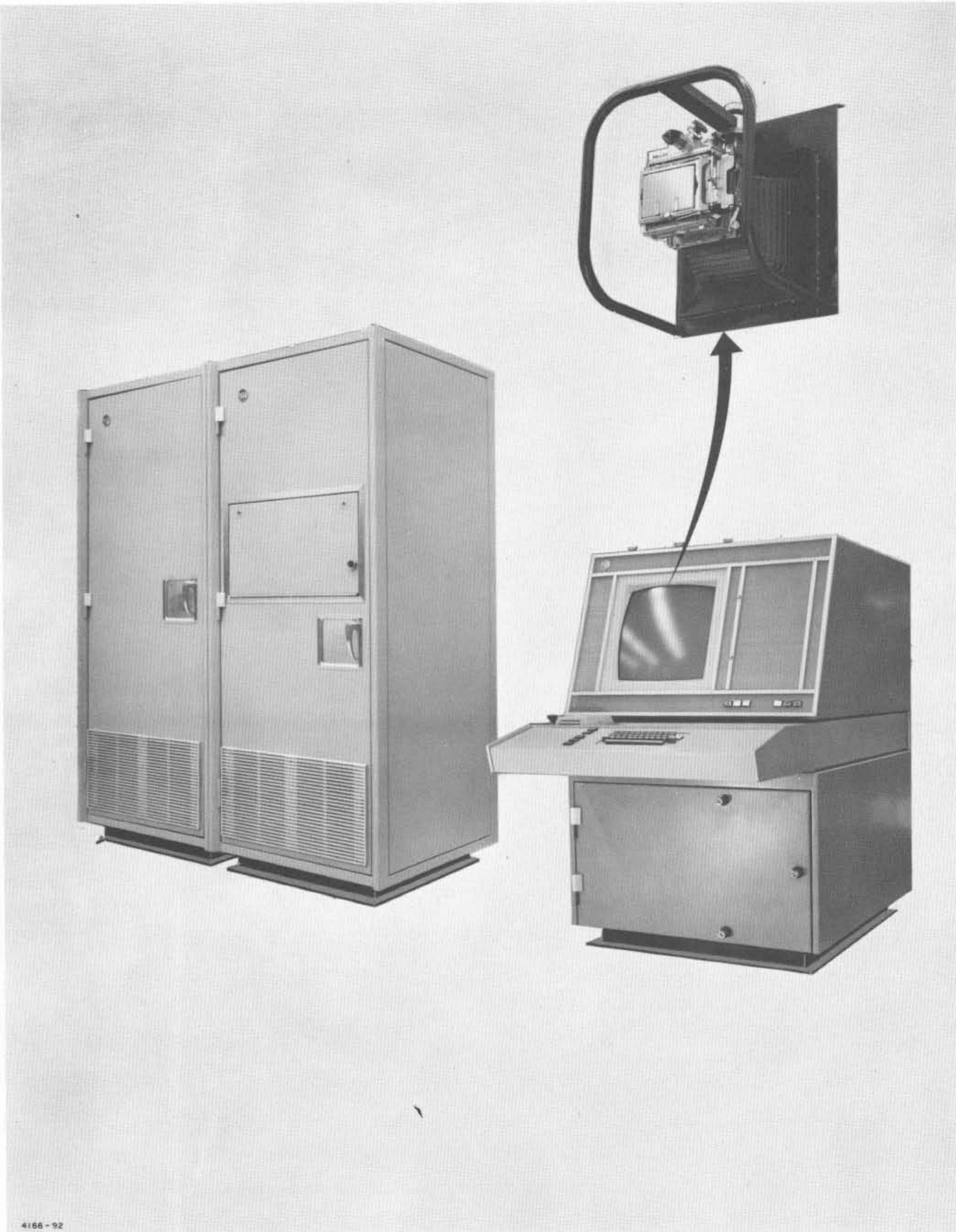


Figure 1-1. Saturn Display Set

CHAPTER 1

GENERAL INFORMATION

1. DESCRIPTION AND PURPOSE

The Saturn Display Set (RCA 2110559-501 through -505) is used in conjunction with the Saturn Ground Computer System to provide a highly versatile testing capability of Saturn Space Vehicle assemblies and subassemblies. Test program results can be requested, composed, edited, and displayed on a direct view storage tube in either tabular or graphic format. A typical Saturn Display Set (figure 1-1) comprises two display cabinets, one or more (6 maximum) display consoles, and one or more camera assemblies. The various Saturn Display Set configurations are tabulated in table 1-1.

1.1 Display Console

The display console (figure 1-2) contains logic circuits, controls, and indicators necessary for an operation of the display system. Switch-indicators provide controls and indicators for activating and monitoring the operating conditions. A card reader provides facilities for identifying operator authority and accessibility. The keyboard is composed of letter, number, punctuation, symbol, and control keys which provide facilities for composing and editing test programs.

1.2 Display Cabinet

The display cabinet (figure 1-3) contains power supplies, controls, indicators, and logic circuits required to facilitate the transposition of keyboard operation to computer digital data, and from computer digital data to display signals. The power supplies provide the secondary operating potentials for the logic and analog circuits of the system. Controls and indicators activate and monitor the application of primary and secondary power, and a simulator is provided to facilitate off line testing of equipment operation.

1.3 Camera Assembly

The camera assembly (figure 1-4) comprises a portable photocopy device consisting of an adapter frame and bellows and a view camera. The camera is equipped to produce positive and negative reproduction of the display image in 20 seconds without the need of a dark room. The negative may be filed for reproduction of positives at a future date.

2. FUNCTIONAL DESCRIPTION

The Saturn Display Set functions as an input/output device for the Saturn Ground Computer System. Data can be displayed in tabular or graphic format (figure 1-5). It provides an operator with the capability to accomplish the following:

a. Requesting data from the computer system.

b. Inputting data or messages to the computer system.

b. Displaying a graph or message from information stored in the computer system memory.

d. Editing data or messages and transferring the correction to the computer system.

2.1 Data Entry

Data is entered and requested through operation of the display console keyboard. When the display set operator depresses one of the manual input request buttons, an interrupt signal is generated. After the computer system acknowledges this interrupt, it enters a program which recognizes the requesting cabinet, selects the display console, places it in the requesting mode, sets the maximum number of words to enter, and selects the initial computer high speed memory location for data storage. Once this selection has been made, the data transfer from the manual input keyboard to the computer system is in one of two operating modes; keyboard compose or keyboard edit. A third mode, keyboard self-check mode, enables an operator to test the operation of the display set.

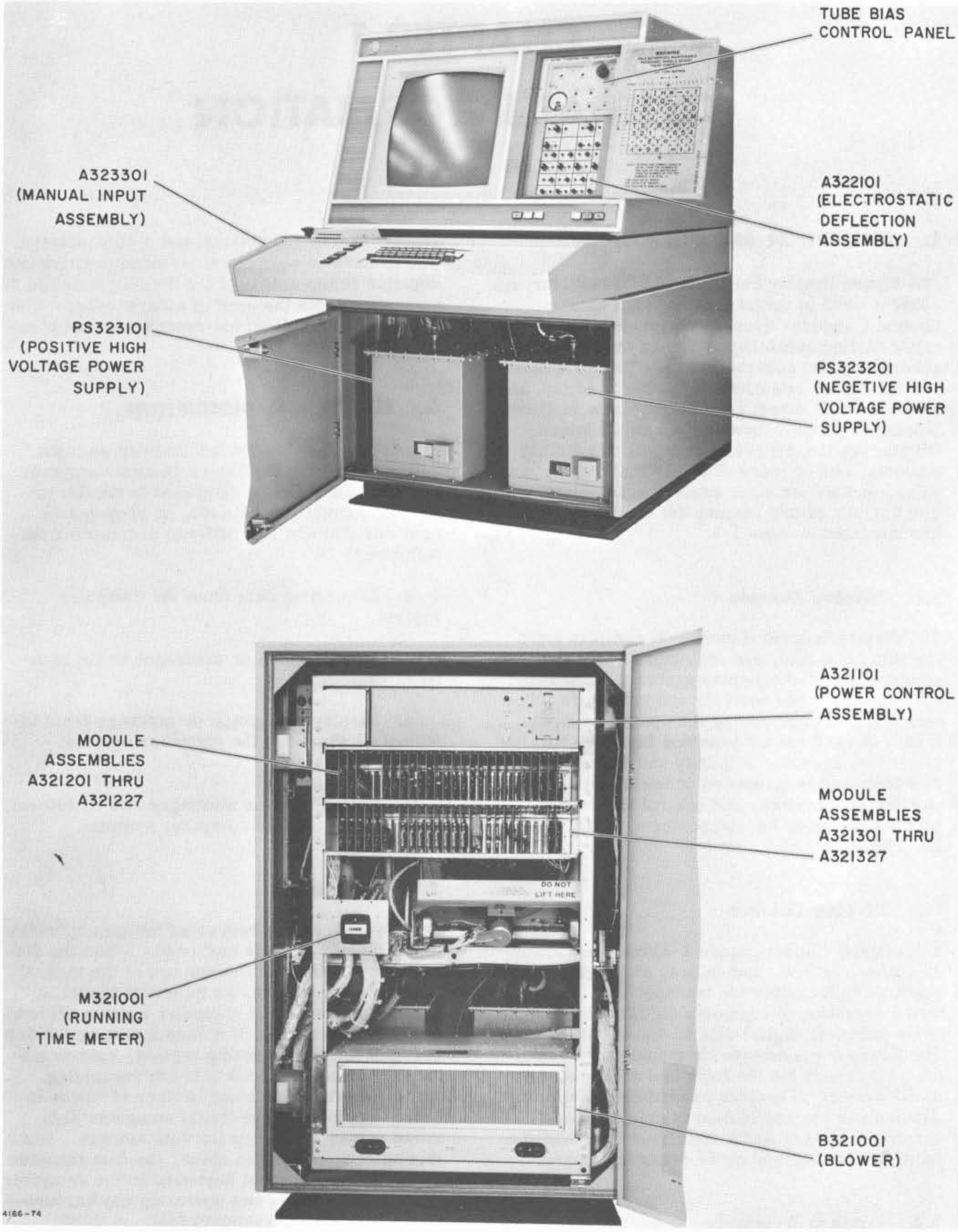


Figure 1-2. Identification of Components, Display Console (Sheet 1 of 2)

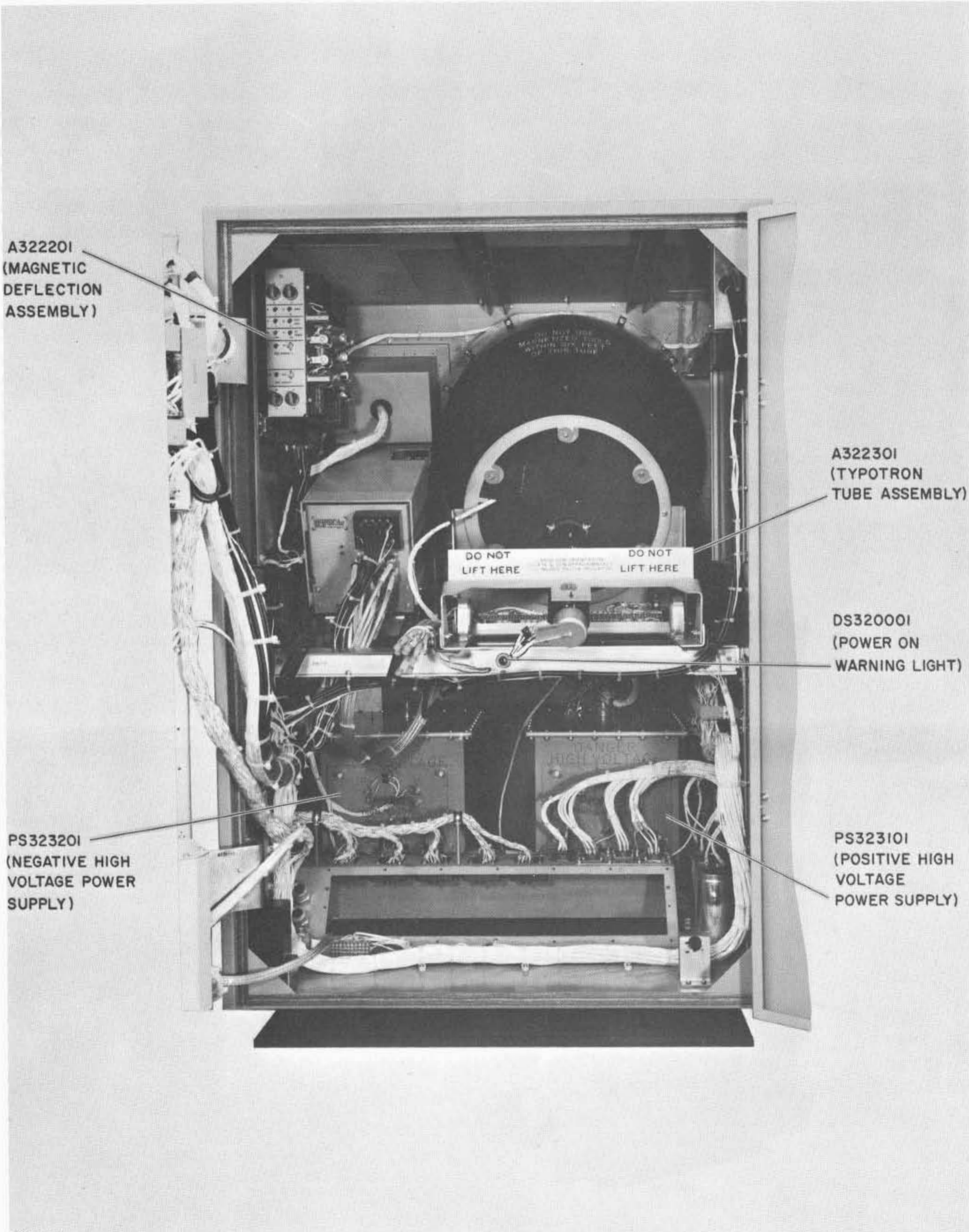


Figure 1-2. Identification of Components, Display Console (Sheet 2 of 2)

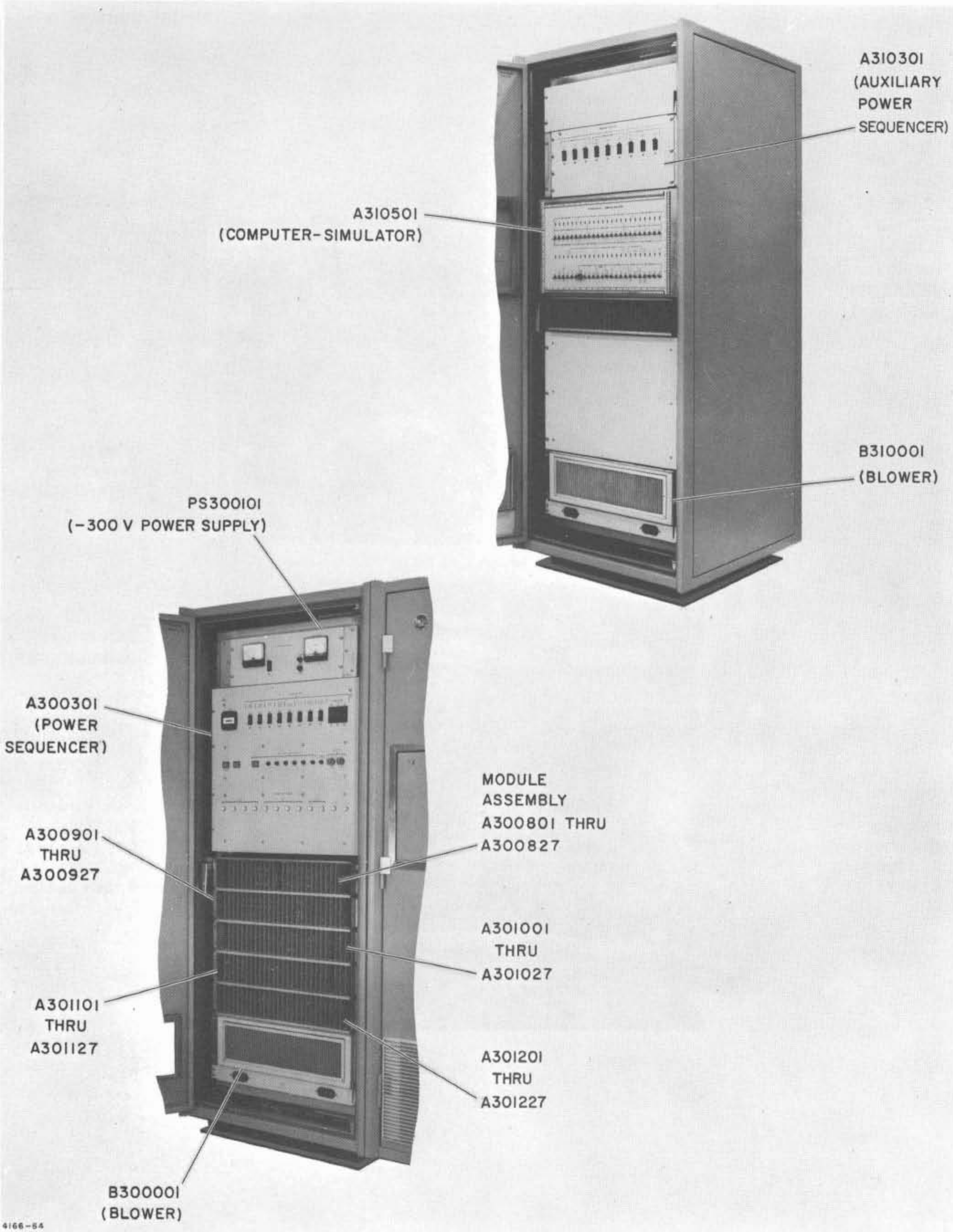


Figure 1-3. Identification of Components, Logic and Power Supply Cabinet (Sheet 1 of 2)

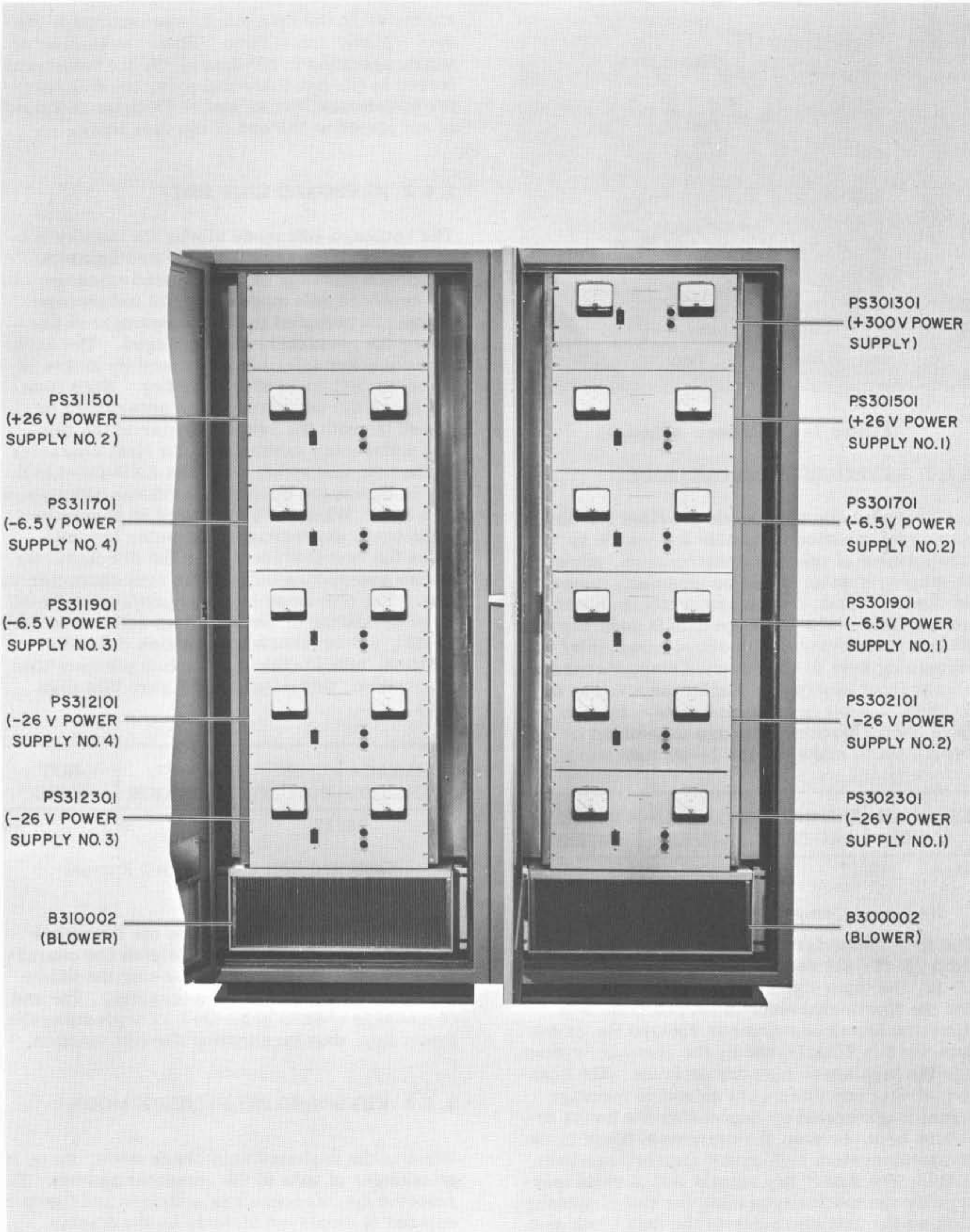


Figure 1-3. Identification of Components, Logic and Power Supply Cabinet (Sheet 2 of 2)

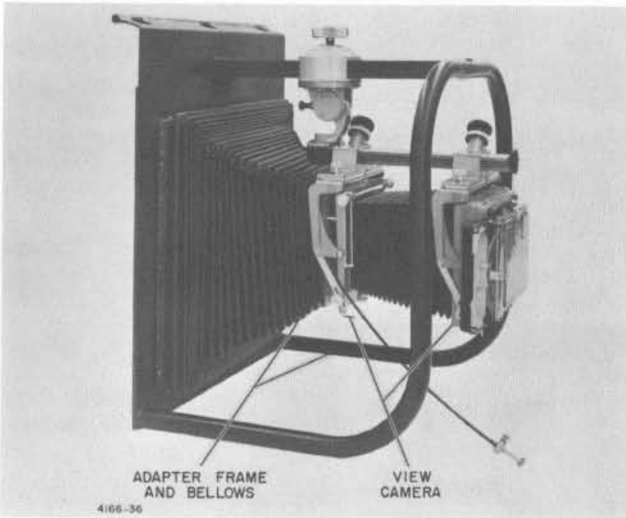


Figure 1-4. Camera Assembly

2.1.1 KEYBOARD COMPOSE MODE

The keyboard compose mode provides for displaying information in tabular form such as arrangement of operating instructions, advisory messages, system status summaries, system checkout information and graph labels in text and/or lists. The message data is inserted into the computer system high-speed memory by depressing keys at the selected display console manual input keyboard. Each time a key is depressed, a 6-bit code is generated. Four of these 6-bit character sets are assembled by the display set to make up one 24-bit data word.

1ST CHARACTER	2ND CHARACTER	3RD CHARACTER	4TH CHARACTER
23 18	17 12	11 6	5 0

Keyboard Compose Mode, Word Format

The first character typed is placed in bit positions 23-18, the second character in bit positions 17-12, the third character in bit positions 11-6, and the fourth character in bit positions 5-0. After the fourth character is entered the 24-bit data word is transferred by the computer system into the high speed memory or drum. The injection of data continues until an end of message signal is generated by depressing the Insert or Delete keys, or until the designated block in the computer system high-speed memory has been filled. The insert key signals end of valid message by automatically placing the end of message code as the last character in the data block and terminating the data transfer instruction. The Delete key terminates an invalid message by automatically placing the delete code as the last character in the data block, and then stops the data transfer instruction. When the number of words specified in the data block has been transferred to the computer memory, the data transfer terminates, but an end of message indication is not placed at the end of the data block.

2.1.2 KEYBOARD EDIT MODE

The keyboard edit mode allows the display console operator to edit, correct, and update a composed message or a requested message. In the keyboard edit mode a special underscore marker is provided to aid the operator in locating the characters to be changed. The underscore marker (____) is positioned by means of the space bar and end-of-line key. Each time the space bar is depressed an underscore is placed beneath the next character in the line. The underscore advances to the first character in the next line either when the END-OF-LINE key is depressed or after the fiftieth underscore on a line. When the underscore is correctly positioned, depressing a character key will place the new character over the old character and an underscore beneath the next character in line. The character key also produces a 24-bit word consisting of the 6-bit character code (bits 23-18), a 6-bit character position code (X-position, bits 17-12), a 6-bit line position code (Y-position, bits 11-6), and 6 zero bits (bits 5-0).

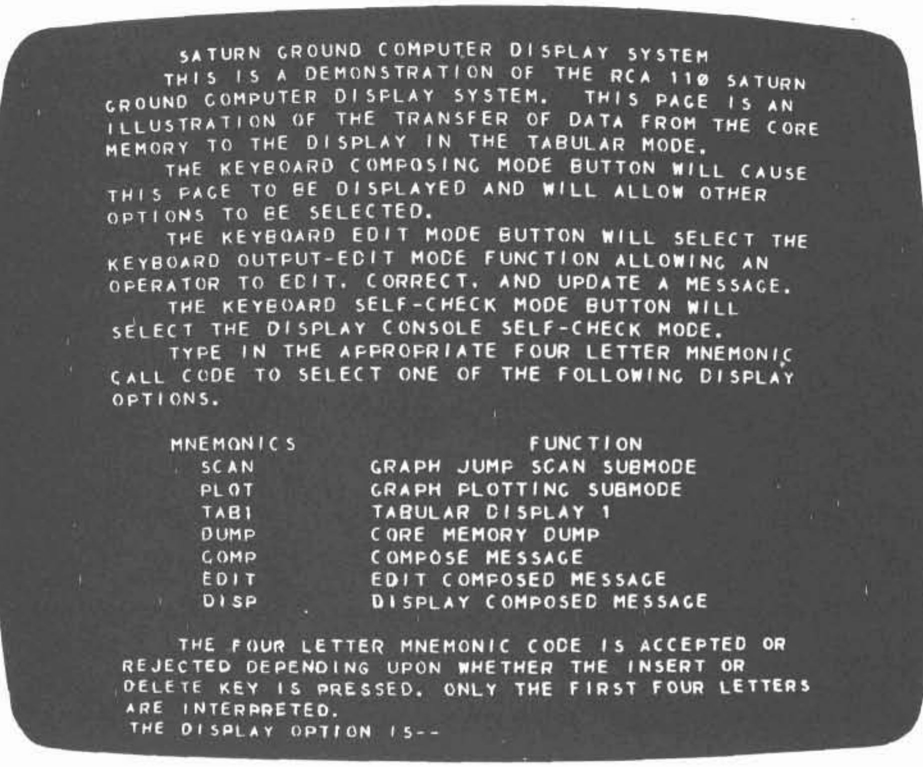
CHARACTER CODE	X POSITION	Y POSITION	NOT USED
23 18	17 12	11 6	5 0

Keyboard Edit Mode, Word Format

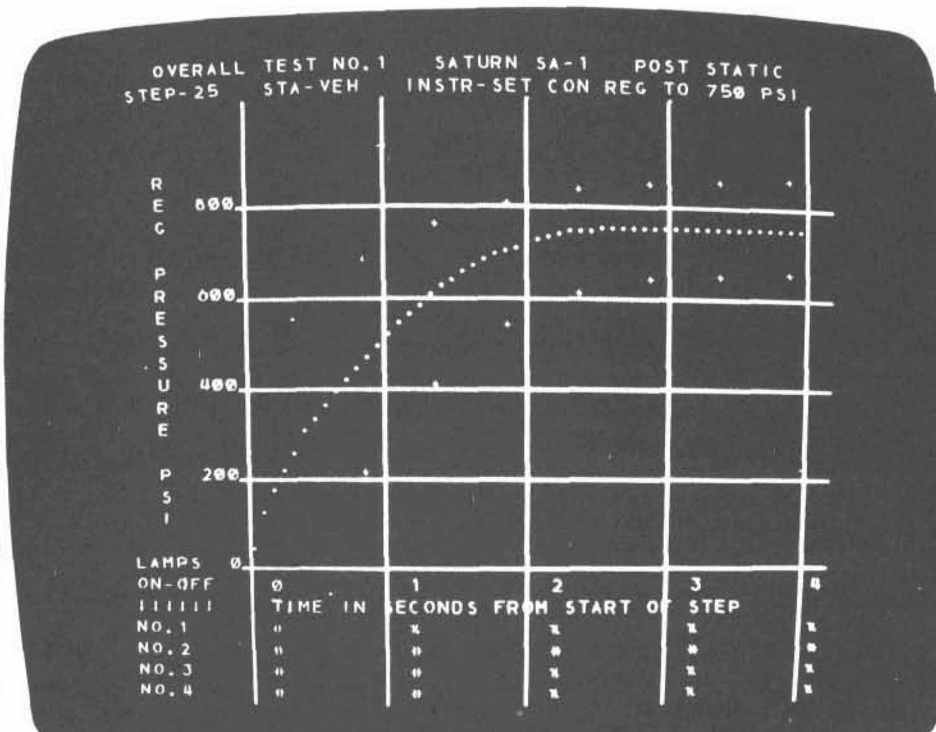
Depressing the delete key does not terminate the keyboard edit mode, but deletes the character above the underscore by placing the delete character (≡) over the old character. The end of message code is generated by depressing the insert key, thus terminating the edit function.

2.1.3 KEYBOARD SELF-CHECK MODE

When in the keyboard self-check mode, there is no transfer of data to the computer system. The selected display console is activated and the data entered is displayed directly on the display screen as it is entered at the keyboard. Once the self-check mode is selected the display console remains in this mode until another mode



TABULAR DISPLAY



GRAPHIC DISPLAY

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NOTE: The above displays were obtained with the camera assembly. Curvature of the data lines is due to the curvature of the tube face.

Figure 1-5. Tabular and Graphic Displays is requested from the computer system. The message is displayed as each key is depressed and the insert logic positions the next character at the starting position (character 1 line 0).

2.2 Data Display

The Saturn Display Set can also request information from the computer system for display and updating. This information can be displayed in either text format using tabular or tabular edit modes, or in graphic format using graph mode. In tabular and tabular edit modes, advisory messages, operating instructions, graph labels, system operating status summaries, and system checkout information may be displayed and edited. The graph mode is divided into three submodes; coordinate submode for drawing of graph coordinate axis, and the plot and jump scan submodes for plotting of graphic values. The data words supplied to the display set consist of 24 bits and are supplied from sequential locations in the selected data block of the computer system memory. Data words are decoded and displayed according to the display mode that is selected.

2.2.1 TABULAR MODE

The tabular mode is used to form a display message from the 24-bit data words supplied by the computer system. Each word consists of four six-bit characters.

1ST CHARACTER	2ND CHARACTER	3RD CHARACTER	4TH CHARACTER
23 18	17 12	11 6	5 0

Tabular Mode, Word Format

A maximum of 50 characters can be displayed in each line and up to 32 lines can be displayed in each message. The line and column positions are controlled by logic circuits in the display set.

2.2.2 TABULAR EDIT MODE

The tabular edit mode is the same as the tabular mode except an underscore mark (. . .) is displayed slightly below the normal character position. The underscore mark indicates character positions where data is to be filled in. For a description of the fill-in function refer to paragraph 2.1.2.

2.2.3 GRAPH COORDINATE SUBMODE

The graph coordinate submode is used to draw the grid pattern on the display screen to provide the set of coordinate axes for the graphs. This submode is automatically specified by octal values 376 or 377 in bit positions 23-16 of the data word.

377_8	X POSITION	NOT USED
23 16	15 8	7 0

Graph Coordinate Submode - Vertical Coordinate, Word Format

377_8	Y POSITION	NOT USED
23 16	15 8	7 0

Graph Coordinate Submode - Horizontal Coordinate, Word Format

A horizontal or vertical line is drawn for each data word space containing either of these coordinate flags. A 376 flags a vertical coordinate and a 377 flags a horizontal coordinate. The position of the coordinate line is specified by bits 15-8 of the data word. Bits 7-0 of the data word are not interpreted.

2.2.4 GRAPH PLOT SUBMODE

The graph plot submode is provided for plotting a relatively continuous single value function containing up to 171 points per curve. This submode is defined when the first 8-bit character of the data word octal value is not 373, 376, or 377. Each 24-bit data word containing this plot flag, defines three Y-coordinate values in the octal value range 40-370.

Y_1	Y_2	Y_3
23 16	15 8	7 0

Graph Plot Submode, Word Format

The X coordinate associated with each of these Y values is determined automatically from the X counter setting as the Y value is picked up. Therefore, each data word in the graph plot data block defines three points of the curve (Y_1 bits 23-16, Y_2 bits 15-8, and Y_3 bits 7-0). The first point plotted is X, Y_1 ; where X is the value of the X-position counter and Y is designated by bits 23-16 of the first data word. The second point is plotted at X + 1, Y_2; where X + 1 is automatically determined from the X counter setting and Y_2 is determined by bits 15-8 of the data word. The third point is plotted X + 2, Y_3 ; where X + 2 is automatically determined from the X counter setting and Y_3 is designated by bits 7-0 of the data word. The fourth point is plotted at X+3, Y_4 , where X+3 is automatically determined from the X counter setting and Y_4 is defined by bits 23-16 of the second data word. This sequence continues until the number of data words requested have been picked-up, decoded and plotted.

2.2.5 JUMP SCAN SUBMODE.

The jump scan submode provides the means to plot double-valued curves or curves with few points using a minimum of computer storage for the data block. Each data word defines one point of the graph curve and the sequence of the data words is not significant.

373_8	X POSITION	Y POSITION
23 16	15 8	7 0

Graph Jump Scan Submode, Word Format

This submode is defined when the first 8-bit character (bits 23-16) of each word is octal value 373. The second 8-bits (15-8) defines the X-position and the third 8-bits (7-0) defines the Y-position of the point. Plotting begins with the point defined in the first data word of the data block and continues until the number of words specified have been plotted. A point may be plotted anywhere within the display area: octal value X = 40 to 313, Y = 40 to 370.

3. APPLICABLE DOCUMENTS

The following technical manuals and documents provide supplementary information for operation and maintenance of the display equipment.

a. Saturn Display Set Illustrated Parts Breakdown (TP 1204).

b. Saturn Ground Computer Display System Acceptance Test Procedure (NSI-525).

c. Saturn Ground Computer System Instruction Manual (TP 1196).

d. Saturn Ground Computer System Module Data Handbook (TP 1198).

e. Installation Specification for RCA 110A Computer System (RCA Dwg. No. 2112021).

f. RCA 110 Computer Display Control Console Test and Maintenance/Demonstration Programs (TP 1281).

4. REFERENCE DATA

Reference data is contained in tables 1-2 through 1-13. Table 1-2 contains the leading particulars and characteristics of the display equipment. Table 1-3 contains power supply voltage and current ratings. Tables 1-4 through 1-10 contain the coding for the typotron tube displays. Tables 1-11 and 1-12 contain the display address and mode select coding. Table 1-13 contains the input and output signal characteristics.

Table 1-1. Saturn Display Set Configurations

DISPLAY SET COMPONENTS	2110559-501	2110559-502	2110559-503	2110559-504	2110559-505
Display Cabinet					
2110568-501			1		1
2110568-502	1	1		1	
Display Console					
2110504-501	6	6	2	6	2
Camera Assembly					
2110537-501	1	1			

Table 1-1. Saturn Display Set Configurations (cont)

DISPLAY SET COMPONENTS	2110559-501	2110559-502	2110559-503	2110559-504	2110559-505
Installation Kit					
2110572-501	1				
2110572-502		1			
2110572-503			1		
2110572-504				1	
2110572-505					1
Cable Set					
2110547		1			
2110548				1	
2110549	1				
2110550					1
2110551			1		

Table 1-2. Leading Particulars and Characteristics

PRIMARY AC POWER	
Type	120/208 v, 4-wire, 3-phase, 60 cycle
Voltage (steady state) per phase	120 v ± 10%
Voltage tolerances	
Maximum fluctuation	± 15%
Maximum rate of change	± 15%/sec
Frequency (steady state)	60 cps ± 1.6%
Frequency tolerances	
Maximum fluctuation	± 1.6% or 1 cps
Maximum rate of change	± 5%/sec
Current (approximate)	
Six console system	50 amps/phase
Five console system	45 amps/phase
Four console system	40 amps/phase
Three console system	35 amps/phase
Two console system	30 amps/phase
One console system	20 amps/phase
PHYSICAL CHARACTERISTICS (APPROXIMATE)	
Logic and Power Supply Cabinets	
Weight	2750 lbs
Height	80 inches
Width	64 inches
Depth	34 inches

Table 1-2. Leading Particulars and Characteristics (cont)

PHYSICAL CHARACTERISTICS (APPROXIMATE) (cont)	
Display Console	
Weight	1200 lbs
Height	53 inches
Width	35 inches
Depth	56. 5 inches
AMBIENT TEMPERATURE	
Operating	60°F to 80°F
Non-operating	50°F to 110°F
RELATIVE HUMIDITY	
Operating	20 to 80%
Non-operating	0 to 80%
BAROMETRIC PRESSURE (ALTITUDE)	
Operating	-400 ft to + 6000 ft (31. 5 inches of mercury to 24 inches)
Non-operating	-400 ft to + 6000 ft (31. 5 inches of mercury to 24 inches)
DISPLAY RATE	
Tabular Modes and Graph Coordinate Mode	100 to 125 usec per character
Graph Plot and Jump Scan Modes	200 to 250 usec per character
Keyboard Modes	200 to 250 usec per character
SIGNAL DRIVING CAPABILITIES	
Logic and Power Supply Cabinet	
Sending or receiving signals to and from computer	Maximum 25 ft of cable
Display Console	
Sending or receiving signals to and from logic and power supply cabinet	Maximum - 600 ft of cable to the last console or terminating unit device
TYPOTRON TUBE DISPLAY CHARACTERISTICS	
Typotron matrix (see figure 1-6)	
Character height for letters and numbers	0. 190 inch ± 10%
Minimum display storage time	Four minutes
Erase time	0. 6 - 1. 9 seconds
TABULAR MODE CHARACTERISTICS	
Display Format (see figure 1-7)	50 characters by 32 lines
GRAPHIC MODE CHARACTERISTICS	
Display Format (see figure 1-8)	168 "X" increments and 217 "Y" increments

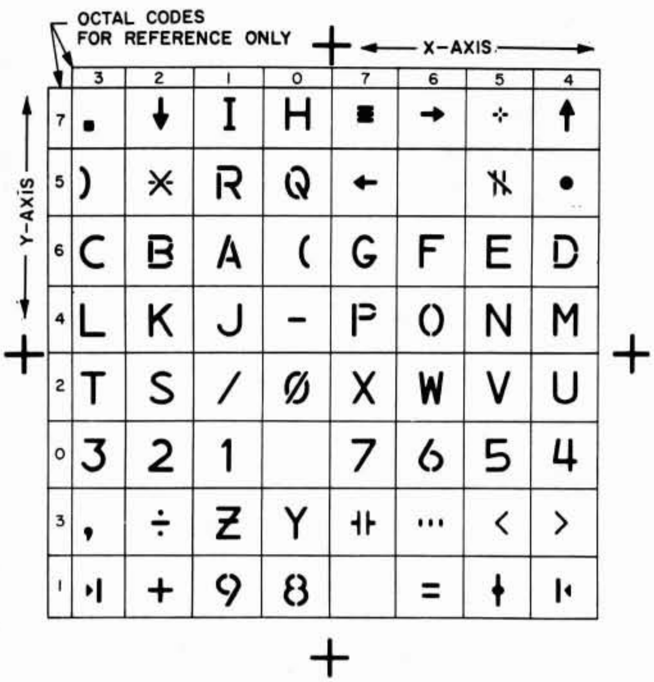

Figure 1-6. Matrix for H1123P4 Typotron Tube

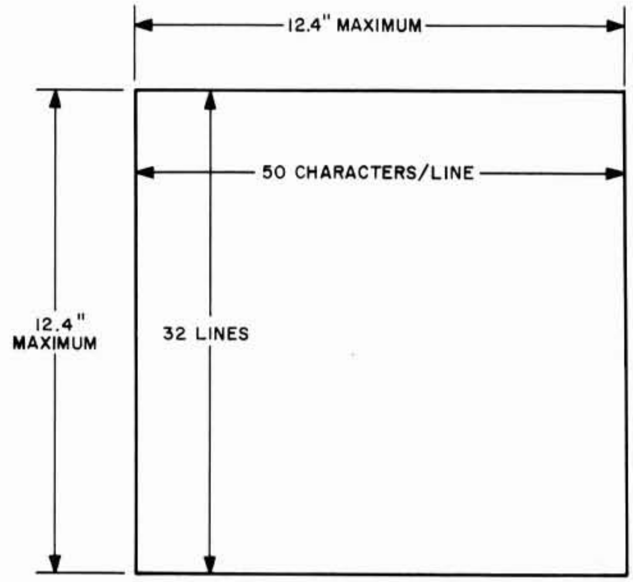

Figure 1-7. Tabular and Keyboard Modes Display Area

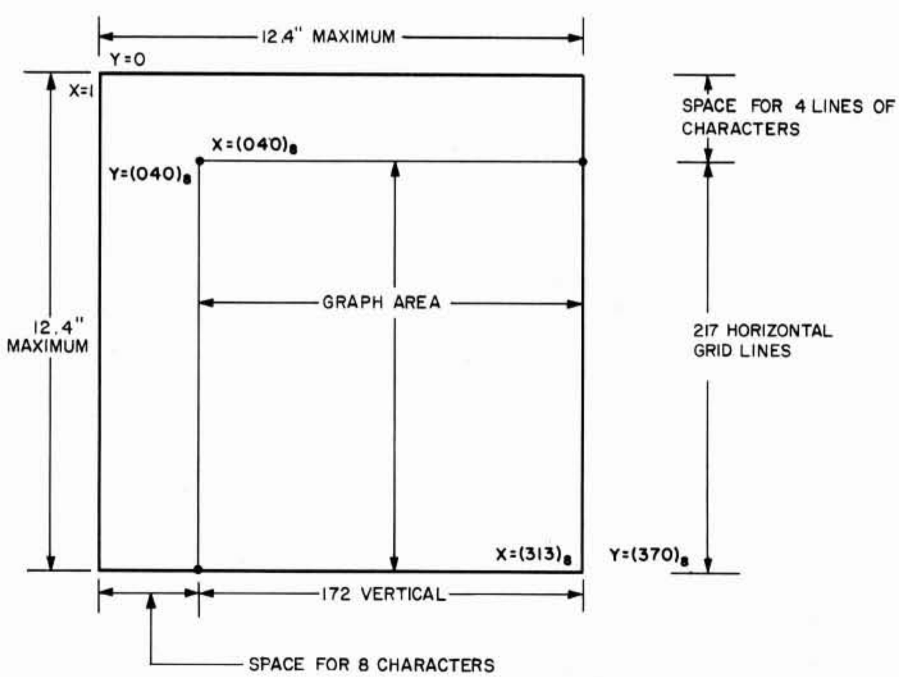

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Figure 1-8. Graph Submodes Display Area

Table 1-3. Power Supply Voltage and Current Ratings

MRF. AND PART NO.	VOLTAGE	CURRENT	QTY
*Lambda LA200-03BM-1456-1	-6.5 ± 0.01%	25.0 Amp	4
Lambda LA200-03BM-1456-1	-26 ± 0.01%	25.0 Amp	4
Lambda LA200-03BM-1456-1	+26 ± 0.01%	25.0 Amp	2
**Lambda LA15-08BM-1457-1	+300 ± 1%	1.5 Amp	1
Lambda LA15-08BM-1457-1	-300 ± 1%	1.5 Amp	1
Transval 5417 (Positive high voltage supply)			1
Output 1	5,000 (+0, -500) to 9,000 (+0, -210)	2.5 Milliamp	
Output 2	2,100 (+0, -83) to 3,000 (+83, -0)	0.6 Milliamp	
Transval 5418 (Negative high voltage supply)			1
Output 1	-3,150 (+250, -75) to -3,332 (+47, -0)	5.0 Milliamp	
Output 2	-60 (+60, -10) to -250 (± 10) with respect to output 1	0.5 Milliamp	

NOTE: *The output voltage of power supply LA200-03BM-1456-1 is adjustable from 1.4 to 27 VDC.
**The output voltage of power supply LA15-08BM-1457-1 is adjustable from 75 to 300 VDC.

Table 1-4. Character and Matrix Codes

BINARY CODE	OCTAL EQUIV-ALENT	CHAR-ACTER DIS-PLAYED	MEANING
000000	00	(None)	space or blank
000001	01	1	number "one"
000010	02	2	number "two"
000011	03	3	number "three"
000100	04	4	number "four"
000101	05	5	number "five"
000110	06	6	number "six"
000111	07	7	number "seven"
001000	10	8	number "eight"
001001	11	9	number "nine"
001010	12	+	"plus" sign
001011	13	▶|	"forward stop"
001100	14	|◀	"reverse stop"
001101	15	⧫	"absolute value" sign
001110	16	=	"equals" sign
001111	17	(None)	"end of message" ("Insert" for keyboard)
010000	20	Ø	number "zero"
010001	21	/	"slash" sign
010010	22	S	letter S
010011	23	T	letter T
010100	24	U	letter U
010101	25	V	letter V
010110	26	W	letter W
010111	27	X	letter X
011000	30	Y	letter Y
011001	31	Z	letter Z
011010	32	÷	"division"
011011	33	,	"comma"
011100	34	>	"greater than"
011101	35	<	"less than"
011110	36	. . .	"tab" sign (tab edit underscore)
011111	37	⊣⊢	"discrete off"
100000	40	-	minus, dash, or keyboard under-score

BINARY CODE	OCTAL EQUIV-ALENT	CHAR-ACTER DIS-PLAYED	MEANING
100001	41	J	letter J
100010	42	K	letter K
100011	43	L	letter L
100100	44	M	letter M
100101	45	N	letter N
100110	46	O	letter O
100111	47	P	letter P
101000	50	Q	letter Q
101001	51	R	letter R
101010	52	*	"asterisk" sign
101011	53	)	"close parenthesis"
101100	54	●	"spot" (for graph writing)
101101	55	⊣/⊢	"discrete on"
101110	56	(None)	"end of line"
101111	57	←	"arrow pointing left"
110000	60	(	"start paren-thesis"
110001	61	A	letter A
110010	62	B	letter B
110011	63	C	letter C
110100	64	D	letter D
110101	65	E	letter E
110110	66	F	letter F
110111	67	G	letter G
111000	70	H	letter H
111001	71	I	letter I
111010	72	↓	"arrow pointing down" (lower case)
111011	73	▪	"period"
111100	74	↑	"arrow pointing up" (upper case)
111101	75	-|-	"limit" sign
111110	76	→	"arrow pointing right"
111111	77	≡	"delete" sign

"End of line" (Code 101110) and "end of message" or "insert" (Code 001111) are command codes and are used in all keyboard and tabular modes but do not display any symbol. These signals are used for beam positioning commands and other logic functions.

Table 1-5. Graph Plotting Submode Character Coding

DECIMAL EQUIVALENT	OCTAL EQUIVALENT	CODING OF EACH EIGHT-BIT CHARACTER 2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	MEANING CH 1, 2 OR 3 Y VALUE ONLY
0	000	0	0	0	0	0	0	0	0	Not used: These positions reserved for 4 lines of characters to label the graph
↓	↓	etc. in straight binary								
31	037	0	0	0	1	1	1	1	1	
32	040	0	0	1	0	0	0	0	0	Maximum Y value of point (Note 3)
33	041	0	0	1	0	0	0	0	1	Total of 217 possible Y increments. (Note 1)
34	042	0	0	1	0	0	0	1	0	
↓	↓	etc. in straight binary								
247	367	1	1	1	1	0	1	1	1	
248	370	1	1	1	1	1	0	0	0	
249	371	1	1	1	1	1	0	0	1	Not used in this submode
250	372	1	1	1	1	1	0	1	0	Not used in this submode
251	373	1	1	1	1	1	0	1	1	Not used in this submode
252	374	1	1	1	1	1	1	0	0	End of Curve of Graph (Note 2)
253	375	1	1	1	1	1	1	0	1	Blank or Space
254	376	1	1	1	1	1	1	1	0	Not used in this submode
255	377	1	1	1	1	1	1	1	1	Not used in this submode

NOTES:
1) X value of point determined by sequence of receipt of Y values.
2) This signal resets the x position to the left side of the graph area.
3) Graph point y = 32 is not plotted.

Table 1-6. Graph Coordinate Submode Coding

DECIMAL EQUIVALENT	OCTAL EQUIVALENT	CODING OF EACH EIGHT-BIT CHARACTER 2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	MEANING OF CH2 IF CH1 = $(254)_{10}$ OR $(376)_8$ X=	MEANING OF CH2 IF CH1 = $(255)_{10}$ OR $(377)_8$ Y=
0	000	0	0	0	0	0	0	0	0	Note 2	Note 2
↓	↓	etc. in straight binary									
31	037	0	0	0	1	1	1	1	1		
32	040	0	0	1	0	0	0	0	0	X = 32 left border	Y = 32 top border
↓	↓	etc. in straight binary									
203	313	1	1	0	0	1	0	1	1	172 possible vertical grid lines	217 possible horizontal grid lines
204	314	1	1	0	0	1	1	0	0	X = 203 right border not used	
↓	↓	etc. in straight binary								↓	
248	370	1	1	1	1	1	0	0	0	↓	Y = 248 bottom border not used
249	371	1	1	1	1	1	0	0	1	↓	↓
250	372	1	1	1	1	1	0	1	0	↓	↓
251	373				↓					↓	↓
252	374				↓					↓	↓
253	375				↓					↓	↓
254	376				↓					↓	↓
255	377	1	1	1	1	1	1	1	1	↓	↓

NOTES:
1) In this submode Character 1 (CH1) must be either $(254)_{10}$ or $(255)_{10}$. Character 3 has no meaning.
2) Positions reserved for labeling graph, at left and top of display screen.

Table 1-7. Graph Jump Scan Submode Coding

DECIMAL EQUIVALENT	OCTAL EQUIVALENT	CODING OF EACH EIGHT-BIT CHARACTER 2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	MEANING OF CH2 IF CH1 = $(251)_{10}$ OR $(373)_8$ X=	MEANING OF CH3 IF CH1 = $(251)_{10}$ OR $(373)_8$ Y=
0	000	0	0	0	0	0	0	0	0	Note 1	Note 1
↓	↓	etc. in straight binary								↓	↓
31	037	0	0	0	1	1	1	1	1		
32	040	0	0	1	0	0	0	0	0	X = 32 left side	Y = 32 top side
↓	↓	etc. in straight binary								172 possible X values of a point	
203	313	1	1	0	0	1	0	1	1	X = 203 right side	217 possible Y values of a point
↓	↓										
204	314	1	1	0	0	1	1	0	0	not used	
205	315	1	1	0	0	1	1	0	1	↓	
↓	↓				↓						
248	370	1	1	1	1	1	0	0	0		Y = 248 bottom side
↓	↓										
249	371	1	1	1	1	1	0	0	1		not used
250	372	1	1	1	1	1	0	0	1		↓
↓	↓				↓						
255	377	1	1	1	1	1	1	1	1	↓	↓

NOTES: 1) Positions reserved for labeling graph at left and top of display screen.
2) See figure 1-8 for physical representation of values.

Table 1-8. Keyboard Edit Mode X and Y Position Coding

DECIMAL EQUIVALENT	OCTAL EQUIVALENT	CODING OF SIX-BIT CHARACTER 2^5	2^4	2^3	2^2	2^1	2^0	CH2 X POSITION IS:	CH3 Y POSITION IS:
0	00	0	0	0	0	0	0	not used	first line
1	01	0	0	0	0	0	1	first column	32 possible lines
↓	↓	etc. in straight binary							
31	37	0	1	1	1	1	1	50 possible columns	32nd line
32	38	1	0	0	0	0	0		not used
↓	↓	etc. in straight binary							↓
50	62	1	1	0	0	1	0	50th column	
51	63	1	1	0	0	1	1	not used	
↓	↓			↓				↓	
64	77	1	1	1	1	1	1	↓	↓

NOTES: 1) See figure 1-7 for keyboard edit mode display area.

Table 1-9. Identification Card Data Code

CARD NO.	2^5 2^4 2^3 2^2 2^1 2^0	MEANING
0	0 0 0 0 0 0	no card inserted
1	0 0 0 0 0 1	established by NASA
2	0 0 0 0 1 0	
3	0 0 0 0 1 1	
	etc. in straight binary	
61	1 1 1 1 0 1	
62	1 1 1 1 1 0	
63	1 1 1 1 1 1	

Table 1-11. Display Address Coding

CONSOLE ADDRESSED	ADDRESS LINE		
	2^2	2^1	2^0
Not used	0	0	0
No. 1	0	0	1
No. 2	0	1	0
No. 3	0	1	1
No. 4	1	0	0
No. 5	1	0	1
No. 6	1	1	0
Not used	1	1	1

Table 1-10. Graph Mode Symbol Coding

SYMBOL	MEANING	GRAPH SYMBOL	MODE LINE
		2^1	2^0
●	Spot	0	0
⊣/⊢	Discrete on	0	1
⊣ ⊢	Discrete off	1	0
-¦-	Limit Symbol	1	1

Table 1-12. Mode Select Coding

MODE	MODE LINE		
	2^2	2^1	2^0
None	0	0	0
(TM) Tabular	0	0	1
(GM) Graphic	0	1	0
(TEM) Tabular Edit	0	1	1
(KSCM) Keyboard Self-Check	1	0	0
(KCM) Keyboard Output-Compose	1	0	1
(KEM) Keyboard Output-Edit	1	1	0
Not used	1	1	1

Table 1-13. Input and Output Characteristics

INPUT SIGNAL CHARACTERISTICS	
Serial Display Data	
Input	One line from computer
Rate	312 kilocycles (nominal)
Pulse Width	24 bits, 3.2 usec, non return to zero
Tabular mode	Six 4-bit characters
Graphic mode	Three 8-bit characters
Data Shift	
Input	One line from computer
Rate	312 kilocycles
Pulse width	24 pulses, 0.5 to 1.25 usec
Logical level	Logical "1" (0 volts), logical "0" (-6.5 volts)
Data Strobe	
Input	One line from computer
Rate	312 kilocycles
Pulse width	24 pulses, 0.5 to 1.25 usec
Logical level	Logical "1" (0 volts)

The leading edge (positive going) of the data shift pulse is coincident with the leading edge of the display data bit. The data strobe pulse occurs approximately 1 usec after the leading edge of the display data.

Table 1-13. Input and Output Characteristics (cont)

INPUT SIGNAL CHARACTERISTICS (cont)	
Display Address	
Input	Three lines from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts)
Display Mode	
Input	Three lines from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts)
Mode Trigger	
Input	One line from computer
Pulse width	1 usec (coincident with the last usec of Display Mode and Graph Mode symbol signals)
Logical level	Logical "1" (0 volts) triggers Display Mode and Graph Mode symbol registers
Cabinet Address Operate and Sense	
Input	Two lines from computer
Logical level	Logical "1" (0 volts)
OUTPUT SIGNAL CHARACTERISTICS	
Serial Keyboard Data	
Output	One line to computer
Rate	312 kilocycles
Data	24 bits, non return to zero. Maximum of four 6-bit alphanumeric characters or symbols. Coding is listed in table 1-4
Card Data	
Output	Six lines to computer. Signal levels are dependent on the code punched on the card. Coding is listed in table 1-9.
Read for Next Word	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicates "Ready"
Request Keyboard Compose Mode	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicating keyboard compose request to computer
Request Keyboard Edit Mode	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicating keyboard edit request to computer
Request Keyboard Self-Check Mode	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicating keyboard self-check request to computer

Table 1-13. Input and Output Characteristics (cont)

OUTPUT SIGNAL CHARACTERISTICS (cont)

Insert	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicates "Insert"
Delete	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicates "Delete"
Enable Data Shift	
Output	One line to computer
Logical level	Logical "1" (0 volts) indicates "Enable"
Mode Reset	
Input	One line from computer
Pulse width	1 usec
Logical level	Logical "1" (0 volts) resets Display Mode registers
Keyboard Self-Check Mode	
Input	One line from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts)
Computer Off	
Input	One line from computer
Logical level	Open set of relay contacts when the computer is off. Logical "1" (0 volts) when the computer is on
Graph Mode Select Symbols	
Input	Two lines from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts)
Clear Display	
Input	One line from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts)
CC Strobe	
Input	One line from computer
Pulse width	1 usec (during last 1 usec of 3 usec CC data)
Logical level	Logical "1" (0 volts)
Error	
Input	One line from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts) indicates "Error"
Emergency Test Stopped	
Input	Two lines from computer
Pulse width	10 usec

Table 1-13. Input and Output Signal Characteristics (cont)

OUTPUT SIGNAL CHARACTERISTICS (cont)	
Logical level	Logical "1" (0 volts) indicates "Test Stopped" (SET signal). Logical "1" (0 volts) indicates dangerous condition no longer exists (RESET signal)
Word Accepted	
Input	One line from computer
Logical level	Logical "1" (0 volts) indicates "Accepted"
Counter Reset	
Input	One line from computer
Pulse width	3 usec
Logical level	Logical "1" (0 volts) resets the horizontal and vertical counters
Priority Interrupt Pulse	
Output	One line to computer
Pulse	90 to 150 usec
Logical level	Logical "1" (0 volts) indicates a "Priority Interrupt"
Displays Inoperable	
Output	One line to computer
Logical level	Logical "0" (-6.5 volts) when power sequence not complete (open line)
Mode Request Address Lines	
Output	Six lines to computer
Logical level	Logical "1" (0 volts) to indicate which console has made a keyboard compose, edit, or self-check request

CHAPTER 2
INSTALLATION

INTRODUCTION

This chapter contains a detailed description of a Saturn Display Set installation and provides the information on the site facility aspects of the display set that is required for effective system-level operation and maintenance. Due to the variable complement of equipments and site configurations, detailed installation procedures are beyond the scope of this manual and are therefore omitted.

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CHAPTER 2

ILLUSTRATIONS

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CHAPTER 2
INSTALLATION

1. SITE PLANNING

1.1 Equipment Layout

A typical Saturn Display Set is shown in figure 1-1. The equipment complement shown is the same as that described in the description and purpose paragraphs of Chapter 1. Unit 3001 (power supply and simulator unit) consists of two cabinets joined at their sides and having common internal cabling. The unit may be connected to one or more consoles (six maximum) in any physical arrangement so long as the maximum cable lengths are not exceeded. Operating and maintenance access area should be provided which allow adequate space for the console operator chair, and cabinet and console equipment removal area. (See figures 2-1 and 2-2.)

1.2 Weights and Dimensions

Weights and dimensions of the display cabinet and display console are listed in table 1-2.

1.3 Flooring Requirements

The cable entries of the Saturn Display Set cabinets require a raised-floor equipment room construction of at least 12" clearance.

1.4 Power Requirements

The primary power requirements of the Saturn Display Set are listed in table 1-2.

1.5 DC Power and Signal Cables

Dc power and signal cable maximum lengths are critical if optimum performance of the display system is to be obtained. No dc or signal cable length may exceed 600 feet. When dc power cables exceed 400 feet it is necessary to use two parallel dc power return cables. The signal cables from the Saturn Ground Computer System display input/output data channel cabinet (1101) to the display cabinet (3001) must not exceed 40 feet of maximum length. Signal output cables from the display cabinet to the display console shall not have a sum total which exceeds 600 feet. Therefore, it is advised that the consoles be arranged in a series configuration with display console 3201 closest to display cabinet 3001 and display console 3206 farthest from display cabinet 3001. See table 2-1 for cable dash number, function, and from-to data, and cable diagram figure 6-30, 6-31, and 6-32 for cable distribution.

1.6 AC Power Distribution System

The primary site power is connected to the display set at a bank of rfi filters located beneath the equipment room flooring. (See figure 2-3.) The filtered ac power is then distributed through standard flexible conduit to the display cabinet. Ac power to the consoles is distributed through individual cables from display cabinet 30 to console No. 1 and from cabinet 31 to all other consoles. (See cable diagrams Chapter 6, Volume 2.)

1.7 Customer/RCA Power Interface

The input power wiring from the equipment room main circuit breaker panel to the display set line filters is the responsibility of the customer. The input power shall be provided from a WYE connected isolation transformer, or a prime source transformer to which no other loads are connected, to supply three phase four wire power with a grounded neutral. It is the recommendation of RCA, however, that power to these filters should be supplied with four AWG 4 type R or T cables installed in conduits. The cable terminations should be ring lugs to fit the 3/8-inch line filter input terminal studs. Each phase leg and the neutral leg will terminate at a separate filter. All power wiring from the filters to the display set is provided by RCA.

2. GROUNDING PROVISIONS

2.1 RFI Ground Plane

The Saturn Display Set is grounded to a low-impedance RFI ground plane which rests between

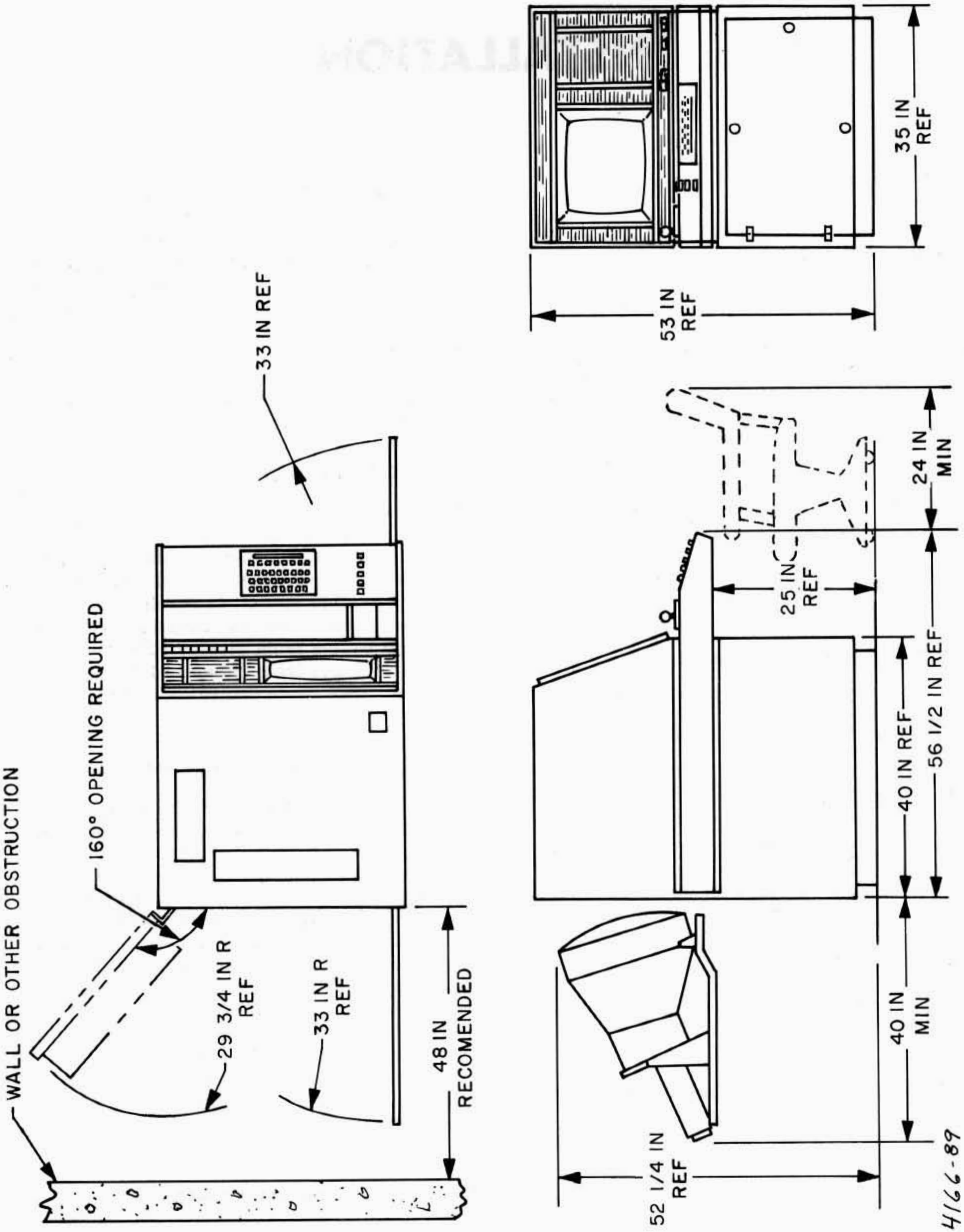

Figure 2-1. Display Console Dimensions and Floor Area Requirements

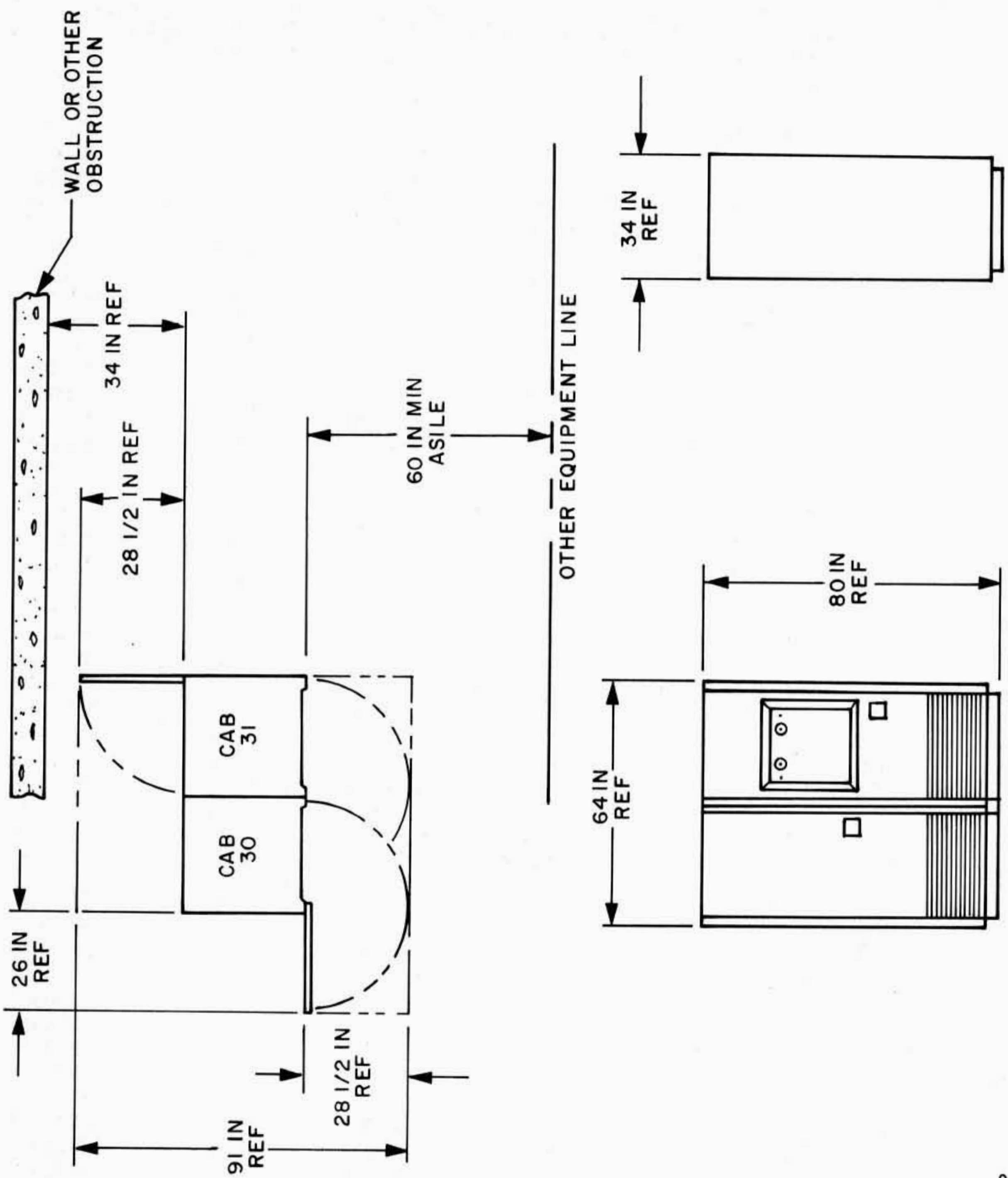

Figure 2-2. Display Cabinet Dimensions and Floor Area Requirements

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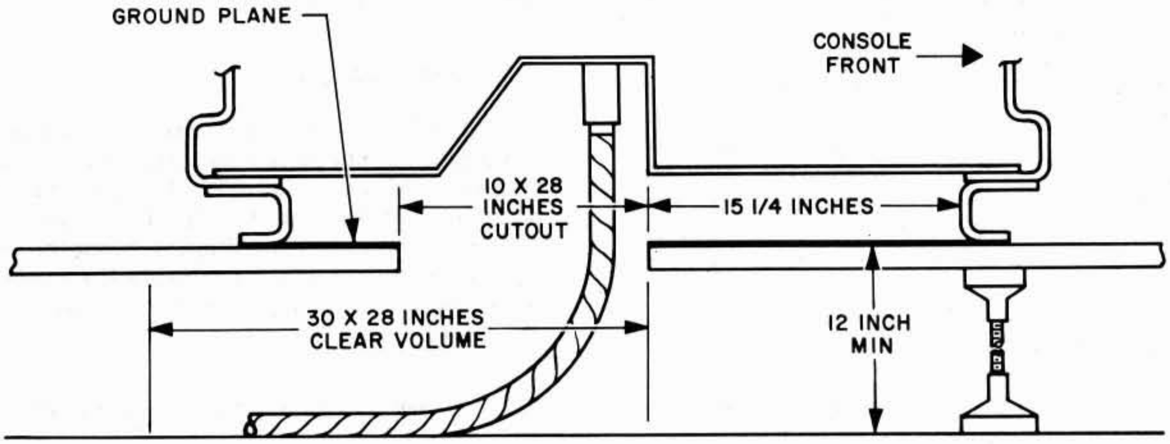
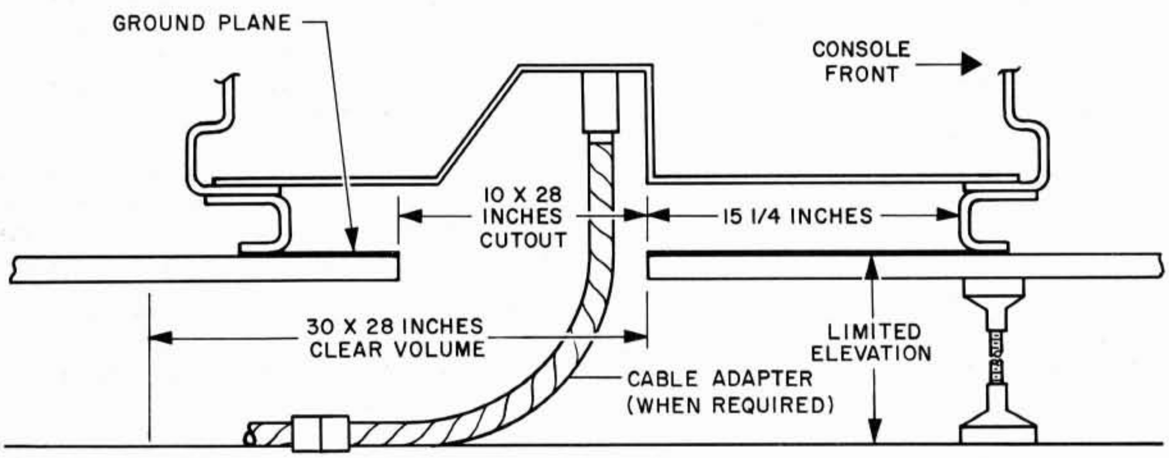
Table 2-1. Cable Connection List

CABLE DASH NO. / DISPLAY SET 2110559			FROM		TO	
-504	-501, -502, -503, -505	FUNCTION	UNIT NO.	CONNECTOR	UNIT NO.	CONNECTOR
501	501	DC Return	3001	E300001	CMP	E000001
502	502	CMP Dig. Signal	3001	J300017	1101	J110006
503	503	CMP Dig. Signal	3001	J300018	1101	J110007
521	504	AC PWR	3001	J300001	3201	J320001
522	505	DC PWR	3001	J300002	3201	J320002
523	506	DC PWR	3001	J300003	3201	J320003
524	507	Control	3001	J300004	3201	J320004
*525	*508	Digital Out	3001	J300005	3201	J320005
*526	*509	Digital Out	3001	J300006	3201	J320007
*527	*510	Digital In	3001	J300007	3201	J320009
528	511	DC Return	3001	E300001	3201	E320001
512	512	DC Return	3001	E300001	3001	E310001
504	513	AC PWR	3001	J310001	3202	J320001
505	514	DC PWR	3001	J310002	3202	J320002
506	515	DC PWR	3001	J310003	3202	J320003
507	516	Control	3001	J310004	3202	J320004
*508	*517	Digital Out	3201	J320006	3202	J320005
*509	*518	Digital Out	3201	J320008	3202	J320007
*510	*519	Digital In	3001	J300008	3202	J320009
511	520	DC Return	3001	E300001	3202	E320001
545	521	AC PWR	3001	J310005	3203	J320001
546	522	DC PWR	3001	J310006	3203	J320002
547	523	DC PWR	3001	J310007	3203	J320003
548	524	Control	3001	J310008	3203	J320004
*549	*525	Digital Out	3202	J320006	3203	J320005
*550	*526	Digital Out	3202	J320008	3203	J320007
*551	*527	Digital In	3001	J300009	3203	J320009
552	528	DC Return	3001	E310001	3203	E320001
513	529	AC PWR	3001	J310009	3204	J320001
514	530	DC PWR	3001	J310010	3204	J320002
515	531	DC PWR	3001	J410011	3204	J320003
516	532	Control	3001	J310012	3204	J320004
*517	*533	Digital Out	3203	J320006	3204	J320005
*518	*534	Digital Out	3203	J320008	3204	J320007
*519	*535	Digital In	3001	J300010	3204	J320009
520	536	DC Return	3001	E310001	3204	E320001
537	537	AC PWR	3001	J310013	3205	J320001
538	538	DC PWR	3001	J310014	3205	J320002
539	539	DC PWR	3001	J310015	3205	J320003
540	540	Control	3001	J310016	3205	J320004
*541	*541	Digital Out	3204	J320006	3205	J320005
*542	*542	Digital Out	3204	J320008	3205	J320007
*543	*543	Digital In	3001	J300011	3205	J320009
544	544	DC Return	3001	E310001	3205	E320001
529	545	AC PWR	3001	J310017	3206	J320001
530	546	DC PWR	3001	J310018	3206	J320002
531	547	DC PWR	3001	J310019	3206	J320003
532	548	Control	3001	J310020	3206	J320004
*533	*549	Digital Out	3205	J320006	3206	J320005
*534	*550	Digital Out	3205	J320008	3206	J320007
*535	*551	Digital In	3001	J300012	3206	J320009
536	552	DC Return	3001	E310001	3206	E320001

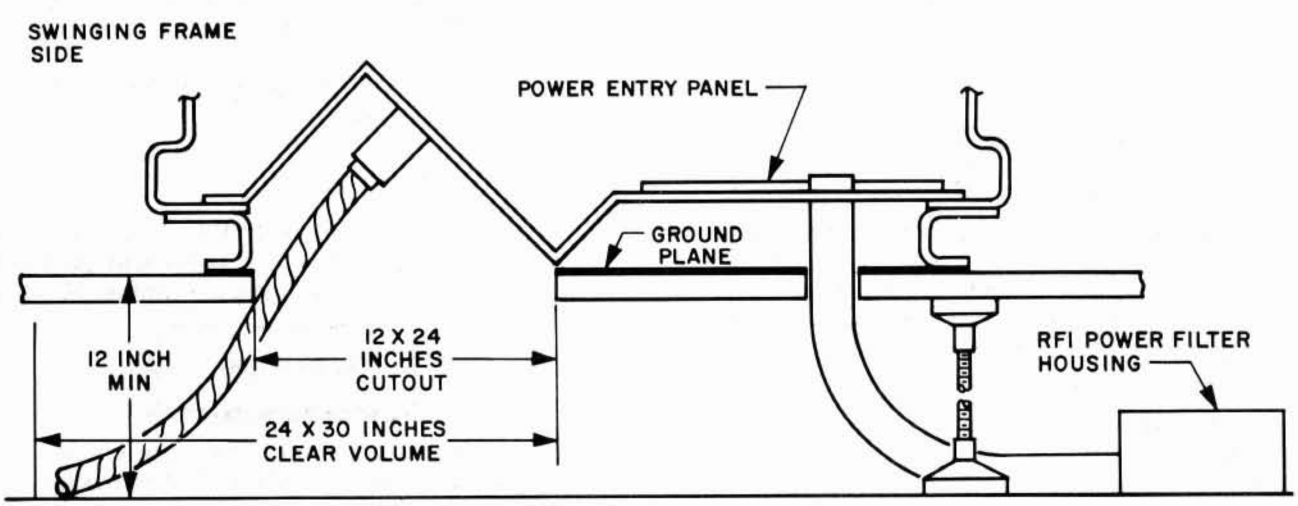
*Cable adapter used for display sets 2110559-501 and 2110559-504.



Display Console Normal Cable Access



Display Console Limited Cable Access



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Display Cabinet Cable Access

Figure 2-3. Typical Cable and Power Access the equipment and the equipment room flooring. (See figure 6-14.) The RFI ground plane consists of a thin (0.032-inch), tin-plated copper sheet which is mechanically bonded to the display set equipment. It is recommended that the joining straps which connect the separate sections of the ground plane have a maximum length-to-width ratio of five to one. The RFI ground plate must be bonded to the facility ground. This connection should be made as close to cabinet 3001 as practicable to maintain the recommended length-to-width ratio of five to one for the connecting strap.

2.2 Pad Ground

A 500 MCM ground cable, supplied by the customer, connects the display set and computer system ground bus to an external ground. This ground cable terminates on a 3/8-inch stud, labeled PAD GROUND, which is located on top of the con-duct module beneath the computer system cabinet 05. An extra stud, located two inches from the PAD GROUND stud is provided for connecting the signal grounds of display and data link equipments to this common point. The studs are bussed inside the con-duct and the bus is connected to the computer system signal ground bus bar.

3. AIR CONDITIONING

3.1 Ambient Conditions

The equipment inlet air shall be maintained at a temperature between 60 and 80 degrees Fahrenheit, with 20 to 80 percent relative humidity. Estimated heat dissipated is 5 KW for the display cabinet and 1 KW per console.

3.2 Air Flow

Four air blowers are installed in the display cabinet unit to provide operating air flow of approximately 400 CFM each blower (1600 CFM total). The system draws air from the bottom front and rear cabinet doors, and exhausts through the cabinet top. Each display console draws approximately 400 CFM at the bottom of the rear door and exhausts through the console top.

4. CABLING

Detailed cable routing information is given in Section III, Chapter 6, Volume 2 of this manual. The cabling diagram is general to a six console system and the cable numbers are the dash number of the individual cable set employed.

Primary power phase relation can be critical and should be connected as indicated in the AC Power Distribution diagram.

4.1 Cable Adapter

An extra flexible cable adapter is available for installations where the minimum platform elevation cannot be maintained. The coaxial cables supplied require a minimum 16 inch bend radius which is critical at the display console. If this minimum radius is not available the cable adapter provides for extension of connector along with improved cable flexibility.

4.2 Proper Three-Phase Relationship of AC Power

When removal of the ac power input to the display system RFI filters becomes necessary, all electrical connections should be tagged before removal. If doubt exists as to the proper ac power phase relationship, an oscilloscope should be used to determine phase relationship prior to turning on the display system.

Regardless of where the 120-volt 3-phase ac power was disconnected, after it has been reconnected and before the display system is turned on, perform the test procedure as outlined below.

a. Recommended Test Equipment

(1) Oscilloscope - Tektronix Model 545A or equivalent.

(2) Dual Trace Preamplifier - Tektronix Model CA or equivalent.

(3) 10X Attenuation Scope Probes (2) - Tektronix P6006 or equivalent.

(4) Multimeter - Simpson Model 260 or equivalent.

b. Test Procedure

(1) Switch MAIN POWER circuit breaker CB9 on the power sequencer panel of logic and power supply cabinet 30 to OFF.

WARNING

Lethal voltages are present when ac power is on. To eliminate the possibility of fatal electric burns or shocks, ensure that all personnel are clear of the equipment before applying primary ac power.

(2) Turn to ON the primary ac input power to the Saturn Display Set System.

(3) Using a multimeter, check for 120-volts ac between the following points of the power interface (RFI filters): FL00030-1 (return) to FL00031-1 (phase 1), FL00032-1 (phase 2), and FL00033-1 (phase 3).

(4) If one reading is 120 volts ac and the other two are 208-volts ac, return is connected improperly. To connect properly, reverse the return cable with the cable that gave a 120-volt ac reading.

(5) Set the oscilloscope as follows:

(a) Sweep rate: 20 milliseconds/ cm

(b) Sync: External + (sync on channel A).

(c) Sensitivity: 5 volts/ cm.

(6) Connect the channel A 10X attenuator probe to FL00031-1 (phase 1) and adjust the STABILITY TRIGGERING LEVEL to obtain the proper waveform.

(7) Connect the channel B 10X attenuator probe to FL00032-1 (phase 2). Phase 1 should lead phase 2 by 120°.

(8) If the channel A waveform leads the channel B waveform by more than 120° (approximately 240°), phases 1 and 2 are connected improperly. To connect phases 1 and 2 properly, the cables on FL00031-1 and FL00032-1 must be reversed.

CHAPTER 3
OPERATION

INTRODUCTION

This chapter contains the instructions necessary to operate the display equipment properly. The chapter is divided into three sections. Section I contains tables listing all controls and indicators used to operate the display equipment. Section II contains the operating instructions for starting, operating, and stopping the display equipment. Section II also contains an example of a typical sequence of operation. Section III contains emergency procedure instructions for discharging the typotron tube during a "runaway charging" condition.

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Section II.	Operating Instructions
Section III.	Emergency Procedure Instructions

SECTION I

CONTROLS AND INDICATORS

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SECTION I

CONTROLS AND INDICATORS

1. GENERAL

The controls and indicators for operating the display equipment are located on several different panels, therefore the function and operation of the controls and indicators at each location are explained separately. Adjustment and alignment controls are explained in Chapter 5.

Table 3-1 is an index of display system panels and states their purpose. In addition, table 3-1 includes references to figures illustrating the panels and references to tables listing the control or indicator placard nomenclature, reference designation, and function of the control or indicator.

2. INTERLOCK CIRCUITS

Blower vane switches are on cabinet blowers B310001, B310002, B300001, and B300002 and console blower B321001. Cabinet blower vane switches sense the blower airflow and open when the blowers are operating properly. These air vane switches close if the air flow diminishes below safe operating level and remain insufficient for a period of time exceeding the time delay setting of K310001. (The time delay eliminates equipment turn-off due to air flow fluctuation and spurious closures of the air vane switches.) When K310001 deenergizes, closure of its contacts remove operating potential from relay K300318. This deenergizes relay K300318 and initiates a dc power off sequence which prevents equipment damage. Console blower vane switch B1001 is normally closed and opens when the console blower is operating properly. If the console blower fails, B1001 closes causing K18 to deenergize and dc power is sequenced off preventing damage to the equipment. If the Power Sequencer Assembly INHIBIT switch is ON, a console blower failure or pressing of the console DC POWER OFF switch does not turn dc power off.

CRT power interlock circuits are provided to prevent damage to the typotron tube. Connecting plugs J1 and J2 of the electrostatic deflection assembly, J1 and J2 of the magnetic deflection assembly, and J1, J2, and J3 of the power control unit must be properly seated or CRT power will not be applied to the tube. Power sequence must also be completed.

Table 3-1. Index to Display System Equipment Panels

PANEL	PURPOSE	FIGURE AND TABLE REFERENCE
Power sequencer panel	Provides the controls and indicators to control and monitor the sequencing and application of primary and secondary power to the system display equipment	Figure 3-1; Table 3-2
Auxiliary sequencer panel	Controls application of primary power to supplies, console blowers, and console convenience outlets	Figure 3-2; Table 3-3
Manual input panel	a. Provides controls and indicators to request, control, and monitor data from the computer b. Provides keyboard and card reader to insert data into the computer	Figure 3-3; Table 3-4

Table 3-1. Index to Display System Equipment Panels (cont)

PANEL	PURPOSE	FIGURE AND TABLE REFERENCE
Display console panel	a. Displays data on typotron tube b. Provides controls and indicators to control and monitor console and CRT power c. Provides control to erase displays d. Provides displays busy and test stopped indicators	Figure 3-4; Table 3-5
Power supply panels (-300 v and +300 v)	Provides the controls and indicators to control and monitor the operation of the -300 v and +300 v power supplies	Figure 3-5; Table 3-6
Power supply panels (-6.5 v, -26 v and +26 v)	Provides the controls and indicators to control and monitor the operation of the -6.5 v, -26 v and +26 v power supplies	Figure 3-6; Table 3-7
Hard copy device	Provides controls for operating the camera for obtaining photographic records of display tube information	Figure 3-7; Table 3-8

Table 3-2. Power Sequencer Assembly, Controls and Indicators

FIGURE 3-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	DC POWER ON switch-indicator	A1	Controls the application of dc power, and indicates the dc power application status: Red-Filament Delay, indicates tube filaments are heating and dc power cannot be applied Yellow-Standby, indicates equipment readiness for application of dc power White-Sequence Incomplete, indicates dc power sequencing is in process. Green-Sequence Complete, indicates dc power has been applied and equipment is in operational readiness
	MAIN LOGIC RESET		Controls resetting of all logic counters after dc power sequencing is complete

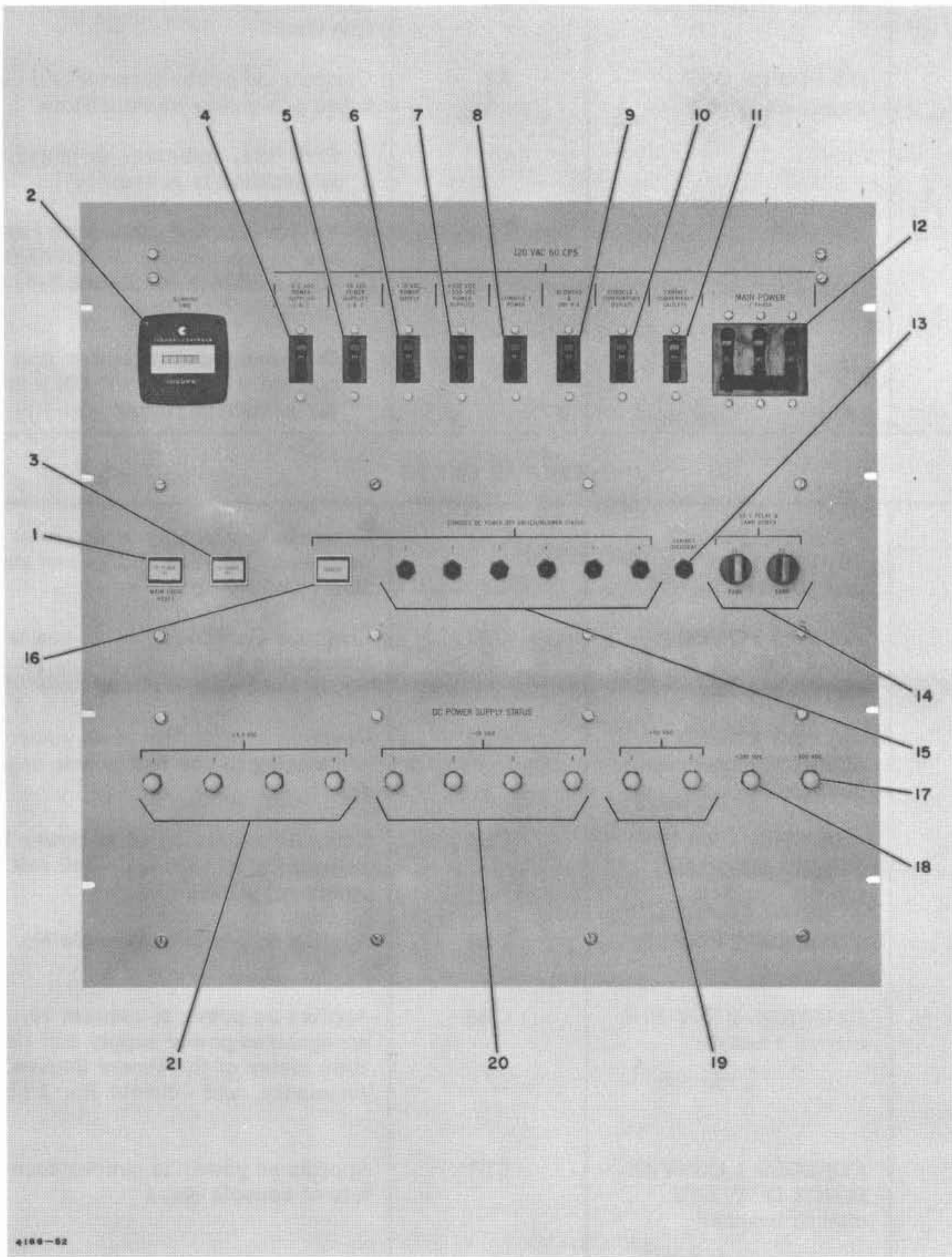

Figure 3-1. Power Sequencer Panel, Controls and Indicators

Table 3-2. Power Sequencer Assembly, Controls and Indicators (cont)

FIGURE 3-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
2	RUNNING TIME meter	M1	Indicates and totalizes system operation time
3	DC POWER OFF switch-indicator	A2	Controls dc power turn off and indicates pre-power on conditions Red-Safe, indicates dc power application is prevented Yellow-Caution, indicates that one of the console DC POWER OFF switches (4, figure 3-4) is in the OFF position Dark-indicates dc power may be applied if DC POWER ON indicator is lighted yellow
120 VAC 60 CPS			
4	-6.5 VDC POWER SUPPLY 1 & 2 circuit breaker	CB1	Controls availability of ac power for sequencing to -6.5 volt power supplies No. 1 and No. 2
5	-26 VDC POWER SUPPLIES 1 & 2 circuit breaker	CB2	Controls availability of ac power for sequencing to -26 volt power supplies No. 1 and No. 2
6	+26 VDC POWER SUPPLY circuit breaker	CB3	Controls availability of ac power for sequencing to +26 volt power supply No. 1
7	+300 VDC, -300 VDC POWER SUPPLIES circuit breaker	CB4	Controls avilability of ac power for sequencing to +300 and -300 volt power supplies
8	CONSOLE 1 POWER circuit breaker	CB5	Applies ac power to console No. 1
9	BLOWERS & 28V P.S. circuit breaker	CB6	Applies ac power to cabinet 30, 28 volt unregulated power supply and running time meter of the Power Sequencer Assembly, and console No. 1 blowers
10	CONSOLE 1 CONVENIENCE OUTLETS circuit breaker	CB7	Applies ac power to convenience outlets of console No. 1
11	CABINET CONVENIENCE OUTLETS circuit breaker	CB8	Applies ac power to convenience outlets of cabinet 30

Table 3-2. Power Sequencer Assembly, Controls and Indicators (cont)

FIGURE 3-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
12	MAIN POWER 3-PHASE circuit breaker	CB9	Applies main 3ϕ ac power to circuit breakers in cabinets 30 and 31
13	CABINET OVERHEAT indicator	DS19	Indicates when temperature in cabinets 30 or 31 becomes excessive
28 V RELAY & LAMP POWER			
14	F1, F2 fuse indicators	F1 and F2	Protects against overload of 28 volt unregulated power supply; lights amber to indicate fuse is open
CONSOLE DC POWER OFF SWITCH/BLOWER STATUS			
15	1, 2, 3, 4, 5, and 6 indicators	DS1 through DS6	Indicate when any console DC POWER OFF or blower switch is in OFF position, lights red
16	INHIBITED switch-indicator	A3	Inhibits the power turn off function of all console DC POWER OFF and all blower switches, lights yellow when activated
DC POWER SUPPLY STATUS			
17	-300 VDC indicator	DS18	Indicates that -300 VDC Power Supply is turned on, lights white
18	+300 VDC indicator	DS17	Indicates that +300 VDC Power Supply is turned on, lights white
19	+26 VDC 1 and 2 indicators	DS15 and DS16	Indicates that +26 VDC Power Supplies No. 1 and No. 2 are turned on, light white
20	-26 VDC 1, 2, 3, and 4 indicators	DS11 through DS14	Indicates that -26 VDC Power Supplies No. 1, No. 2, No. 3 and No. 4 are turned on, light white
21	-6. 5 VDC 1, 2, 3, and 4 indicators	DS7 through DS11	Indicates that -6. 5 VDC Power Supplies No. 1, No. 2, No. 3, and No. 4 are turned on, light white

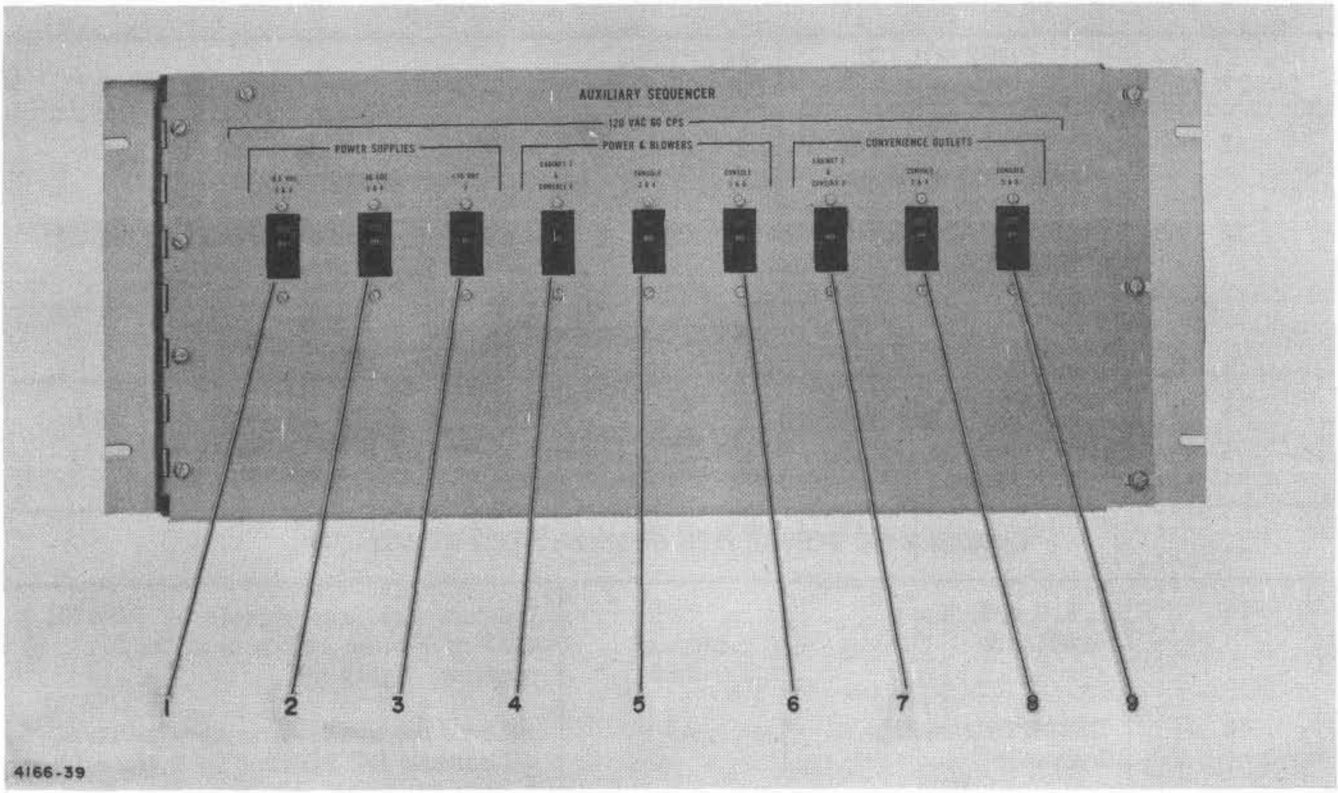

Figure 3-2. Auxiliary Sequencer Assembly, Controls

Table 3-3. Auxiliary Sequencer Assembly, Controls

FIGURE 3-2 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
		POWER SUPPLIES	
1	-6.5 VDC 3 & 4 circuit breaker	CB1	Controls availability of ac power for sequencing to -6.5 VDC Power Supplies No. 3 and No. 4
2	-26 VDC 3 & 4 circuit breaker	CB2	Controls availability of ac power for sequencing to -26 VDC Power Supplies No. 3 and No. 4
3	+26 VDC 2 circuit breaker	CB3	Controls availability of ac power for sequencing to +26 VDC Power Supply No. 2
		POWER & BLOWERS	
4	CABINET 2 & CONSOLE 2 circuit breaker	CB4	Applies ac power to blowers and assemblies of cabinet 31 and console No. 2
5	CONSOLE 3 & 4 circuit breaker	CB5	Applies ac power 00 blowers and assemblies of consoles No. 3 and No. 4

Table 3-3. Auxiliary Sequencer Assembly, Controls (cont)

FIGURE 3-2 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
6	CONSOLE 5 & 6 circuit breaker	CB6	Applies ac power to blowers and assemblies of consoles 3205 and 3206
		CONVENIENCE OUTLETS	
7	CABINET 2 & CONSOLE 2 circuit breaker	CB7	Applies ac power to convenience outlets of cabinet 31 and console No. 2
8	CONSOLE 3 & 4 circuit breaker	CB8	Applies ac power to convenience outlets of consoles No. 3 and No. 4
9	CONSOLE 5 & 6 circuit breaker	CB9	Applies ac power to convenience outlets of consoles No. 5 and No. 6

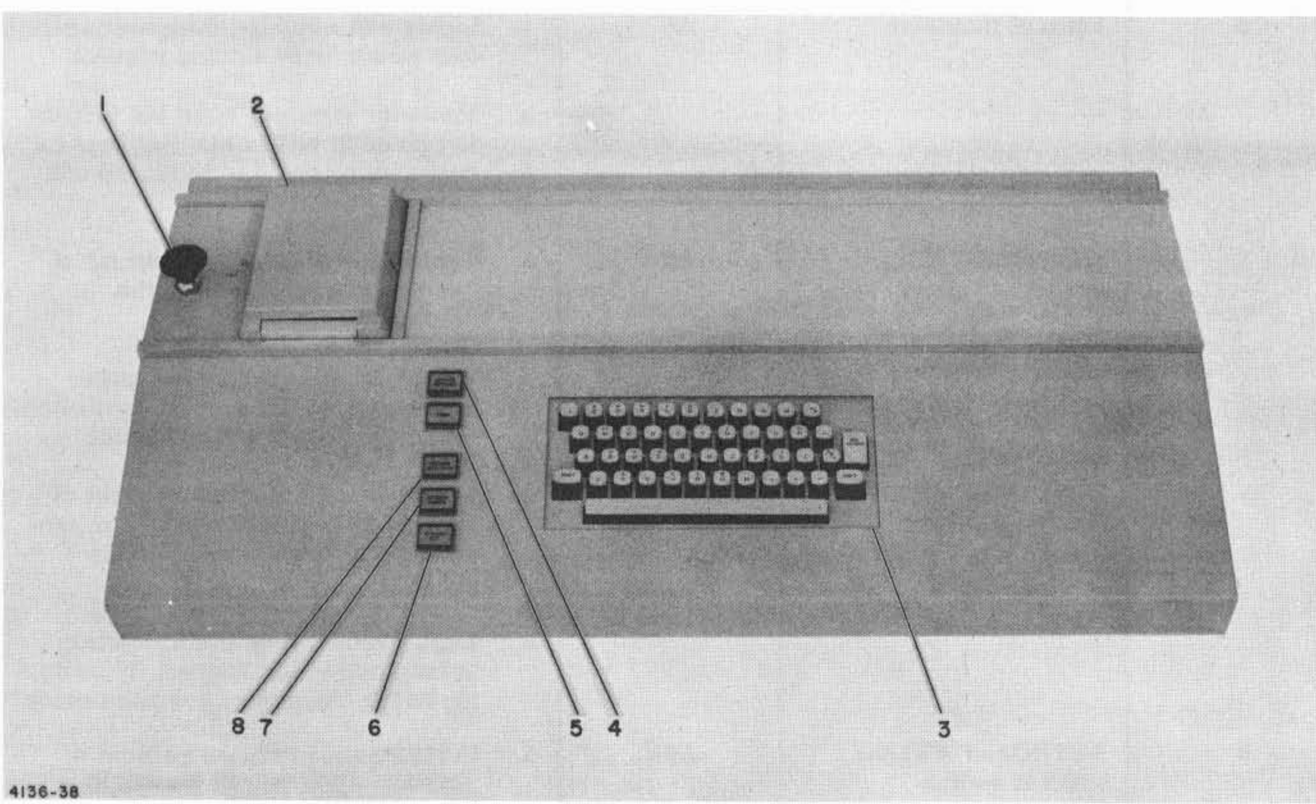

Figure 3-3. Manual Input Panel, Controls and Indicators

Table 3-4. Manual Input Panel, Controls and Indicators

FIGURE 3-3 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	Push to release card, plunger		Releases card from card reader
2	Card Reader	A1	Reads card and provides 6 bit coded signal to the computer which identifies security level and degree of access of operator
3	Alphanumeric and Symbol Keyboard	A2	a. Provides 6-bit codes for selection of symbols from typotron matrix. (See table 1-6) b. Press insert key (INS) to indicate to the computer that the data just typed on keyboard is valid c. Press delete key (DEL) to indicate to the computer that the data just typed is not valid
4	KEYBOARD INOPERABLE indicator	A4	Lights yellow when the logic cannot accept data from the keyboard
5	ERROR indicator	A5	a. Lights red when the computer identifies an error or invalid request b. Indicator goes out when the display is placed in either the "keyboard compose mode" or "keyboard edit mode"
6	KEYBOARD EDIT switch-indicator	A8	a. Controls and indicates request of "keyboard edit mode" to the computer, lights yellow b. Lights green when the computer acknowledges the request by switching to the "keyboard edit mode"
7	KEYBOARD COMPOSE switch-indicator	A7	a. Controls and indicates request of "keyboard compose mode" for producing computer inputs, lights yellow b. Lights green when the computer acknowledges the request by switching to the "keyboard compose mode"
8	KEYBOARD SELF-CHECK switch-indicator	A6	a. Controls and indicates request of "keyboard self-check mode" to the computer, lights yellow b. Lights green when the computer acknowledges the request by switching to the "keyboard self-check mode"

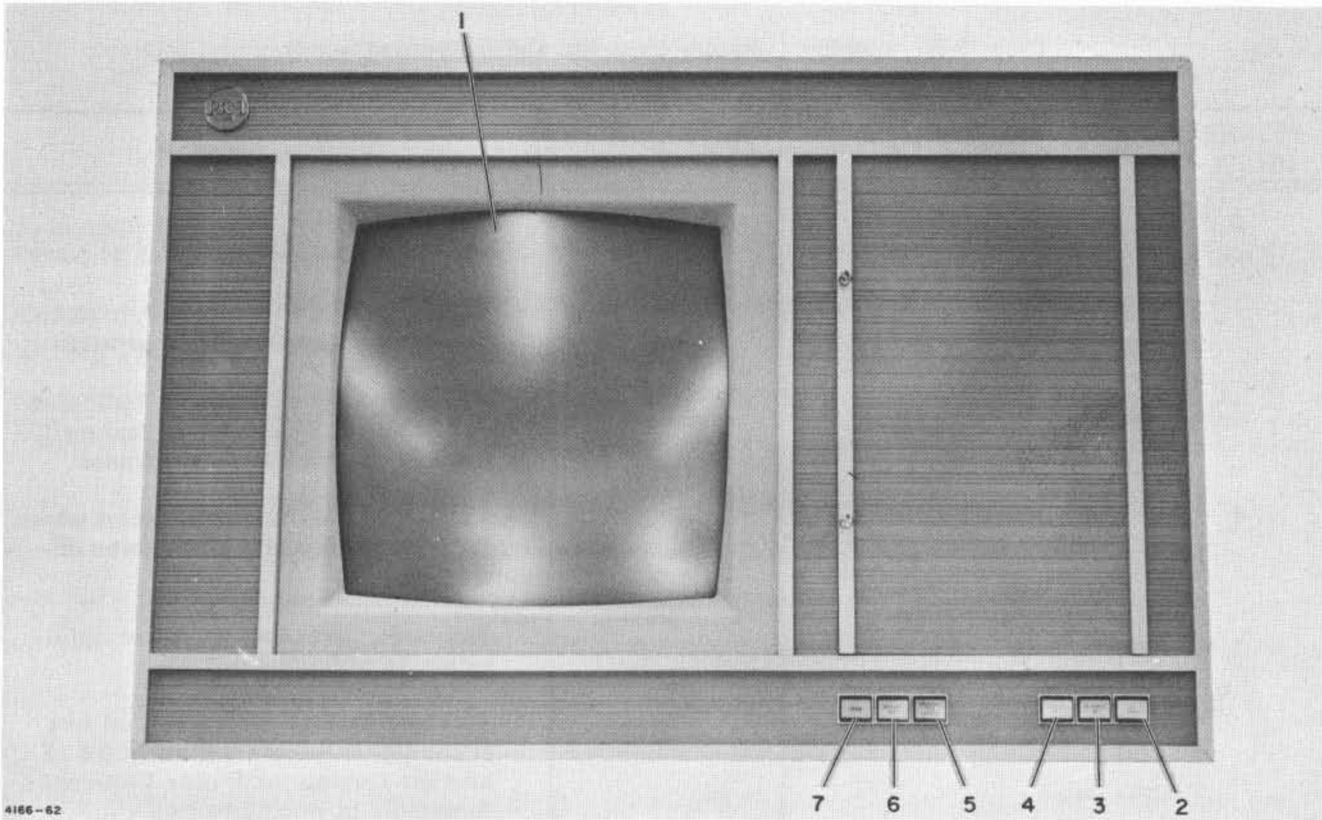

Figure 3-4. Display Console Panel, Controls and Indicators

Table 3-5. Display Console, Controls and Indicators

FIGURE 3-4 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	Typotron Display Tube	A322301	Displays stored data in either text or graphic form on direct view screen
2	CRT POWER switch-indicator	A320003	Controls application of display tube power and indicates the status: Yellow-when in off position and power sequence is complete White-when in on position, AC applied to high voltage supplies and filament time delay in process Green-when all power is applied to display tube
3	DC POWER ON switch-indicator	A320001	Controls the application of dc power, and indicates the dc power application status: Red-Filament delay, indicates tube filaments are heating and dc power cannot be applied

Table 3-5. Display Console, Controls and Indicators (cont)

FIGURE 3-4 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
3 (cont)			Yellow-Standby, indicates equipment readiness for application of dc power White-Sequence incomplete, indicates dc power sequencing is in process Green-Sequence complete, indicates dc power has been applied and equipment is in operational readiness
4	DC POWER OFF switch-indicator	A320002	Controls dc power turn off (except when inhibited) and indicates pre-power on conditions: Red-Safe, indicates dc power application is prevented Yellow-Caution, indicates that one of the DC POWER OFF switches of another console or Power Sequencer Assembly is in off position Dark-indicates dc power may be applied if DC POWER ON indicator is lighted yellow
5	EMERGENCY TEST STOPPED indicator	A320005	Indicates that test was stopped by the computer because an unsafe condition exists, lights red
6	DISPLAYS BUSY indicator	A320004	Indicates operational status of consoles Green-indicates console is being addressed and is in some mode Yellow-indicates console is not being addressed but one of the other consoles is being addressed and in some mode
7	ERASE switch	A320006	Controls the message erase function of display tube, does not light

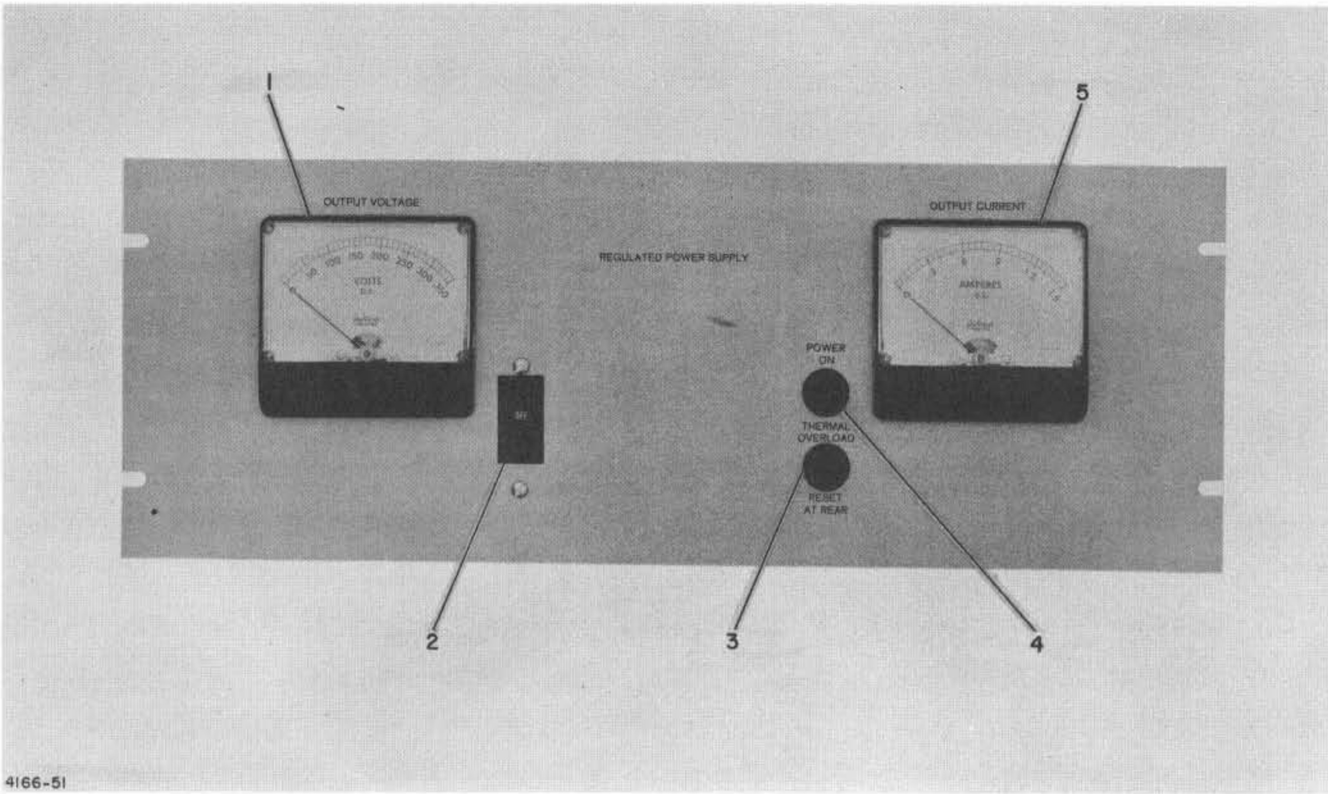

Figure 3-5. Power Supply Panels (-300 v and +300 v), Controls and Indicators

Table 3-6. Power Supply Panels (-300 v and +300 v), Controls and Indicators

FIGURE 3-5 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	OUTPUT VOLTAGE meter	M1	Indicates operating output voltage
2	ON-OFF circuit breaker	CB1	Controls the application of ac power. Circuit breaker trips to OFF position if supply is overloaded
3	THERMAL OVERLOAD indicator	I2	Indicates when temperature of the power supply exceeds a maximum safe value, lights red. Power supply shuts off and the POWER ON indicator goes out when thermally overloaded
4	POWER ON indicator	I1	Indicates that ac power has been applied, lights green. Power supply is not thermally overloaded, and fuse F1 is not open
5	OUTPUT CURRENT meter	M2	Indicates operating load output current

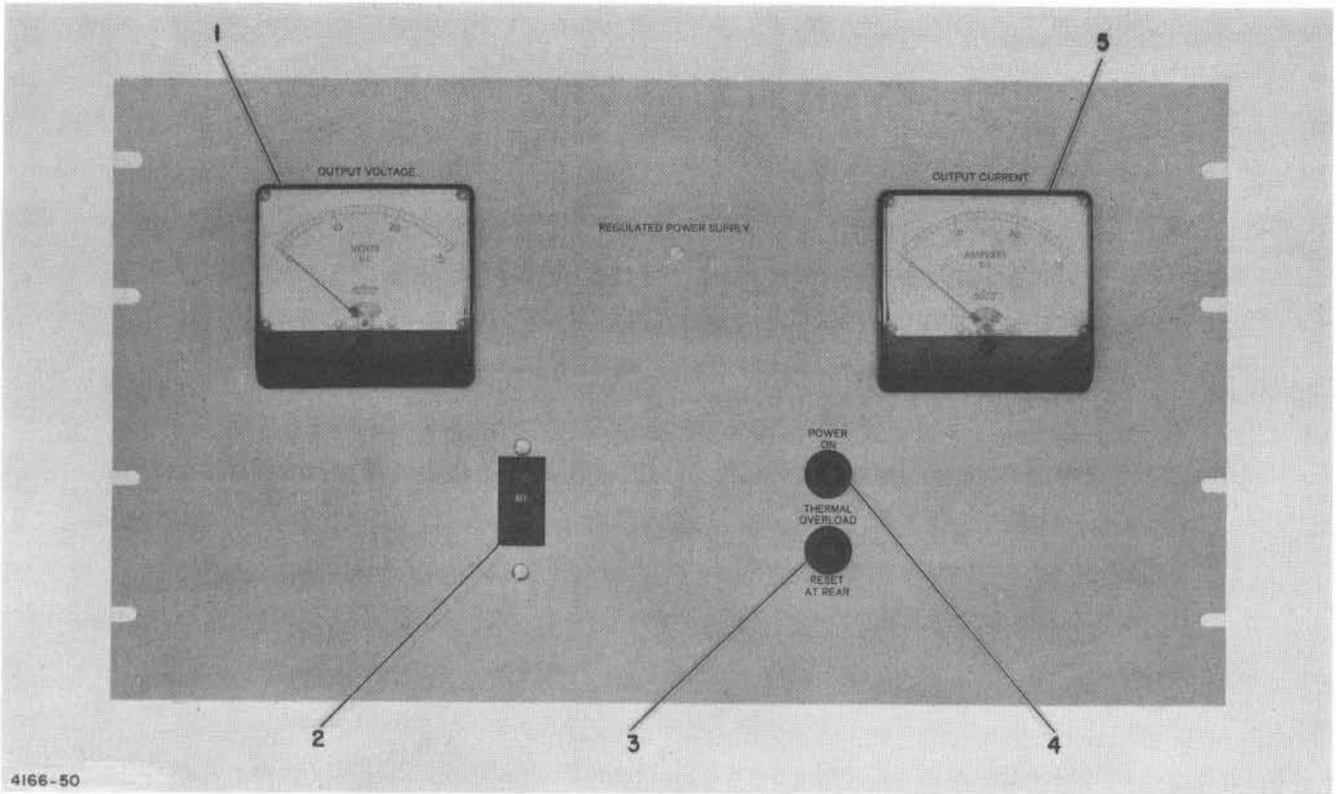

Figure 3-6. Power Supply Panels (-6.5 v, -26 v, and +26 v), Controls and Indicators

Table 3-7. Power Supply Panels (-6.5 v, -26 v, and +26 v), Controls and Indicators

FIGURE 3-6 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	OUTPUT VOLTAGE meter	M1	Indicates operating output voltage
2	ON-OFF circuit breaker	CB1	Controls the application of ac power. Circuit breaker trips to OFF position if supply is overloaded
3	THERMAL OVERLOAD indicator	I2	Indicates when temperature of the power supply exceeds a maximum safe value, lights red. Power supply shuts off and the POWER ON indicator goes out when thermally overloaded
4	POWER ON indicator	I1	Indicates that ac power has been applied, lights green. Power supply is not thermally overloaded and fuse F5 is not open
5	OUTPUT CURRENT meter	M2	Indicates operating load output current

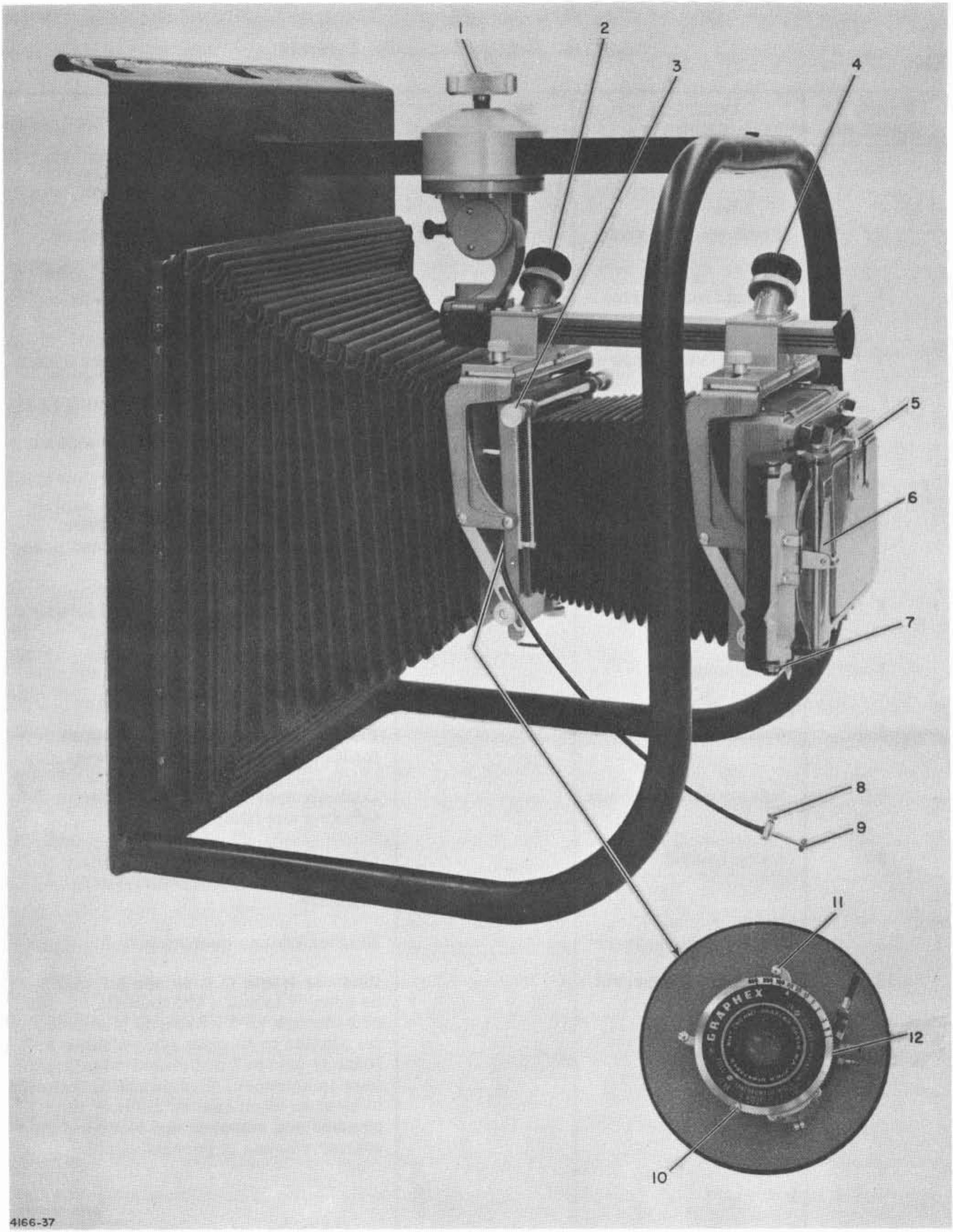

Figure 3-7. Camera Assembly Controls

Table 3-8. Camera Assembly, Controls

FIGURE 3-7 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	Adapter screw		Controls and locks camera to correct operating position
2	Front focusing knob		Controls coarse focusing of subject matter
3	Rising front control knob		Controls correction to obtain best perspective view
4	Rear focusing knob		Controls fine focusing of subject matter
6	Film process lever		Controls application of processing fluid: Load-film may be removed without processing effected Process-processing fluid is applied as film is removed from holder causing development of picture positive and negative
5	View hood release		Releases viewing hood to avail focusing glass
7	Film holder		Provides for insertion of film and control of developing process
8	Shutter cable lock		Provides locking of shutter in open position for focusing of camera
9	Shutter release control		Controls operation of shutter for focusing and film exposure
10	f stop control		Controls light aperture to regulate amount of light penetration during exposure
11	Shutter cocking lever		Enables shutter operation
12	Shutter speed control		Controls length of time shutter will be open, 1 through 400 indicate speeds of 1 through 1/400 second, B allows for shutter to be open when shutter release is pressed and closed when pressure is released, T allows for shutter to be open when shutter release is pressed and released and closed when shutter release is pressed again

SECTION II

OPERATING INSTRUCTIONS

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SECTION II

OPERATING INSTRUCTIONS

1. STARTING PROCEDURE

The equipment is turned-on by first energizing the display cabinet, which contains the power supplies, common logic elements, power sequencers, and simulator; and then energizing the display console, which contains the display tube, deflection circuits, high voltage power supplies, and manual input controls. If the display cabinet is not turned-on when operation is desired it is necessary to complete the procedures outlined in paragraphs 1. 1 and 1. 2. If the display cabinet power has already been applied then it is only necessary to complete the procedure outlined in paragraph 1. 2.

1.1 Display Cabinet

The display cabinet may be turned on without energizing the complete system. This will keep the system in readiness so that energizing any console will activate the system. The display cabinet is energized in the following manner:

a. Set MAIN POWER circuit breaker (12, figure 3-1) to ON.

b. Set circuit breakers (4 through 9, figure 3-1) of Power Sequencer Assembly and circuit breakers (1 through 6, figure 3-2) of Auxiliary Sequencer Assembly to ON.

c. Wait approximately 30 seconds until the DC POWER ON indicator (1, figure 3-1) of Power Sequencer Assembly, and DC POWER ON indicators (3, figure 3-4) of all display consoles light yellow.

NOTE

If the DC POWER OFF indicator lights yellow it indicates that a DC POWER OFF switch (4, figure 3-4) of one of the display consoles is in the "safe" condition, lighted red. Locate this display console (indicated by CONSOLE DC POWER OFF SWITCH BLOWER STATUS indicators; 15 figure 3-1), depress the DC POWER OFF switch, and assure that it goes out. All DC POWER OFF indicators must be dark before secondary power can be applied.

d. Press DC POWER ON switch (1, figure 3-1) and observe that it lights green.

1.2 Display Console

After the display cabinets are energized, operation from any display console is possible by energizing the console in the following manner:

a. Observe that DC POWER ON indicator (3, figure 3-4) is lighted green and CRT POWER indicator (2) is lighted yellow.

b. Turn on display tube power by depressing CRT POWER switch (2) wait approximately three minutes for indicator to light green.

2. DISPLAY CONSOLE OPERATION

The display console may be employed to compose and edit computer test instructions, compose and edit computer programs, display test results, and perform off-line self-check operations. The message or display format can be text, tabular, or graphic. All computer instructions and requests are entered from the manual input panel switch-indicators and keyboard (figures 3-3 and 3-4). The computer will not accept an instruction or request until it has determined the operators clearance and validated the instruction or request. Verification of the operator's access is accomplished by the computer program. A typical sequence of operation in the various modes is described in the subsequent paragraphs.

2.1 Keyboard Compose

The keyboard compose mode of operation permits the operator to compose text instructions.

(See figure 3-8.) A typical sequence of operation is as follows:

a. Insert identification card into card reader (2, figure 3-3).

b. Press KEYBOARD COMPOSE switch (7), indicator lights yellow.

c. When the computer recognizes the console request the KEYBOARD COMPOSE indicator (7) and DISPLAYS BUSY indicator (6, figure 3-4) light green. The computer connects the display equipment to the IODC, resets the logic, and erases the display tube. The keyboard (3, figure 3-3) is enabled and message can be composed.

d. Depress keys of keyboard in the same manner as a typewriter; lower and individual letters, numbers, and symbols are obtained by direct action; and upper symbols are obtained by pressing either of the SHIFT keys and then the desired symbol key. The space bar provides a blank space between groups of characters, and END OF LINE (EOL) positions the next character inserted at the left side of screen to begin the next line.

e. When desired message has been completed, press INS (insert) key.

f. If cancellation of the message is desired, press the DEL (delete) key. This will delete all typed copy subsequent to last operation of the insert key.

g. When the message is inserted the computer compares the message and operator's identification. If message and identification agree, the computer accepts the instruction; if they do not agree the ERROR indicator (5, figure 3-3) lights red.

h. The program selected may now direct the computer to erase the display tube of the addressed console and transmit the requested data.

2.2 Keyboard Edit

The console operator may edit a composed message or a requested message to correct or update instructions. (See figure 3-9.) A typical sequence of operation is as follows:

a. Insert identification card into card reader (2, figure 3-3).

b. Press KEYBOARD EDIT switch (6), indicator lights yellow.

c. Computer recognizes console request, resets the logic, erases tube display, and transmits the requested data to the IODC for display. The KEYBOARD EDIT indicator (6) and DISPLAYS BUSY indicator (6, figure 3-4) light green, and the keyboard is enabled.

d. Operate the space bar and END OF LINE Key, to position the underscore below the character(s) or space to be changed. (See figure 3-9.)

e. When the underscore is properly positioned press the appropriate character or DEL (delete) key to complete the correction.

f. When the edited message is complete, press the INS (insert) key to insert the instruction into the computer for action.

2.3 Keyboard Self-Check

The Keyboard self-check mode prevents keyboard data from entering the computer, thus allowing diagnostic checks of keyboard and logic functions without interrupting the computer operation. (See figure 3-10). A typical sequence of self-check operation is as follows:

a. Insert identification card into card reader (2, figure 3-3).

b. Press KEYBOARD SELF-CHECK switch (8), indicator lights yellow.

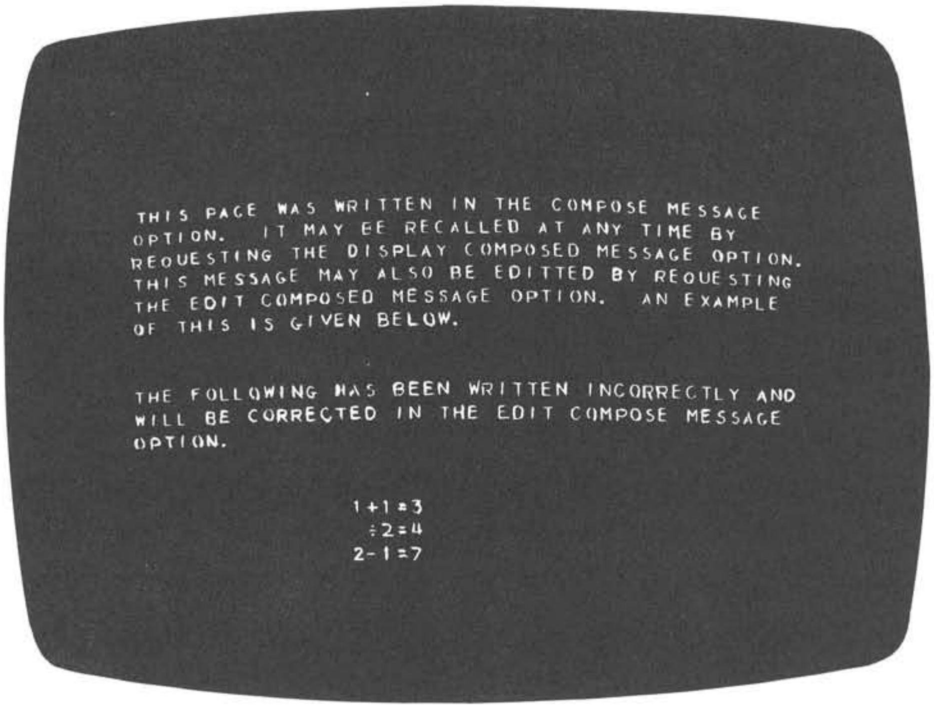
c. When the computer recognizes the console request the KEYBOARD SELF-CHECK indicator (8) lights green. The computer enables the keyboard (3) and inhibits the transfer of keyboard signals.

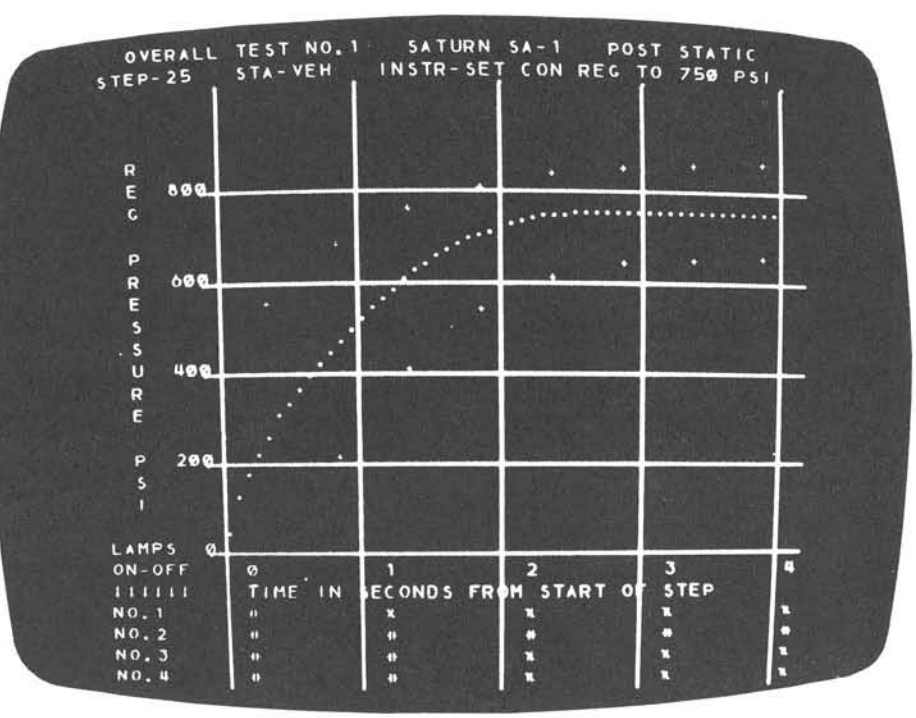
d. Activate keys as desired and observe display for concurrence.

e. Before console may be turned off, place console in keyboard compose or keyboard edit mode and strike delete key.

3. CAMERA ASSEMBLY OPERATION

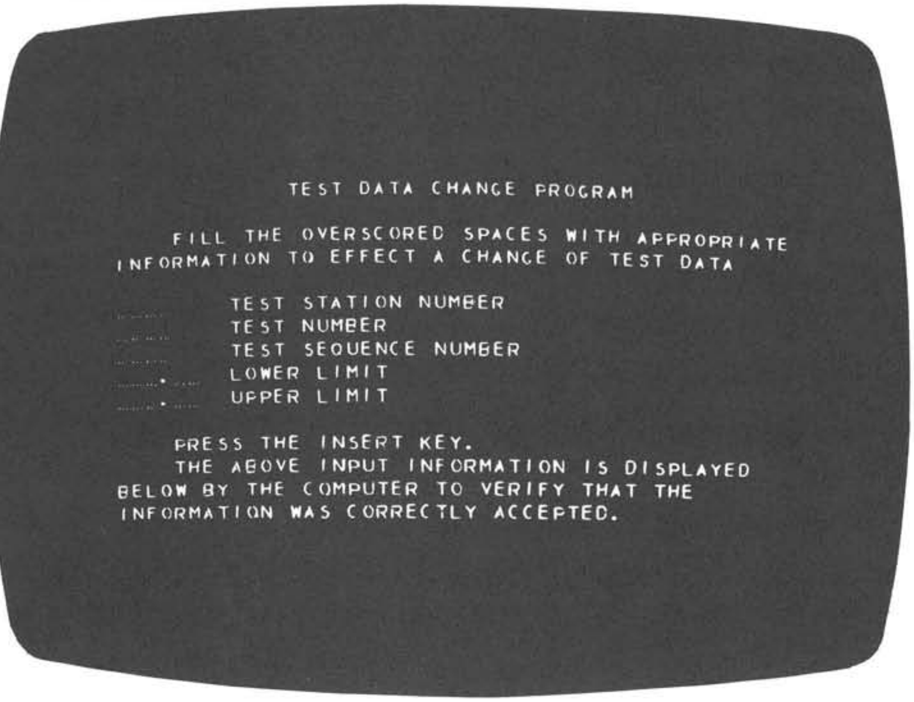
The camera assembly is used to obtain a permanent record of the displayed instruction or test results. The copy device provides for immediate (20 seconds) processing of positive and negative copy or delayed processing if so desired. When the negative copy is properly prepared, it may be stored for future reproduction.

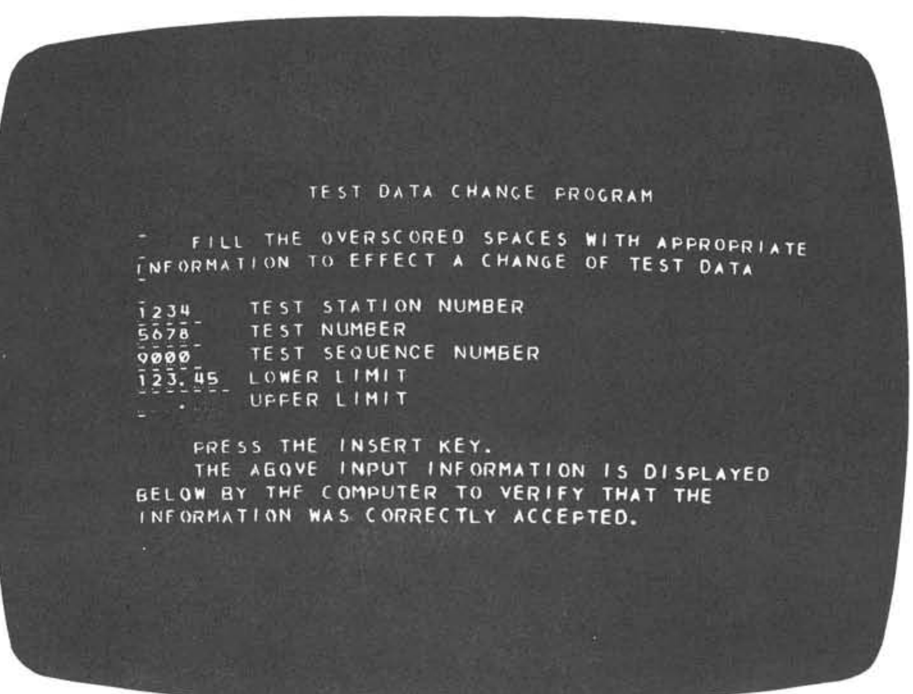




4166-85

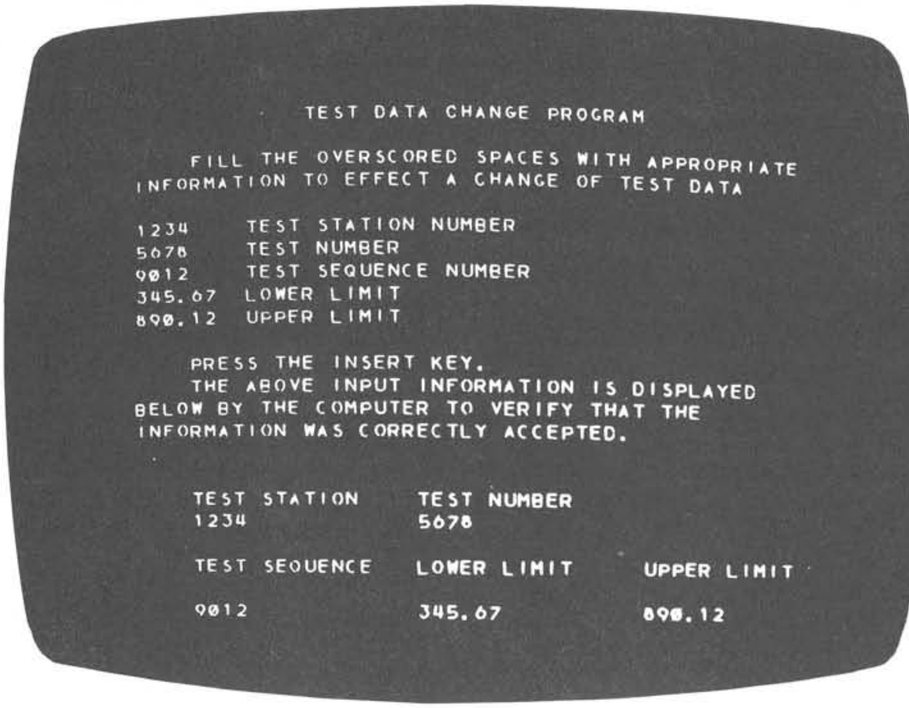
Figure 3-8. Examples of Tabular and Graphic Messages





4166-86

Figure 3-9. Example of Message Being Corrected in Keyboard Edit Mode of Operation



4166-87

Figure 3-10. Example of Keyboard Self-Check Mode of Operation

3.1 Preliminary Preparation

The camera assembly must be focused occasionally to assure high quality definition of subject matter; therefore these preliminary adjustments are not required every time the device is used. A quick check of the definition can be made by performing steps d, e, and h otherwise equipment can be stored without disturbing the locked settings.

a. Compose or request a full page of copy on the display tube.

b. Install the hard copy device (figure 3-7) on the display console.

c. Release adapter screw (1) and slide camera rearward (toward operator) to end of stop and retighten adapter screw.

d. Press view hood release (5) to gain access to focus glass.

e. Set f stop (10) for full open, set shutter speed control to "B" (12), set shutter cocking lever (11), loosen shutter cable lock (8) press plunger of shutter release control (9) to obtain image on focus glass, and retighten shutter cable lock with plunger fully depressed.

f. Loosen rising front control knob (3) and slide up or down to vertically center image and obtain best perspective view of image, retighten knob.

g. Loosen front focusing knob (2) and rear focusing knob (4) so that slide friction exists and move both alternately in small amounts to obtain best definition of image, retighten knobs.

h. Close view hood and loosen shutter cable lock (8) to close shutter.

3.2 Operation

After preparing the camera assembly in accordance with paragraph 3.1 a copy of the display tube image can be obtained in the following manner:

a. Insert film holder (7) behind view hood frame, insure that process lever is in load position.

b. Insert film packet (Polaroid Type 55 P/N until fully engaged, and pull back protective envelope.

c. Press shutter release control (9) and hold for five seconds, then release. (The depth of field of the camera may be increased by decreasing the f stop and increasing the exposure time.)

d. Slide protective envelope back into engaged position.

e. If processing is desired place film process lever (6) to process position and remove film packet from film holder (7). (If processing is not desired until later, remove film packet and mark to indicate it has been exposed.)

f. Wait 20 seconds for developing process completion and separate positive from negative.

g. Swab positive with felt pad fixing solution. Remove excess developer from negative by washing with an 18 percent solution of sodium sulfite and water until gelatine substance is removed, then wash approximately five minutes under cold running water (below 70 degrees F).

NOTE

If a developing box and film hangers are available a number of negatives can be suspended in the sodium sulfite solution before running water washing is necessary.

4. TURN-OFF PROCEDURE

Complete turn-off is accomplished by first removing power from the operated display console and then removing power from the display cabinet. If the display consoles are to remain in readiness condition the individual operating console may be turned off and left in standby by completing only the procedures outlined in paragraph 4.1a. If the complete display system is to be turned off then the procedures of both paragraphs 4.1 and 4.2 are necessary.

4.1 Display Console

The display tube high voltage and filament voltage must be removed first. This will leave the display console in a standby status; if a malfunction exists the operating power may also be removed by completing the following procedure:

a. Press CRT POWER switch (2, figure 3-4), indicator lights yellow to indicate display power has been removed.

b. Press DC POWER OFF switch (4), if INHIBITED switch (16, figure 3-1) has not been activated the operating power supplies will sequence off and the DC POWER OFF indicator will light red. If INHIBITED switch has been activated, the DC POWER OFF switch will be inactive.

4.2 Display Cabinet

Primary power can only be removed at the display cabinet. Activating the DC POWER OFF switch only removes operating power. The 28 volt relay power and 115 volt blower power is still present until removed by circuit breakers at the display cabinet. Complete equipment turn-off is accomplished as follows:

a. Press DC POWER OFF switch (4, figure 3-4), indicator lights red.

b. Set MAIN POWER circuit breaker (12, figure 3-1) to OFF.

SECTION III

EMERGENCY PROCEDURE INSTRUCTIONS

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SECTION III

EMERGENCY PROCEDURE INSTRUCTIONS

1. GENERAL

This section contains the procedure to discharge the typotron tube during a "runaway charging" condition.

2. RUNAWAY CHARGING

Runaway charging occurs when the storage surface of the typotron tube becomes more positive than the flood gun cathode potential. Runaway charging is characterized by "dancing dots" or "sparkling" on the face of the typotron tube.

CAUTION

Runaway charging can destroy the typotron tube storage surface. Perform discharging procedures immediately upon detection of a runaway charging condition.

3. RUNAWAY DISCHARGING

Perform the following steps to discharge the tube during a runaway charging condition.

a. Press CRT POWER switch indicator (2, figure 3-4); observe that the indicator lights yellow.

b. Open runaway discharge door (2, figure 3-11) located on Power Control Assembly.

c. Press and hold RUNAWAY DISCHARGE SWITCH (1).

d. Release RUNAWAY DISCHARGE SWITCH (1) after 5 minutes.

e. Close runaway discharge door (2).

f. Press CRT POWER switch indicator (2, figure 3-4); observe that the indicator initially lights white and after approximately 3 minutes lights green.

g. If the runaway condition has not cleared (evident immediately after the view screen voltage has turned on), repeat steps a through f holding the RUNAWAY DISCHARGE SWITCH (1, figure 3-11) pressed for 10 minutes.

h. Steps a through f may be repeated until the tube is cleared of the runaway condition. Each time steps a through f are repeated, press and hold RUNAWAY DISCHARGE SWITCH S1 (1) for an additional 5 minutes up to a maximum of 15 minutes.

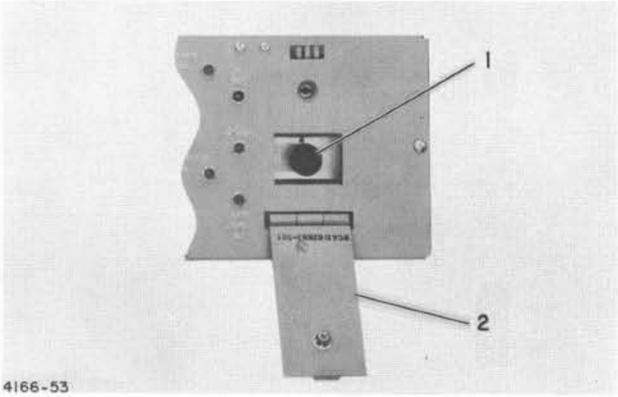

Figure 3-11. Runaway Discharge Controls

CHAPTER 4
THEORY OF OPERATION

INTRODUCTION

This chapter contains information to aid in understanding the operation of the Saturn Ground Computer System Display. The chapter is divided into 2 sections. Section I provides the detailed description including logic description, of the functional sections of the display system and operational flow charts for the various modes of operation. Section II provides a circuit analysis of the major electronic assemblies.

CONTENTS

Section I. Principles of Operation
Section II. Circuit Analysis of Electronic Assemblies

SECTION I

PRINCIPLES OF OPERATION

1. GENERAL

The display system is used with the Saturn Ground Computer System to provide an operator with the capability of testing various systems and subsystems of the Saturn Space Vehicle. (See figure 6-1.) Test results are visually displayed on the face of a direct view storage tube. This purpose is accomplished by twelve major functions and three power functions of the display system. The major functional divisions are the address function, mode selection and control function, timing function, card reader function, data transfer function, transfer control function, graph submode selection function, underscore generation function, character positioning function, character selection function, clear/erase and unblank function, and the tube and bias control function. The power functional divisions are the ac power distribution function, power sequencing function and dc power distribution function. A list of the display system functions and their purpose appear in table 4-1. The mnemonics used throughout this chapter and on functional diagrams are listed in Chapter 6, Volume II.

Table 4-1. Display System Functions

FUNCTION	PURPOSE
Address	a. Decodes the three-bit address code from the computer system to determine which of the six possible display consoles has been selected to send or receive data b. Receives cabinet address sense and operate signals from the computer system indicating which display system is operating with the computer system
Mode Selection and Control	a. Transfers keyboard mode requests to the computer system b. Generates and transmits priority interrupt signals to the computer system c. Decodes mode bits from the computer system indicating the display system operating mode
Timing	Generates clock phase counts to regulate display system operation
Card Reader	Transmits six-bit code to the computer system indicating the display console operator's identity, access level, security level, etc.
Data Transfer	Provides a 24-bit register to accept display data from the computer system or keyboard data and transfer the contents of the 24-bit register to other display system functions for display on the tube face or to CMP
Transfer Control	Regulates data transfer within the display system and between the display system and computer system
Graph Submode Selection	Decodes graph submodes to provide logic control during graph submode operations

Table 4-1. Display System Functions (cont)

FUNCTION	PURPOSE
Underscore Generation	Generates an underscore mark when the SPACE or END OF LINE keys are pressed on the keyboard during keyboard self-check and compose modes of operation. All keys except insert generate an underscore in the keyboard edit mode
Character Positioning	a. Provides counters to generate digital position signals b. Converts digital position signals to analog signals c. Provides magnetic deflection circuits to position the write beam of the display tube
Character Selection	a. Decodes the character selected for display b. Converts digital code of the character to an analog signal c. Provides electrostatic deflection circuits to drive selection and compensation plates in the display tube
Clear/Erase and Unblank	a. Provides circuits to erase the display tube b. Provides circuits to "dunk" the high voltage applied to the display tube view screen c. Provides unblank circuits to enable the display tube write gun when a character is ready for display
Tube and Bias Control	a. Provides a direct view storage tube used to visually display data b. Provides circuits to control the bias voltages applied to the display tube
Power	The three power functions provide power sequencing and supply operating voltages to the display system

2. FUNCTIONAL SECTIONS

2.1 Address Function

(See figure 6-2.)

The address function provides the circuits that store and decode the three-bit address code from the computer system, designating which of the six possible display consoles has been selected to receive or transmit data. The address function also receives a CABINET ADDRESS SENSE or CABINET ADDRESS OPERATE signal from the computer system allowing the computer system to work with two display systems.

Address bits 2^0 - 2^2 (figure 4-1) are generated in the computer system by an instruction command word. The three-bit address is strobed into the address register by a CC STROBE signal from the computer. MAIN CLEAR A resets the address register each time display system power is sequenced on. The contents of the address register is decoded to obtain the six CONSOLE ADDRESS signals. A CONSOLE ADDRESS signal enables control and display data input gating in the display console.

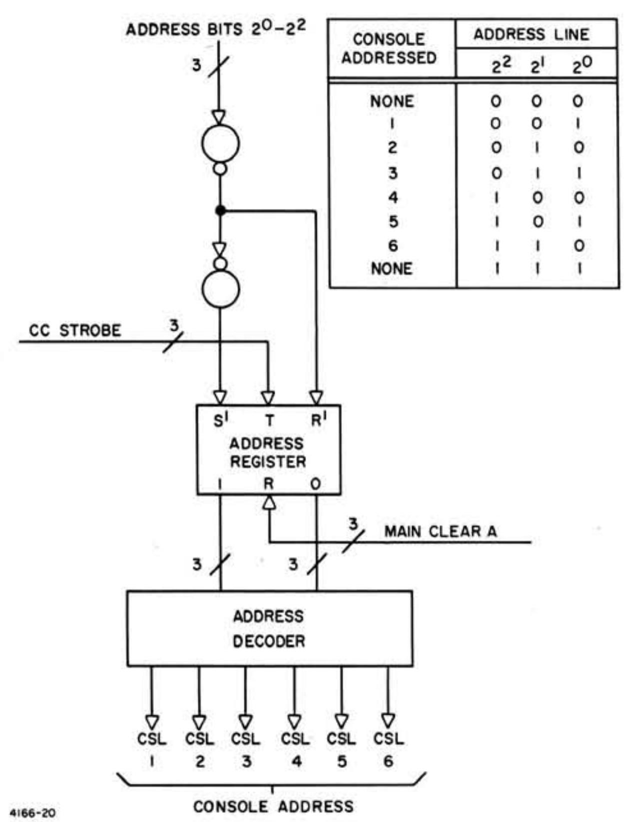

Figure 4-1. Console Address Function Simplified Logic Diagram

The CAB ADDRESS SENSE and CAB ADDRESS OPERATE signals allow the computer system to operate with two display systems (up to 12 consoles). Tables 4-2 and 4-3 list the interface signals gated by CAB ADDRESS SENSE and CAB ADDRESS OPERATE signals.

Table 4-2. Cabinet Address - Sense Gating

SIGNAL	NO. OF LINES
Display System to Computer System	
Card Data Bits	6
Request Keyboard Compose	1
Request Keyboard Edit	1
Request Keyboard Self-Check	1
Computer System to Display System	
Address Bits	3
CC Strobe	1
Clear Display	1
Error	1
Keyboard Self-Check Mode	1
Emergency Test Stopped-Set	1
Emergency Test Stopped-Reset	1

Table 4-3. Cabinet Address-Operate Gating

SIGNAL	NO. OF LINES
Display System to Computer System	
Insert	1
Delete	1
Enable Shift	1
Ready for Next Word	1
Keyboard Data	1

Table 4-3. Cabinet Address-Operate Gating (cont)

SIGNAL	NO. OF LINES
Computer System to Display System	
Mode Bits	3
Graph Symbol Bits	2
Display Serial Data	1
Data Strobe	1
Data Shift	1
Word Accepted	1
Mode Trigger	1
Mode Reset	1
Address	3
Counter Reset	1

2.2 Mode Selection and Control Function

(See figure 6-7.)

The mode selection and control function provides the circuits to request keyboard modes of operation and decode display modes of operation from the computer system. The display system operator requests a keyboard output mode (KCM or KEM) when the display system is to be used to supply input data to the computer. The keyboard self-check mode (KSCM) is used for diagnostic check of display system logic. A priority interrupt is sent to the computer each time a keyboard mode request is made. The computer acknowledges the keyboard mode request by sending the three-bit code of the selected keyboard mode, to the display system. Once in a keyboard output mode, the display console operator can request data from the computer system using the keyboard to generate the request message. After the computer system receives the request, it generates the three-bit code of the mode selected for output of data to the display system.

2.2.1 KEYBOARD MODE REQUEST

When a keyboard mode request (figure 4-2) is made by pressing the KEYBOARD SELF-CHECK, KEYBOARD COMPOSE, or KEYBOARD EDIT pushbutton switch-indicator on the manual input panel, the request control flip-flop of the mode requested is set. A NO CARD IN READER or DVST NOT READY signal resets the request control flip-flop to prevent a mode request by an unauthorized source or when console is not operable. A request control flip-flop of the mode requested is also reset when the computer system acknowledges a request by sending the three-bit code of the selected keyboard mode. The mode request pushbutton switch-indicator lights yellow when pressed indicating a request has been made.

The output of the request control flip-flop is gated from the display console by a $\overline{\text{CONSOLE ADDRESS}}$ signal to a terminating - OR gate in the common logic cabinet. A keyboard request from one of six possible display consoles is gated to the computer system by a $\overline{\text{CAB ADDRESS SENSE}}$ signal. The $\overline{\text{CAB ADDRESS SENSE}}$ signal is generated by the computer system as a result of a priority interrupt by the display system. A keyboard self-check mode request is enabled only when a keyboard output mode (keyboard compose or keyboard edit) request has not been made.

A $\overline{\text{MODE REQUEST ADDRESS}}$ ($\overline{\text{MRA}}$) signal is sent to the computer system to identify which of six possible consoles has made a keyboard mode request.

2.2.2 PRIORITY INTERRUPT

A PRIORITY INTERRUPT signal is sent to the computer system to activate the display system priority level. A PRIORITY INTERRUPT signal is generated when a keyboard compose or keyboard edit (ARKO) request is made and the display system is not in a mode (NM) or in the keyboard self-check mode (KSCM). Any keyboard self-check mode request (ARKSC) generates a PRIORITY INTERRUPT signal only if the display system is not in any mode. The PRIORITY INTERRUPT signal is supplied through contacts B1 and B2 of power sequence complete relay K10 to the computer system to disable priority interrupts when power is not on.

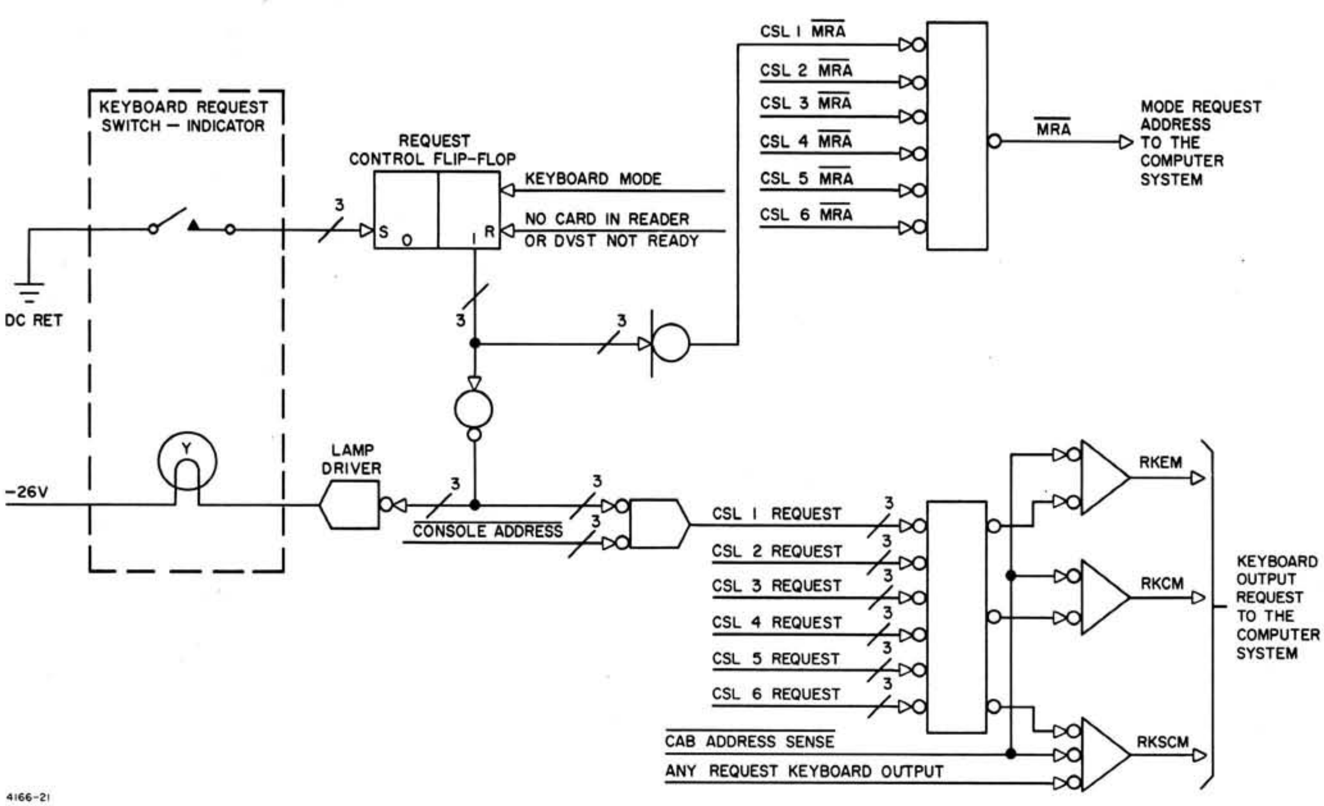

Figure 4-2. Keyboard Mode Request, Simplified Logic Diagram

2.2.3 MODE DECODING

Mode bits 2^0 - 2^2 (figure 4-3) are generated in the computer system by an instruction command word and sent to the display system. The three-bit code of the selected mode of operation, except keyboard self-check mode, is shifted into the mode register by a MODE TRIGGER PULSE (MTP) from the computer system. Since the keyboard self-check mode is not a data transfer operation, the computer system generates a KEYBOARD SELF-CHECK MODE command control signal to set the keyboard self-check mode directly into the mode register rather than initiate a three-bit code. The mode register is reset by MAIN CLEAR A each time display system power is sequenced on, or by a MODE RESET signal from the computer system. In tabular or graphic modes MODE RESET occurs after the last word is sent to the display system from the computer system and a ready for next word signal is generated. In keyboard modes, MODE RESET occurs after an INSERT or DELETE signal and the word accepted signal has been generated by the computer system.

The output of the mode decoder provides common logic control. A decoded keyboard edit mode (KEM) or keyboard compose mode (KCM) signal generates a keyboard output mode (KOM) signal. A decoded tabular edit mode (TEM) or tabular mode (TM) signal generates an any tabular mode (ATM) signal. A no mode (NM) signal is generated when a graphic mode (GM), any keyboard mode (AKM), or any tabular mode (ATM) signal has not been decoded.

A decoded keyboard mode (KSCM, KCM or KEM) signal and a CONSOLE ADDRESS signal resets the request control flip-flop of the mode selected (figure 4-4). The selected keyboard mode signal also lights the pushbutton switch-indicator green indicating the computer system has acknowledged the keyboard request.

2.3 Timing Function

(See figure 6-11.)

The timing function provides timing control to enable synchronous operation of the display system. The timing section consists of clock logic and a phase counter.

2.3.1 CLOCK LOGIC

An adjustable astable multivibrator is used as the clock pulse generator. The clock pulse generator starts when a dc return (SEQ COMP) signal is

MODE	MODE LINE 2^2	2^1	2^0
NO MODE	0	0	0
TABULAR (TM)	0	0	1
GRAPHIC (GM)	0	1	0
TABULAR EDIT (TEM)	1	0	0
KEYBOARD SELF-CHECK (KSCM)	0	1	1
KEYBOARD COMPOSE (KCM)	1	0	1
KEYBOARD EDIT (KEM)	1	1	0
NOT USED	1	1	1

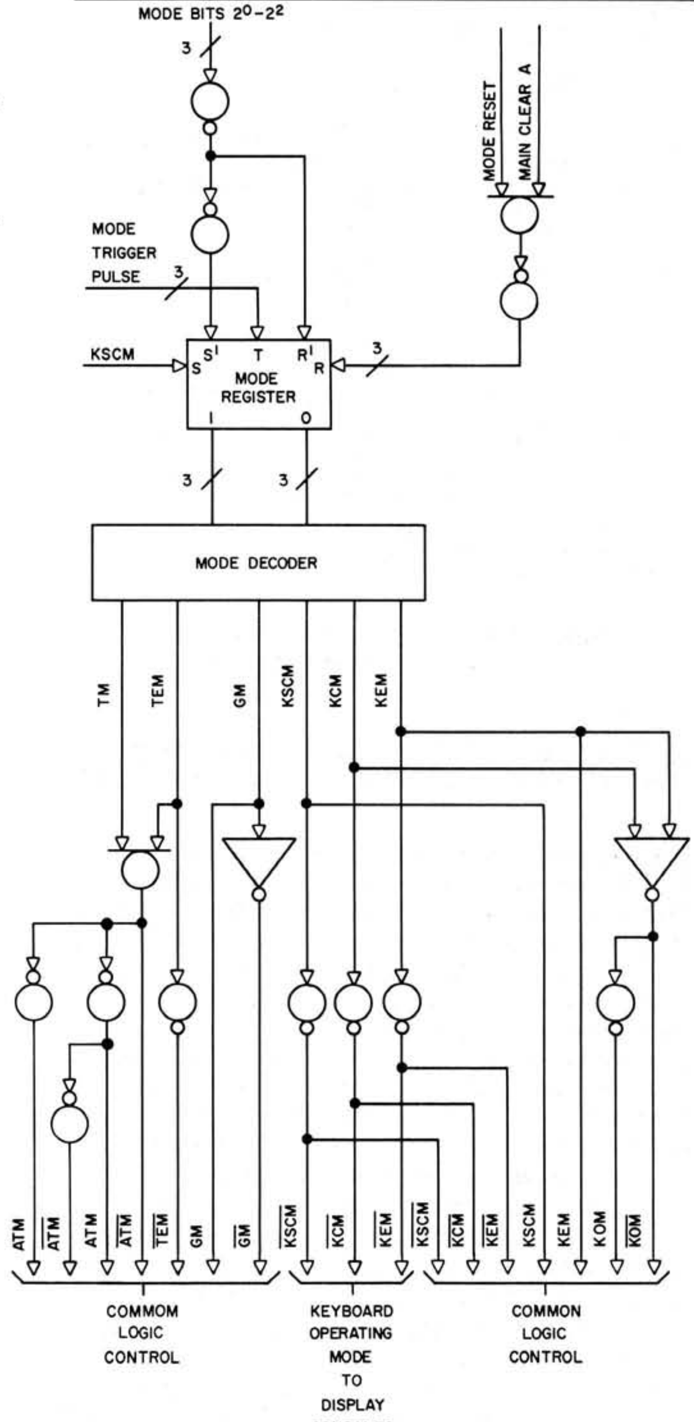

Figure 4-3. Mode Decoding, Simplified Logic Diagram

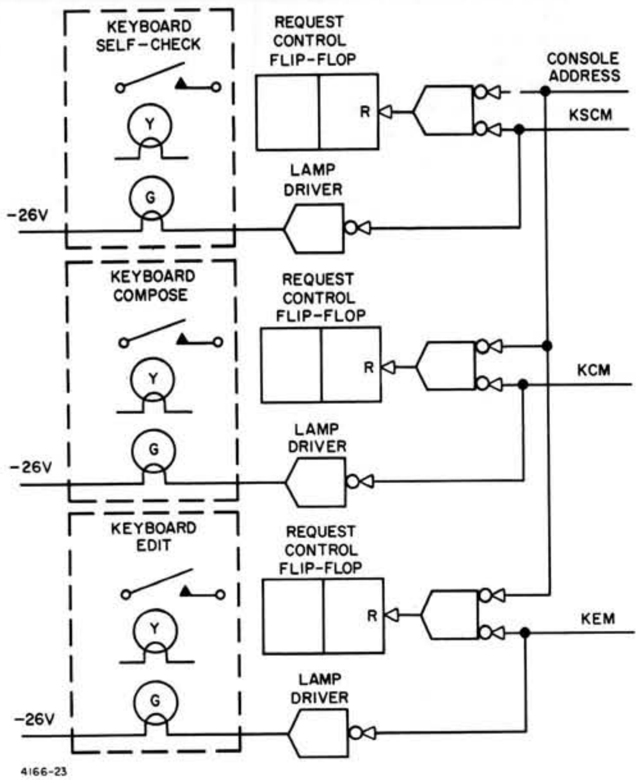

Figure 4-4. Keyboard Request Control, Simplified Logic Diagram

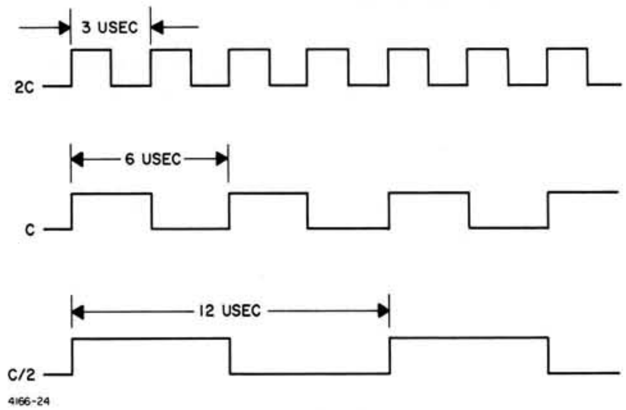

Figure 4-5. Display Pulse Rates

applied to the clock input through power sequence complete relay contacts A1 and A2 of relay K10.

Display pulse rates (figure 4-5) of approximately 6-8 μsec (C) and 12-16 μsec (C/2) are generated for display equipment operation. The display system requires approximately 100 - 125 μsecs to display a character in the Tabular modes and twice as long in the Graphic plot or jump scan and Keyboard modes. The phase counter generates 16 "time slots" (ϕ 0 through ϕ 15) for logic function controls. Therefore the clock, which drives the phase counter, must provide timing of approximately 6 - 8 μsecs or 12 - 16 μsecs depending on the mode. A 3 - 4 μsec (2C) output from clock generator T-3 (figure 6-11) is divided by two by triggerable flip-flop T-4 to provide display rates of 6-8 μsec (C) duration. The 6-8 μsec (C) output of T-4 is divided by triggerable flip-flop T-5 to provide display rates of 12-16 μsec (C/2) duration. Display rate C is used during any tabular mode ($\overline{ATM}$) as decoded by gate T-9. Display rate C/2 is used during any keyboard mode ($\overline{AKM}$) as decoded by gate T-7 or during the graph mode ($\overline{GM}$) as decoded by gate T-8. When set by a keyboard strobe (KS) signal, begin WT1 flip-flop T-2 enables display rate C/2 through gate T-7 during any keyboard mode. A word time (WT1, WT2 or WT3) is defined as 16 time slots (ϕ0 through ϕ15). Flip-flop T-2 is reset when the underscore flip-flop U-6 is set, when the character counter has been advanced, or horizontal end of line (HEL) has been decoded. Display rate pulses trigger the phase counter at the rate selected by gates T-7, T-8, or T-9. The phase counter is enabled by gate T-12 when the console is not busy and when the display is not ready for next word in other than keyboard modes.

2.3.2 PHASE COUNTER

The phase counter provides timing pulses used to regulate display operation. The phase counter consists of a circulating shift register with the complement of the last flip-flop inserted into the first flip-flop. A complete phase count cycle (ϕ0 through ϕ15) starts with the phase counter reset to all zeros. Trigger pulses from the clock logic advance the phase counter as shown in table 4-4. Gates T-13, 18, 21, 24, 27, 30, 33, 37, and 41 decode the outputs of the phase counter to provide timing control for the display system logic. Phase count outputs ($\overline{\phi 11\text{-}14}$)A and ($\overline{\phi 11\text{-}14}$)B + ($\overline{\phi 7\text{-}14}$) are ANDed together at E-9 and E-10 (figure 6-5) to provide approximately 50 μsecs of unblanking time during graph modes and keyboard modes. Phase count (ϕ11-14)B is necessary to disable gate E-9 at the end of phase count 14. Phase count output ϕ7-14 provides the same unblanking time during any tabular mode (ATM). After phase

Table 4-4. Phase Counter Operation

OUTPUT	COUNTER CONTENTS								
		T-15	T-17	T-23	T-26	T-29	T-32	T-36	T-40
$\phi 0$	RESET	0	0	0	0	0	0	0	0
$\phi 1$		1	0	0	0	0	0	0	0
$\phi 2$		1	1	0	0	0	0	0	0
$\phi 3$		1	1	1	0	0	0	0	0
$\phi 4$		1	1	1	1	0	0	0	0
$\phi 5$		1	1	1	1	1	0	0	0
$\phi 6$		1	1	1	1	1	1	0	0
$\phi 7$		1	1	1	1	1	1	1	0
$\phi 8$		1	1	1	1	1	1	1	1
$\phi 9$		0	1	1	1	1	1	1	1
$\phi 10$		0	0	1	1	1	1	1	1
$\phi 11$		0	0	0	1	1	1	1	1
$\phi 12$		0	0	0	0	1	1	1	1
$\phi 13$		0	0	0	0	0	1	1	1
$\phi 14$		0	0	0	0	0	0	1	1
$\phi 15$		0	0	0	0	0	0	0	1
$\phi 0$	STOP OR RESET	0	0	0	0	0	0	0	0

count 15 ($\phi 15$), the phase counter starts a new cycle, or is held reset to all zeros, or stopped by removing the trigger pulse.

2.4 Card Reader Function

(See figure 6-9.)

The card inserted in the card reader indicates to the computer system the operator's identity, access level, security level, etc. The computer system compares the keyboard data with the card data to determine if the display console operator has made a valid request. When a card is not inserted in the card reader, the typotron view screen voltage is reduced (dunked) and the keyboard request logic inhibited.

Card data bits 2^0 - 2^5 from the display console are gated to common logic cabinet by a $\overline{\text{CONSOLE ADDRESS}}$ signal from the computer system. Card data bits are accepted by terminating OR gates in the common logic cabinet and sent to the computer system through output gating enabled by a $\overline{\text{CAB ADDRESS SENSE}}$ signal.

2.5 Data Transfer Function

(See figure 6-4.)

The data transfer function provides a 24-bit shift register to store display data from the computer system, keyboard data, and keyboard edit position data. The computer system shifts display data serially into the 24-bit register and shifts keyboard data from the 24-bit register. Keyboard data is supplied through parallel input gating into the 24-bit register.

2.5.1 KEYBOARD DATA GENERATION

Keyboard bits 2^0 - 2^5 and a keyboard strobe is generated each time a key is pressed on the keyboard (figure 4-6). The six-bit keyboard

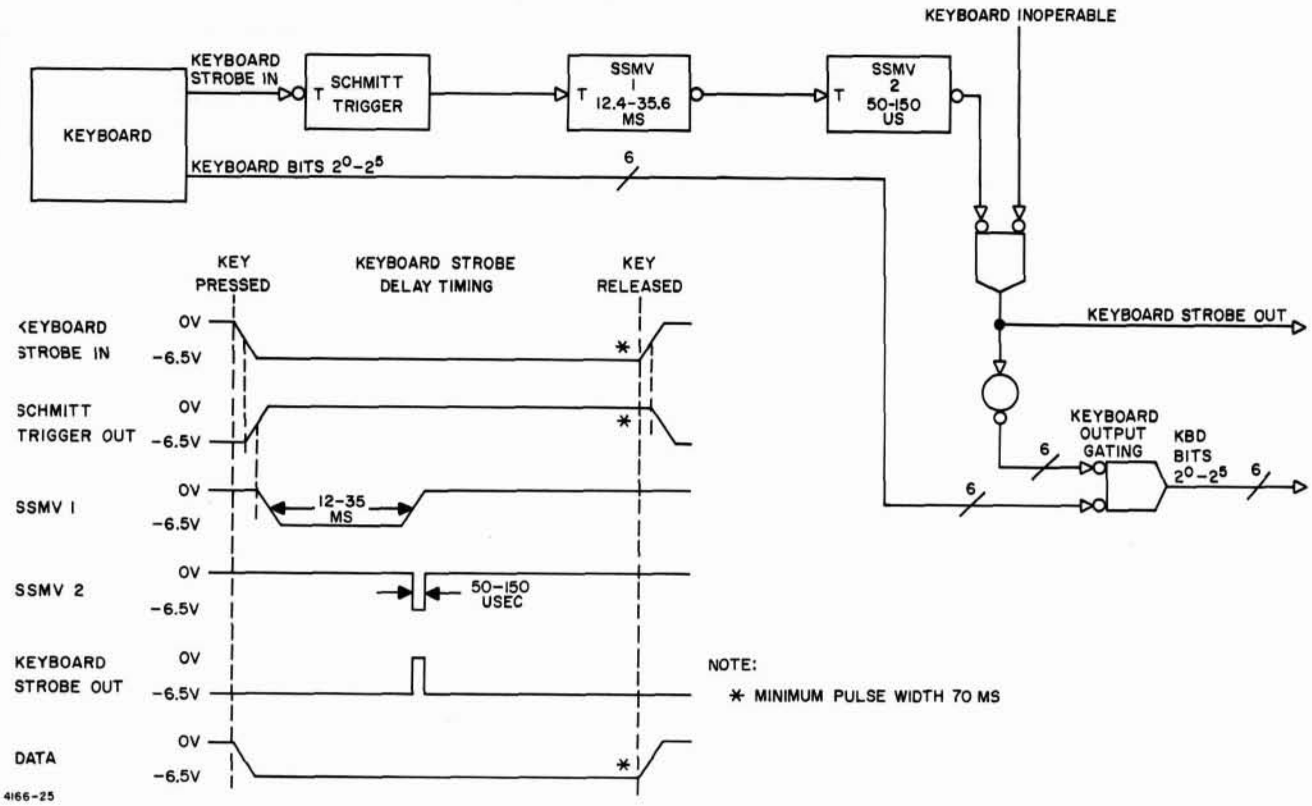

Figure 4-6. Keyboard Data Generation, Simplified Logic Diagram

data (see table 1-4 for keyboard character coding) is strobed into the 24-bit register by a delayed $\overline{\text{KBD STROBE}}$ signal. The $\overline{\text{KBD STROBE}}$ signal enables the keyboard output gating to ensure that the six-bit keyboard data is transmitted simultaneously to the parallel input gating circuits. Keyboard strobe delay timing is provided by a multivibrator circuit consisting of a Schmitt trigger and two monostable multivibrators (figure 4-6). The multivibrator delay circuit compensates for the photolectric and mechanical reaction time of the Keyboard.

2.5.2 PARALLEL INPUT GATING

Keyboard bits $K2^0$ - $K2^5$ and a keyboard strobe signal from the selected display console are applied to terminating OR gates (figure 4-7). Each keyboard character bits $K2^0$ - $K2^5$ are gated to the 24-bit register input gating during phase count 5 ($\overline{\phi 5}$). Keyboard bits $K2^0$ - $K2^5$, are also used in the underscore generation function to decode keyboard space or end of line. Keyboard strobe (KS) provides logic control. During the keyboard edit mode (KEM), the horizontal position ($H2^2$ - $H2^7$) and vertical position ($V2^3$ - $V2^7$) of the position being changed or filled in is gated to the 24-bit register input gating during phase count 9 ($\overline{\phi 9}$) and phase count 7 ($\overline{\phi 7}$) respectively. The $\overline{\text{KEM} \cdot \text{KS} \cdot \text{ACC}}$ signal is generated by the transfer control function when the display system is in the keyboard edit mode, a keyboard strobe signal is present, and the advance character count (ACC) flip-flop is set. The keyboard strobe signal from SSMV2 must be less than one word time long but greater than $\phi 0$ to $\phi 9$ time (approx. 150 μsec).

Keyboard data is gated into the 24-bit register by character counts 1 - 4 and a keyboard strobe ($\overline{\text{KS}}$) signal (figure 4-8). During the keyboard edit mode (KEM), the console operator positions the underscore under the position of the character or space to be changed or filled-in. The 6-bit code, 6-bit x position, and 6-bit y position of the new key is loaded into the 24-bit register. The 6-bit code of the new character is gated into the 24-bit register by character count1 ($\overline{\text{CH1}}$), phase count 5 ($\overline{\phi 5}$) and a keyboard strobe ($\overline{\text{KS}}$) signal. The 6-bit x position is gated into character position 2 during phase count 9 ($\overline{\phi 9}$) by a $\overline{\text{KEM} \cdot \text{KS} \cdot \text{ACC}}$ signal from the transfer control function and a keyboard strobe ($\overline{\text{KS}}$). The 6-bit y position is gated into character position 3 during phase count 7 ($\overline{\phi 7}$)

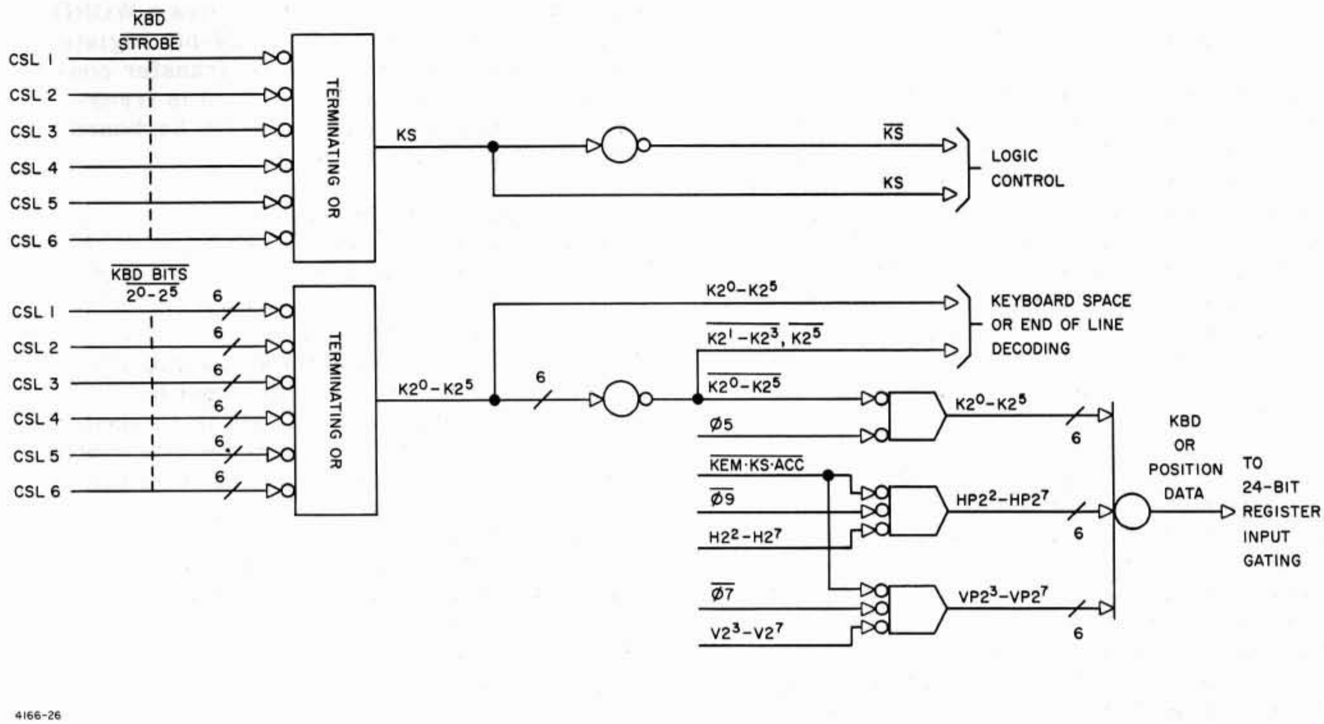

Figure 4-7. Parallel Input Selection, Simplified Logic Diagram

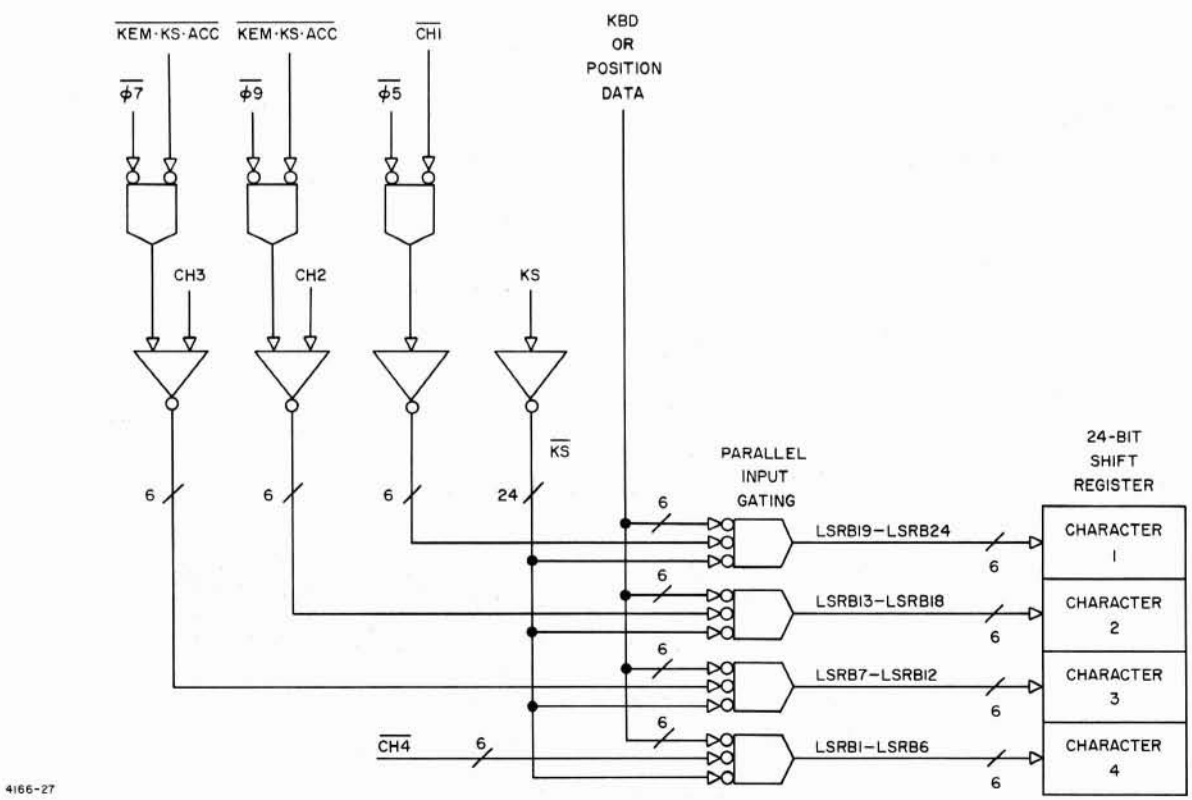

Figure 4-8. Parallel Input Gating, Simplified Logic Diagram

by a $\overline{KEM \cdot KS \cdot ACC}$ signal from the transfer control function and a keyboard strobe ($\overline{KS}$).

2.5.3 DATA TRANSFER

During keyboard output modes of operation, keyboard data is loaded into the 24-bit register and shifted serially in the computer system. During tabular and graphic modes of operation, display serial data is shifted serially into the 24-bit register from the computer system. The 24-bit register is cleared prior to receiving keyboard data or display data from the computer system. The data (shift register bits 1-24) stored in the 24-bit register is applied to character selection and positioning circuits for display on the Typotron tube face.

Display System to Computer System. During keyboard output modes (KEM or KCM) of operation, keyboard data is stored in the 24-bit register until an ENABLE SHIFT signal is sent to the computer system indicating a 24-bit keyboard word is ready to be transferred. When the computer system is ready to accept the keyboard data word, DATA SHIFT pulses (figure 4-9) are applied to the 24-bit register and the keyboard data (KBD DATA) is shifted serially into the computer system input/output buffer register (IOBR). After receiving the keyboard data, the computer system generates a WORD ACCEPTED signal to clear the 24-bit register (CLEAR WA) and circuits in the transfer control function. Each keyboard word is transferred in identical manner until the keyboard request message is complete.

Computer System to Display System. During tabular and graphic modes display data is shifted into the 24-bit register from the computer system. Prior to receiving display serial data from the computer system, the data control flip-flop is set to "1" and the remaining flip-flops in the 24-bit register are reset to "0" (figure 4-9). Display serial data is strobed through data control gating into the data control flip-flop by DATA STROBE pulses from the computer system. DATA SHIFT pulses from the computer system shifts the display serial data into the 24-bit register. The leading edge of the DATA SHIFT pulses are coincident with the leading edge of the data bits. DATA STROBE pulses occur approximately 1.5 μsec after the leading edge of the display data (figure 4-10).

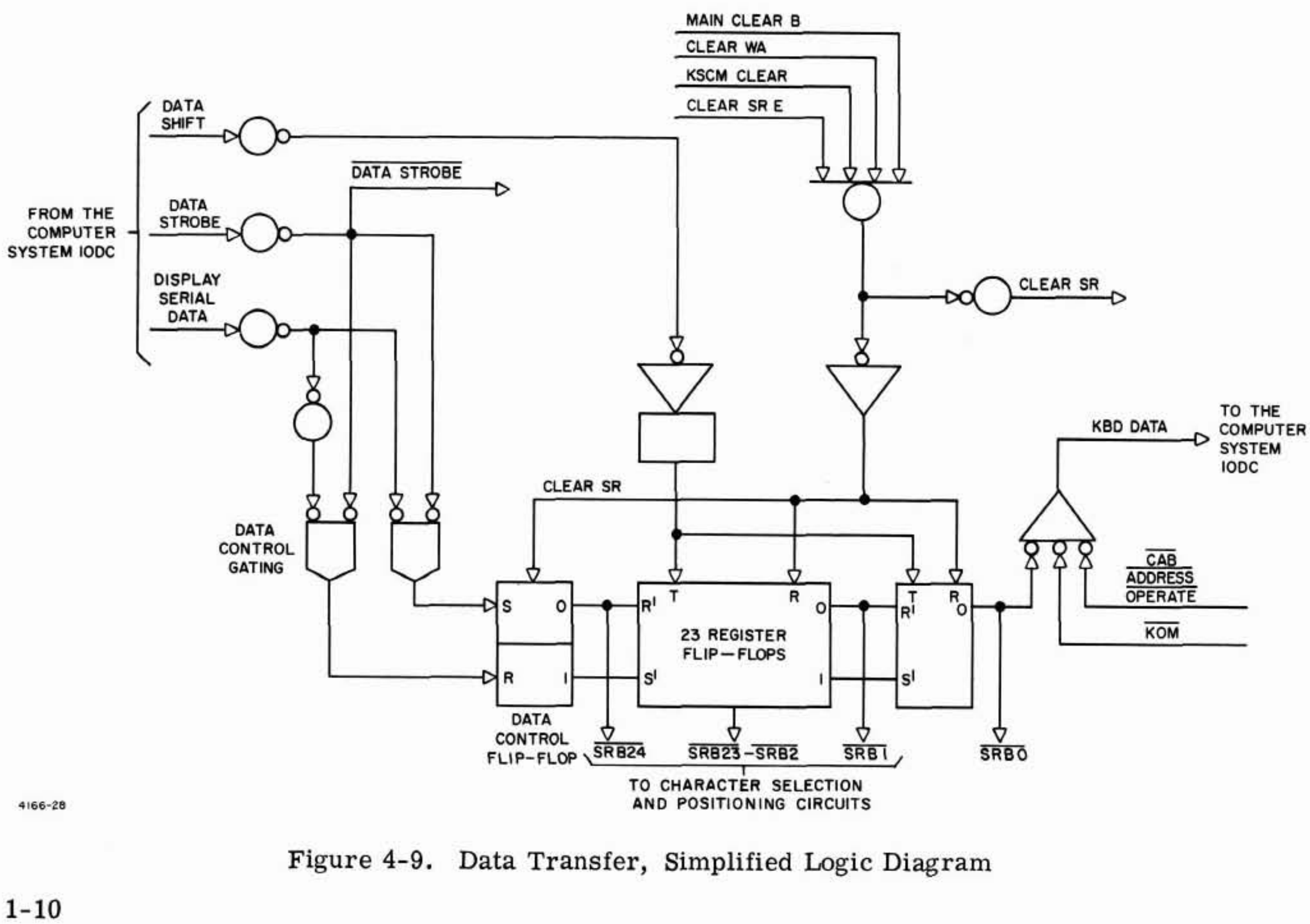

Figure 4-9. Data Transfer, Simplified Logic Diagram

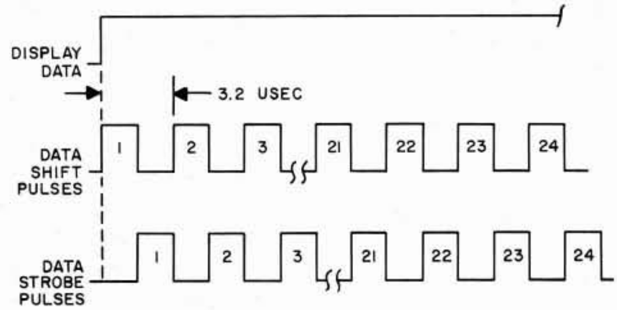

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Figure 4-10. Data Shift, Data Strobe, and Display Data Timing

As display data is shifted into the 24-bit register, the "1" set in the data control flip-flop is shifted through each flip-flop in the register. When the 24th data bit is shifted into the register, shift register bit 0 ($\overline{SRBO}$) is applied to ready/busy circuits in the transfer control function. The transfer control function then disables the ready for next word (RFNW) indicating to the computer system that the display system is busy processing the transferred data. When the display system process is complete the transfer control function enables the ready for next word to indicate the display is available to accept the next display word.

2.6 Transfer Control Function

(See figure 6-3.)

The transfer control function regulates the transfer of data between the display system and computer system. The transfer control function consists of circuits to accept and generate operational status, character counter, keyboard data ready transfer, and display serial data busy transfer signals.

2.6.1 OPERATIONAL STATUS CIRCUITS

The computer system generates an EMERGENCY TEST STOPPED to indicate an unsafe condition exists in the vehicle or the test equipment and the computer system has stopped tests. The emergency test stopped flip-flop C-1 is set when the unsafe condition exists and is reset when the unsafe condition no longer exists or by a MAIN CLEAR A signal. MAIN CLEAR A is generated each time display system power is sequenced on. When set, the output of flip-flop C-1 lights EMERGENCY TEST STOPPED indicator on the display console indicating to the console operator that the computer system has stopped operation.

The computer system generates an ERROR signal to indicate an invalid or incorrect request has been made by the display console operator. Error flip-flop C-3 is triggered by a CC STROBE signal from the computer system and the ERROR indicator lights on the display console manual input panel. The EMERGENCY TEST STOPPED and ERROR signals are applied to all six display consoles. A $\overline{CONSOLE\ ADDRESS}$ signal from the computer system enables the lamp drivers in the selected display console.

The DISPLAYS BUSY indicator lights green on the display console being addressed when any mode is decoded by the mode selection and control function. The DISPLAYS BUSY indicator lights yellow on all other display consoles operating with the same common logic cabinet. A no mode (NM) signal disables the display busy lamp drivers.

A KEYBOARD INOPERABLE signal is generated to prevent keyboard data from being strobed into the common logic cabinet when any display console is busy (CSL BUSY), keyboard data is ready for transfer to the computer system (KBD RTX), or the display system is not in any keyboard mode ($\overline{AKM}$). The $\overline{AKM}$ signal is a logical 1 (0 volts) when the display system is not in any keyboard mode. The KEYBOARD INOPERABLE indicator lights yellow indicating keyboard data is inhibited.

A console busy (CSL BUSY) signal is generated by the clear/erase and unblank function. The $\overline{CSL\ BUSY}$ signal is gated to the common logic cabinet by a $\overline{CONSOLE\ ADDRESS}$ signal from the computer system. A $\overline{CSL\ BUSY}$ signal is also generated when the direct view storage tube (DVST) is not ready. Console busy signals from six possible display consoles are applied through a terminating OR gate to provide common logic control. The $\overline{CSL\ BUSY}$ signal (logical "1" when not busy) enables the ready for next word signal to the computer system, disables the unblank signal to the display console when the console is busy, enables clock pulses to the phase counter and provides a $\overline{\text{KEYBOARD INOPERABLE}}$ signal to all display consoles operating with the same common logic cabinet.

Time delay relay K2 in the power control assembly provides an additional 1 minute warmup time for the display tube write gun filament. The DVST READY signal from the power control assembly is a logical "1" (DC RET) when the display tube is not ready and a logical "0" (an open circuit) when the display tube is ready. When time delay relay K2 energizes, the open circuit input to gate C-24 provides a DVST READY (logical "0") indicating the display tube is ready for operation. The DVST READY signal is gated to the common logic cabinet by a console ADDRESS from the computer system. When the display tube is not ready, the $\overline{\text{DVST READY}}$ signal is applied through power sequence complete relay K10 contacts in the power sequencer to the computer system as a $\overline{\text{DISPLAYS INOPERABLE}}$ signal.

2.6.2 CHARACTER COUNTER

The character counter provides sequential readout of display data from the 24-bit register and sequential loading of the register, character by character (figure 6-3). Character count signals control transfer of display data from the 24-bit register to display positioning and selection circuits and loading of keyboard data into the 24-bit register.

The character counter is advanced during any of the following conditions.

a. During phase count 1 ($\overline{\phi 1}$) in a graph or tabular mode. Advance of the character counter is inhibited during graph or tabular mode when horizontal end of line (HEL) is decoded or during character count 2 ($\overline{CH2}$) of a graph coordinate writing submode ($\overline{G376 + G377}$).

b. When the keyboard space (KSPC) bar or keyboard end of line (KEL) key is pressed when not in the keyboard edit mode and phase counts 1 ($\overline{\phi 1}$) and 3 ($\overline{\phi 3}$) respectively.

c. In keyboard modes of operation, an ADVANCE CHARACTER COUNTER (ACC) signal is generated by the ACC flip-flop (U-13)(figure 6-12). The ACC flip-flop is set during phase count 4 ($\overline{\phi 4}$) when the underscore flip-flop U-6 is reset, and horizontal end of line (HEL) is not decoded.

2.6.3 DISPLAY DATA READY/BUSY TRANSFER

During tabular or graphic modes of operation, a ready for next word (RFNW, logical "1")signal is sent to the computer system when the display system common logic is ready to receive the next serial display word (figure 6-3). A busy signal is sent to the computer system when the display system common logic is processing the previous word or the addressed console display is being erased (CSL BUSY) or CRT power is not on.

When the 24th display data bit is strobed into the 24-bit register during tabular or graphic modes, shift register bit 0 (SRB0) and the 24th DATA STROBE signal resets busy transfer (BTX) flip-flop C-62 (figure 6-3) disabling the RFNW output from gate C-75. When the common logic has processed the previous display word, BTX flip-flop C-62 is set by one of the following conditions:

a. During character count 4 and phase count 15 in any tabular mode when horizontal end of line is not decoded ($\overline{ATM} \cdot \overline{CH4} \cdot \phi 15 \cdot \overline{HEL}$).

b. During character count 3 and phase count 15 in the graph plotting submode and horizontal end of line is not decoded ($\overline{GM} \cdot \overline{CH3} \cdot \overline{\phi 15} \cdot \overline{HEL}$).

c. During character count 2 and phase count 15 in the graph jump scan submode ($\overline{G373} \cdot \overline{CH2} \cdot \overline{\phi 15}$).

d. During character count 2 in a graph horizontal or vertical coordinate submode and a horizontal end of line or vertical last line has been decoded.

e. When a word accepted (WA) signal is received from the computer system during a keyboard output mode (KOM). The CLEAR (WA) signal sets BTX flip-flop C-62 during keyboard output modes to provide an immediate RFNW signal when the computer system changes the display system to a tabular or graphic mode before transmitting serial display data.

f. By a MAIN CLEAR B signal each time power sequence is complete or a CLEAR DISPLAY signal is received from the computer system to erase the display tube and clear the common logic circuits.

When set, the output of BTX flip-flop C-62 provides a ready for next word (RFNW) signal during phase count 0 ($\overline{\phi 0}$). The RFNW signal is sent to the computer system if the display system is not in any keyboard mode (AKM) and the CABINET ADDRESS OPERATE signal is being received from the computer system. The RFNW signal is disabled at gate C-72 if the console is busy (CSL BUSY) or the computer system is clearing the display system tube and common logic (CLEAR DISPLAY).

A CLEAR SRE signal is generated during phase count 15 ($\overline{\phi 15}$) by a RFNW signal and the display system is not in a keyboard mode. The CLEAR SRE signal clears the 24-bit register, and resets the horizontal end of line (HEL) flip-flop and vertical last line (VLL) flip-flop prior to receiving the next display word from the computer system.

When the display system is not in any keyboard mode, the output of gate C-76 (RFNW · $\overline{AKM}$) holds the phase counter reset to prevent phase counts during word transfer between the computer system and display system. The RFNW signal from gate C-73 disables graph submode selection gate G-2 (see figure 6-6) while the shift register data is being transferred.

2.6.4 KEYBOARD DATA READY TRANSFER

During keyboard output modes of operation, an ENABLE SHIFT signal is generated indicating the keyboard data word stored in the 24-bit register is ready for transfer to the computer system (figure 6-3). INSERT and DELETE keys on the keyboard provide signals to the computer system indicating the message previously transmitted is valid or invalid.

In the keyboard compose mode, a ready transfer (KCM RTX) signal is generated when the keyboard data word in the 24-bit register is ready for transfer to the computer system. A KCM RTX signal is generated during phase count 15 ($\phi 15$) by an underscore ($\overline{UNSCR}$) signal, a $\overline{KCM}$, and a character count 4 ($\overline{CH4}$), or $\overline{INSERT}$ or $\overline{DELETE}$ signal. In keyboard modes of operation, underscore flip-flop U-6 (figure 6-12) is set during phase count 1 ($\overline{\phi 1}$) by an advance character count (ACC) or horizontal end of line (HEL) signal to provide the $\overline{UNSCR}$ signal enabling KCM RTX.

In the keyboard edit mode, a ready transfer (KEM RTX) signal is generated when the 6-bit horizontal position code, 6-bit vertical position code and the 6-bit code of the character replacing another character or filling-in a space is stored in the 24-bit register. Advance of the character counter (ACC) is inhibited when the operator uses the space bar and END OF LINE key to position the underscore under the character being changed or filled-in (figure 6-12). No ACC disables the KEM RTX signal until character count 1 ($\overline{CH1}$) is generated to gate the new 6-bit character into the register. The ACC signal sets UNSCR flip-flop during phase count 1 ($\overline{\phi 1}$) enabling a KEM RTX signal during phase count 15 ($\overline{\phi 15}$). The $\overline{KEM \cdot KS \cdot ACC}$ signal from gate C-60 (figure 6-3) enables the horizontal and vertical position 6-bit codes through parallel input gating (figure 6-4) into the 24-bit register.

A KCM RTX or KEM RTX signal (figure 6-3) sets keyboard ready transfer (KBD RTX) flip-flop C-71 generating an ENABLE SHIFT signal. The ENABLE SHIFT signal is gated to the computer system during keyboard output modes ($\overline{KOM}$) by a $\overline{CAB\ ADDRESS\ OPERATE}$ signal indicating the keyboard data in the 24-bit register is ready for transfer into the computer system input/output buffer register. The KBD RTX signal is also applied to gate C-6 to initiate a keyboard inoperable ($\overline{KBD\ INOPERABLE}$) signal. KBD RTX flip-flop C-71 is reset by a CLEAR WA signal when the keyboard data word is accepted by the computer system and by MAIN CLEAR A each time power sequenced on is complete. In the keyboard self-check mode a KSCM CLEAR signal is enabled by character count 4 ($\overline{CH4}$) and $\overline{UNSCR}$ during phase count 15 ($\overline{\phi 15}$) to clear the 24-bit register after the keyboard word is applied to positioning and selection circuits.

INSERT and DELETE signals are generated by pressing the appropriate key on the keyboard. The INSERT signal indicates that the keyboard data previously transmitted to the computer system is complete and the message is valid. The DELETE signal activates the INSERT signal to the computer system indicating the keyboard data previously transmitted is not valid. INSERT is decoded during phase count 8 ($\overline{\phi 8}$) by character selection decoding gates S-57 and S-58 (figure 6-10). The output of gate S-57 is disabled by an UNSCR signal to prevent an INSERT signal when the underscore is selected for display. In the keyboard compose mode ($\overline{KCM}$), DELETE is decoded during phase count 7 ($\overline{\phi 7}$). When set by a $\phi 8$ · INSERT or $\phi 7$ · DELETE signal the output of INSERT flip-flop C-70 (figure 6-3) is gated to the computer system by a $\overline{CAB\ ADDRESS\ OPERATE}$ signal. When set by a $\phi 7$ · DELETE signal, the output of DELETE flip-flop C-69 is gated to the computer system by a $\overline{CAB\ ADDRESS\ OPERATE}$ signal. Both the INSERT and DELETE signals are required at the computer to indicate an invalid message, and to terminate IODC transfer.

2.7 Graph Submode Decoding Function

(See figure 6-6.)

The graph submode decoding function provides the circuits to decode graph submode codes from the computer system to provide common logic control during graphic operations. The graph mode consists of the graph plotting, jump scan (G373), x-coordinate ($G376_8$), and y-coordinate ($G377_8$) submodes. The x-coordinate is produced by setting y constant and plotting all values for x horizontally, and the y-coordinate is produced by setting x constant and plotting all values for y vertically. The graph plotting submode is active when the display system is in the graph mode (GM) and not in a G373, G376, or G377 submode.

The computer system shifts graphic display data serially into the display system 24-bit register when a graph mode has been selected. Except in the graph plotting submode, the first 8-bit character position contains the octal code of the selected graph submode. See figure 4-11 for the 24-bit word contents of each graph submode. Shift register bits 17-24, (figure 6-4) the first character position, are decoded to provide the graph submode signals (figure 6-6). Decoded graph submode signals (G373, G376, or G377) are combined with character counts to provide signals which enable the outputs from the horizontal and vertical counter and provide other common logic control. Table 4-5 is a list of graph submode control signals and their purpose.

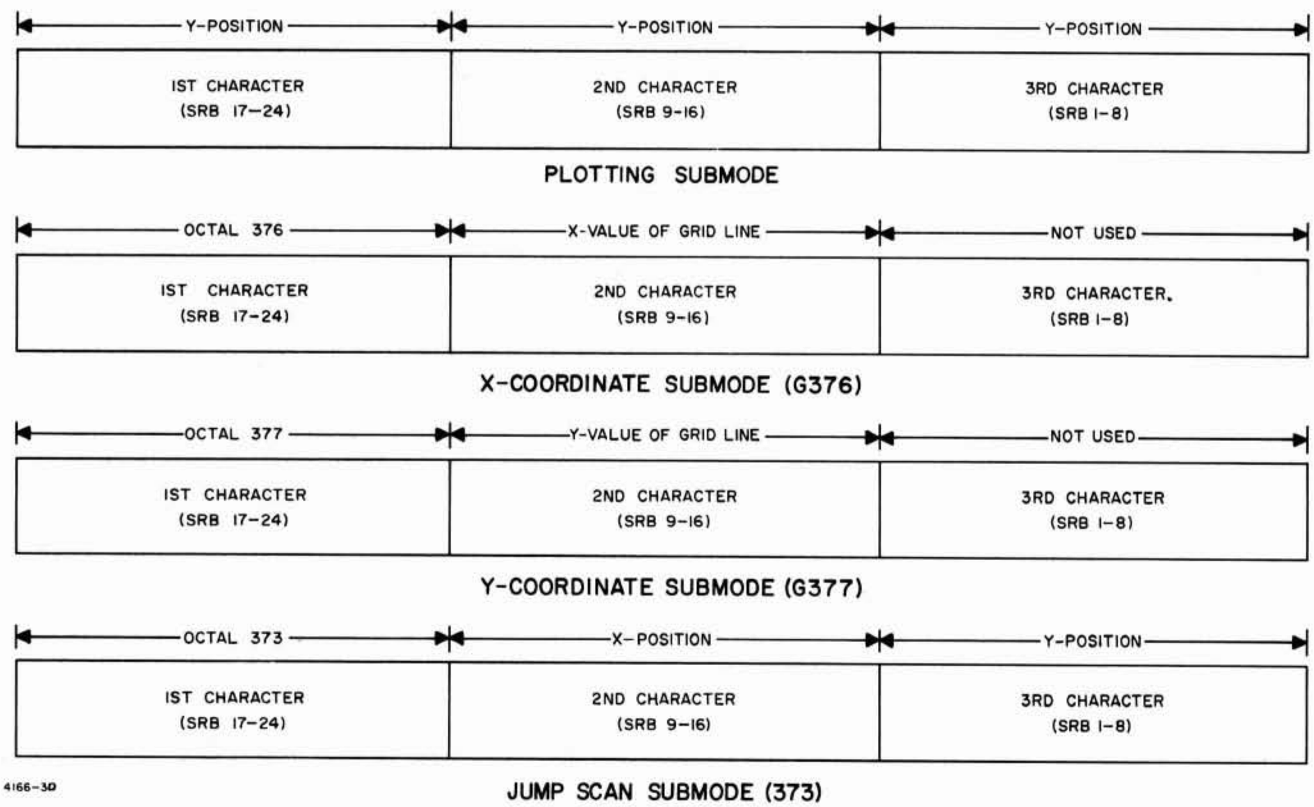


Figure 4-11. 24-Bit Register Contents, Graph Mode

Table 4-5. Graph Submode Control Signals

SIGNAL	PURPOSE
$\overline{G \cdot \overline{G373} \cdot \overline{G376} \cdot \overline{G377}}$	a. Enables the 1st character (SBR 17-24) y-position code into the display console positioning logic in the graph plotting submode (G373, G376, or G377 not decoded) during character count 1 $(\overline{CH1})$ b. Enables advance of the horizontal counter in the graph plotting submode (G373, G376 or G377 not decoded) during phase count 1 $(\overline{\phi 1})$
$\overline{G373 + G376}$	Enables the 2nd character (SRB 9-16) x-position code into the display console positioning logic in the x-coordinate submode (G376) or graph jump scan submode (G373) during character count 2 $(\overline{CH2})$
G373 + G376	Disables the horizontal counter output into the display console positioning logic in the x-coordinate (G376) and jump scan (G373) submodes, enables all other modes
$\overline{G \cdot \overline{G373 + G376}}$	Enables the 2nd character (SRB 9-16) y-position code into the display console positioning logic in the graph plotting or y-coordinate (G377) submodes during character count 2 $(\overline{CH2})$
$\overline{G2 \cdot G373 + G3 \cdot \overline{G376} \cdot \overline{G377}}$	Enables the 3rd character (SRB 1-8) y-position code into the display console positioning logic in the graph jump scan submode (G373) during character count 2 and in the graph plotting submode during the character count 3
$\overline{G373} + \overline{G376} + \overline{G377}$	Enables gate C-55 during character count 2 $(\overline{CH2})$ if a horizontal end of line (HEL) or vertical last line (VLL) is decoded to set the BTX flip-flop
CH1 (G373 + G376 + G377)	a. Inhibits unblanking during character count 1 $(\overline{CH1})$ in the jump scan, x-coordinate, or y-coordinate (G373 + G376 + G377) submode b. Forces a 1 into the $MX2^7$ x-position and $MY2^7$ y-position to position the write beam near the center of the display tube prior to receiving graph display data during a jump scan, x-coordinate or y-coordinate submode c. Generates a vertical counter reset $(\overline{VCR})$ signal to reset the horizontal and vertical counters
$\overline{ATM + G376 + G377}$	Inhibits advance of the character counter after character count 2 in a x-coordinate or y-coordinate graph submode

2.8 Underscore Generation Function

(See figure 6-12.)

2.8.1 KEYBOARD UNDERSCORE

A keyboard underscore is generated when the SPACE bar or the END OF LINE KEY is pressed during keyboard output modes. The underscore mark provides the console operator with a visual indication of the writing beam location on the storage tube face. In the keyboard edit mode, the underscore is positioned under the succeeding space or character changed by activation of any key except the insert and shift keys. In the keyboard compose and keyboard self-check modes, the underscore is positioned under the succeeding space of character display following activation of SPACE bar or END OF LINE key.

In the keyboard edit mode, keyboard SPACE (KSPC) is decoded by gate U-2 (figure 6-12) and enabled through gate U-1 by a keyboard strobe ($\overline{KS}$) during the phase count 1 ($\overline{\phi 1}$) in any keyboard mode ($\overline{AKM}$). When decoded, KSPC sets underscore flip-flop U-6 to generate underscore (UNSCR) control signals. The $\overline{UNSCR}$ signal from inverter U-12 advances the horizontal counter gate P-16 (figure 6-8) during phase 2 ($\overline{\phi 2}$) in any keyboard mode ($\overline{AKM}$). Advance of the character counter is inhibited by disabling gate U-8 (figure 6-12). The UNSCR signal from inverter U-11 disables gate S-47 (figure 6-10) to prevent strobing of shift register bits into the character selection gates when the underscore is enabled. The underscore mark is provided by the octal code 40 (dash) output from the character selection gates when UNSCR is applied to gate S-18 (figure 6-10). The dash symbol is displaced to the underscore position by inserting UNSCR from U-11 (figure 6-12) into vertical position gate P-78 (figure 6-8). Since a tabular character occupies the equivalent space of eight vertical graph symbols, presetting the Y magnetic deflection gates by four graph spaces places the underscore completely beneath the character in that position. Unblanking (figure 6-5) occurs between phase counts eleven through fourteen ($\phi 11$ - $\phi 14A$) and the underscore is written. Underscore unblanking is inhibited by the output of gate U-15 (figure 6-12) during the keyboard compose or self-check modes when the following conditions exist:

a. Flip-flop T-2 (figure 6-11) is reset by $\overline{UNSCR}$ during phase count 0 ($\overline{\phi 0}$).

b. UNSCR flip-flop U-6 (figure 6-12) is set by gate 9 during phase count 1 ($\overline{\phi 1}$) in any keyboard mode ($\overline{AKM}$) when horizontal end of line (HEL) is decoded or advance character counter (ACC) flip-flop U-13 is set.

c. Flip-flop U-14 is reset by WT2ϕ0 + WT3ϕ0 (RESET) signal from T-2.

In the keyboard edit mode keyboard END OF LINE (KEL) is decoded by gate U-4 (figure 6-12) and enabled through gate U-3 during phase count 3 ($\overline{\phi 3}$) in any keyboard mode ($\overline{AKM}$). The $\phi 3 \cdot$ KEL signal from U-3 sets HEL flip-flop P-55 (figure 6-8) generating a HEL signal. The HEL signal from P-57 resets the horizontal counter during phase count 5 ($\overline{\phi 5}$) and advances the vertical counter (gate P-79) by 1. The HEL signal inhibits advance of the character counter by disabling gate U-8 (figure 6-12). After phase count 15 ($\overline{\phi 15}$), gate T-1 (figure 6-11) is disabled by no underscore and the phase counter starts a new cycle without stopping, underscore flip-flop U-6 (figure 6-12) is set by the HEL $\cdot \phi 1 \cdot$ AKM signal from gate U-9. An UNSCR signal during phase count 2 ($\overline{\phi 2}$) in any keyboard mode (AKM) at gate P-16 (figure 6-8) advances the horizontal counter by one. Unblanking (figure 6-5) occurs during phase counts 11 through 15 ($\phi 11$ - $\phi 14$) and the underscore is written under the first character position of the next line.

Underscore logic operation during the keyboard compose or keyboard self-check modes and the keyboard edit mode is similar except for conditions advancing the character counter.

2.8.2 TAB UNDERSCORE

During the tabular edit mode (TEM), a TAB underscore (figure 6-10) is positioned under the character or space to be changed or filled in. A TAB UNSCR is (36_8 - tab sign) decoded by gates S-61 and S-62 during the tabular edit mode (TEM). The tab sign (36_8) is displaced to the tab underscore position by inserting the TAB UNSCR signal from S-61 into vertical position gates P-63 and P-71 (figure 6-8). This moves the tab underscore symbol (. . .) down three vertical graph spaces or one graph space above the keyboard underscore.

2.9 Character Positioning Function

(See figure 6-8.)

The character positioning function provides x and y position data to position tabular and graphic information on the display tube face. The x and y position data is transferred from the 24-bit register during jump scan submode. The y position data is transferred from the 24-bit register in graph plotting mode. The x position in a x-coordinate submode ($G376_8$) and the y-position in a y-coordinate submode ($G377_8$) are transferred from the 24-bit register. Horizontal and vertical position counters provide x and y positions during tabular and keyboard modes, y positions during the x-coordinate ($G376_8$) and x positions during the y-coordinate submode ($G377_8$). The horizontal and vertical counters are 8-bit binary countdown counters. Normally reset to the all-ones condition, the position counters decrement one count with the application of each input trigger pulse.

2.9.1 TABULAR AND KEYBOARD MODES

Each character or symbol is displayed sequentially, left to right across the display tube face, under control of the horizontal counter. When the end of the character line has been reached, end of line is decoded, and the next character is displayed in the left most position of the next line and the sequential left-to-right pattern is continued. Each character line is displayed sequentially, top to bottom, under control of the vertical position counter. The tabular display format of 50 characters maximum by 32 lines is shown in figure 1-7.

In tabular or keyboard modes, bits $H2^0$ and $H2^1$ of the horizontal position counter and bits $V2^0$, $V2^1$ and $V2^2$ of the vertical position counter are inhibited. With the least significant bits inhibited and ignored, maximum horizontal count is 64 (however, only 50 horizontal counts are used) and maximum vertical count is 32. The H-bit outputs of the horizontal position counter are gated through the horizontal position output gates P-21, P-28, P-34, P-36, P-40, and P-47 when not in a G373 (jump scan) or G376 (vertical coordinate line) submode. The V-bit outputs of the vertical counter are gated through P-80, P-87, P-93, P-99, and P-105 during any tab mode (ATM) or any keyboard mode (AKM).

As each character is displayed, the horizontal position counter is incremented one count by phase count 1 ($\overline{\phi 1}$) in any tab mode $\overline{(ATM)}$ at gate P-17 and by phase count 2 ($\overline{\phi 2}$) in any keyboard mode $\overline{(AKM)}$ at gate P-16. A tab end of line signal ($\phi 4 \cdot$ TEL), decoded by gates S-59 and S-60 (figure 6-10), may be sent by the computer system at any time indicating that the character line is to be terminated. Horizontal count 51 is decoded by gate P-57 (figure 6-8) and indicates that the maximum horizontal count has been reached. Either $\phi 4 \cdot$ TEL or count 51 at HEL flip-flop P-55 resets the horizontal counter and either signal at gate P-79 increments the vertical counter by one. The vertical position counter is incremented at the end of each horizontal line until vertical count 31 is reached at which time the counter returns to the reset condition (vertical count 0), or until a tabular end of message (INSERT) signal is decoded at gates S-57 and S-58 (figure 6-10). Tabular end of message may be generated at any time by the computer to indicate that the last line of the computer message has been displayed. The $\phi 8 \cdot$ INSERT signal from gate S-57 is applied to gate P-120 (figure 6-8) which resets the horizontal and vertical position counters.

2.9.2 GRAPH SUBMODES OF OPERATION

During graph submodes of operation, the inhibit signals to the least significant horizontal and vertical counter bits are removed and the counters are preset to 32 (gates P-52 and P-113, figure 6-8) establishing the zero-position graph origin. Maximum horizontal count in a graph mode is 204, decoded by gate P-50, which provides for 172 vertical grid lines. Maximum vertical count is 249, decoded by gates P-121 and P-122, which provide for 217 horizontal grid lines. Graph mode format is shown in figure 1-8.

The symbols used to represent a graph are selected by the computer under program control. The coded character is received by the graph symbol decoder and transferred to the character selection circuits (refer to paragraph 2.10). If a discontinuous graph is desired, a blank (or space) character may be inserted in place of the graph symbol at any point. Code 375_8 (blank) or code 374_8 (end of graph) are transferred from the 24-bit register to the vertical position output gates and decoded by gates P-125 and P-126. The G(374 and 375) signal disables symbol decoding gates S-9, S-10, S-11, and S-12 (figure 6-10), resulting in the selection of a blank character (no display).

Graph Coordinate Submode. When a graph coordinate is to be written, the first eight-bit character represents the code for an x or y coordinate. The second eight-bit character represents the x or y position of the coordinate line depending upon whether it is a vertical or horizontal coordinate line respectively. The third character is not used in this mode. A CH1 (G373 + G376 + G377) signal from gate G-24 (figure 6-6) is applied to gate P-45 and gate P-109 (figure 6-8) to position the write beam near the center of the display face preparatory to writing a graph coordinate. Having the beam centered reduces the maximum distance the beam must travel between successive coordinates.

If an x-coordinate (Code 376_8) is to be written, the (G373 and G376) signal (figure 4-12) inhibits the H-bit outputs $H2^0$ - $H2^7$ of the horizontal counter. The $\overline{\text{G373 and G376}}$ signal enables the transfer of the x position $\overline{\text{(SRB4-SRB16)}}$ through the horizontal position output gates to positioning circuits in the display consoles during character count 2 $\overline{\text{(CH2)}}$. The vertical counter is incremented by phase counts ($\phi 2$) during character count 2 $\overline{\text{(CH2)}}$ and $\overline{\text{G376}}$ signal has been decoded. The sequential count is gated through vertical position output gates to positioning circuits in the display consoles by a G376 signal. A vertical line in the corresponding x position is then written. The x-coordinate line is terminated when a vertical last line (VLL) is decoded. A VLL signal from P-127 (figure 6-8) resets the horizontal and vertical counters. Inputs $\overline{\text{VLL}}$, $\overline{\text{G373 + G376 + G377}}$, and CH2 at gate C-51 (figure 6-3) set BTX flip-flop C-62 and a CLEAR SRE signal is initiated during phase count 15 ($\phi 15$) to clear the 24-bit register of the submode code and position data.

If a y-coordinate (code 377_8) is to be written, vertical counter bits $V2^0$ - $V2^7$ (figure 4-13) are inhibited by no G376, ATM, or AKM signal. The $\overline{\text{G373 · G376}}$ signal enables the transfer of the y position $\overline{\text{(SRB9-SRB16)}}$ through vertical position output gates to positioning circuits in the display consoles during character count 2 $\overline{\text{(CH2)}}$. The horizontal counter is incremented by signals $\overline{\phi 2}$, $\overline{\text{CH2}}$, and $\overline{\text{G377}}$ and the sequential count is gated through horizontal position output gates to positioning circuits in the display consoles. A horizontal line corresponding to the coordinate equation is then written. The y-coordinate line is terminated when a horizontal end of line (HEL) is decoded. A HEL signal from P-55 (figure 6-8) resets the horizontal counter. Inputs $\overline{\text{HEL}}$, $\overline{\text{CH2}}$, and $\overline{\text{G373 + G376 + G377}}$ at C-55 (figure 6-3) sets BTX flip-flop C-62 and a CLEAR SRE signal is initiated during phase count 15($\phi 15$) to clear the 24-bit register of the line equation.

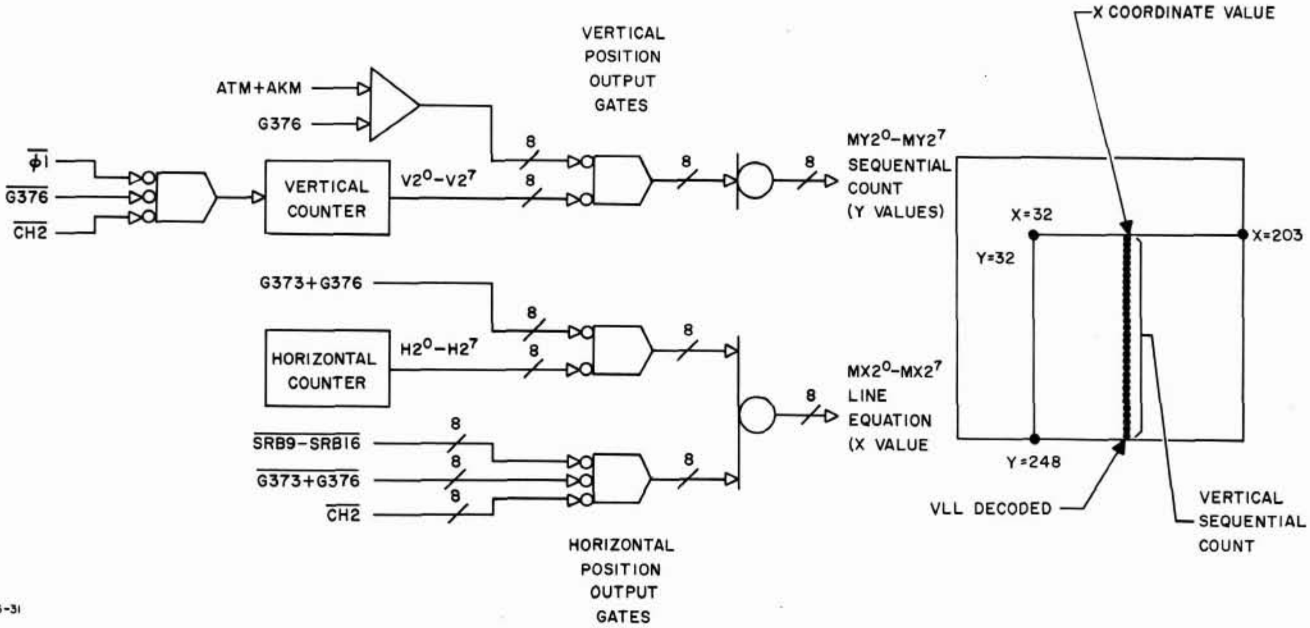
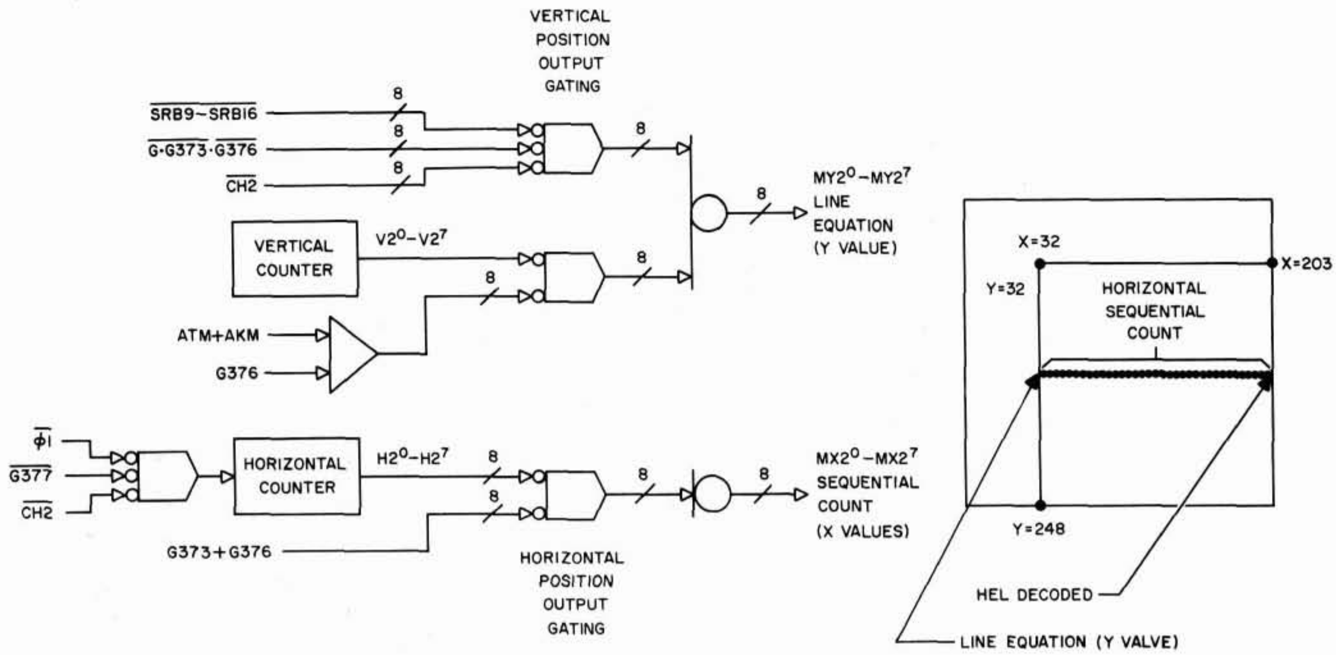


Figure 4-12. X-Coordinate Submode ($G376_8$), Simplified Logic Diagram



4166-32

Figure 4-13. Y-Coordinate Submode ($G377_8$), Simplified Logic Diagram

Graph Plotting Submode. In the graph plotting submode, each eight-bit y-amplitude character (figure 4-11) is transferred from the 24-bit register through vertical position output gates (figure 4-14) to positioning circuits in the display consoles. As each y character (SB1-SB8, SRB9-SRB16, and SRB17-SRB24) is applied to vertical position output gating circuit, the horizontal counter is incremented one count by signals $\overline{\phi 1}$, $\overline{GM}$ and G· $\overline{G373}$· $\overline{G376}$· $\overline{G377}$. The varying vertical data and the sequential horizontal data results in a y graph plotted against equal increments of x. The writing of a graph may be terminated at any time by a $G374_8$ code. A $G374_8$ code is decoded by gates P-123 and P-124 (figure 6-8) as ϕ4· G374 and resets the HEL flip-flop P-55 and the horizontal counter gate P-56.

Graph Jump Scan Submode. The jump scan submode is provided for plotting double valued curves or curves with few plotting points which require a minimum of computer storage space. The first eight-bit character represents the code 373_8 (jump scan submode), the second character represents the x position of the point and the third character represents the y position of the point.

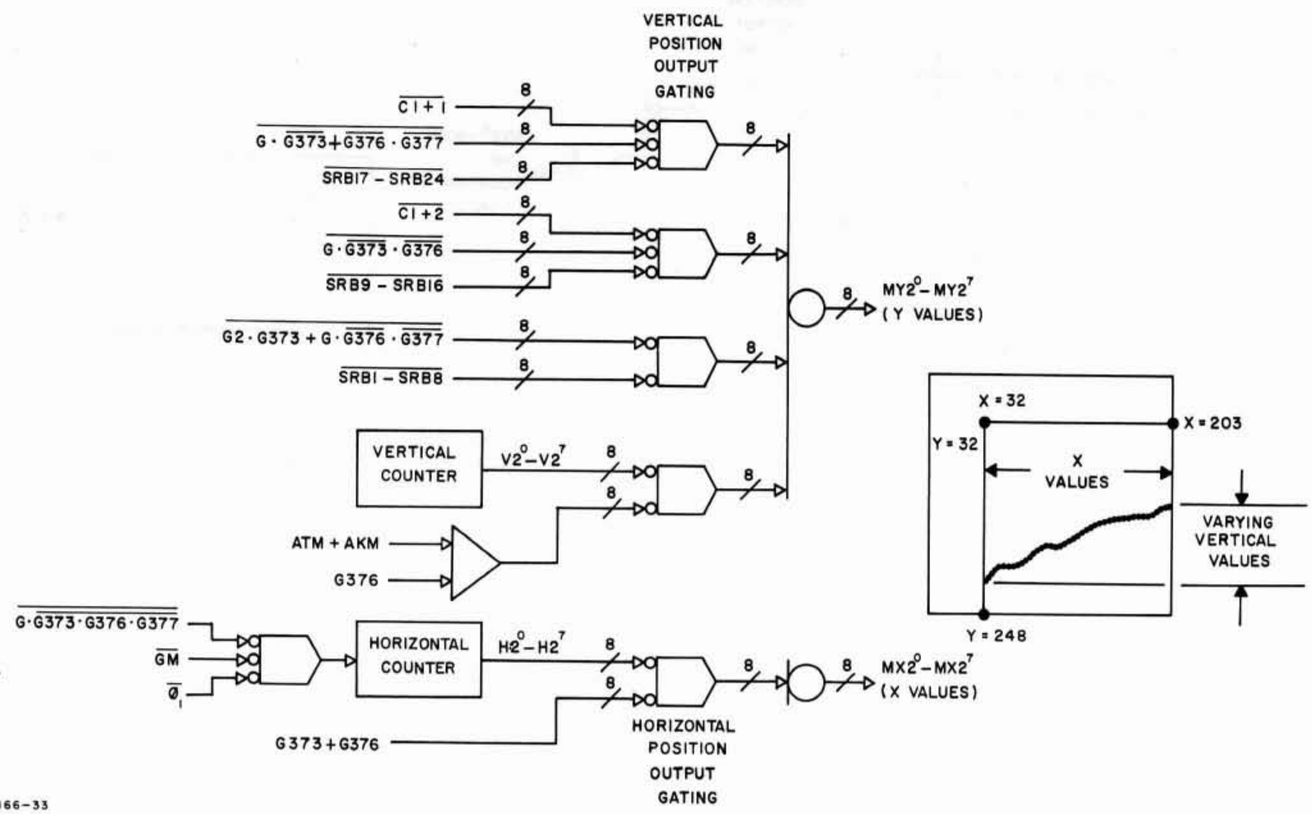
When a graph curve is drawn in the jump scan submode, the 8-bit x position (figure 4-15) $\overline{SRB9\text{-}SRB16}$ is transferred from the 24-bit register through horizontal position output gates to positioning circuits in the display consoles. Horizontal counter H-bits are inhibited by the $\overline{G373+G376}$ signal. The 8-bit y position $\overline{(SRB1\text{-}SRB8)}$ is transferred from the 24 bit register through vertical position output gates to positioning circuits in the display consoles. Vertical counter V-bits are inhibited by no G376, or ATM+ AKM signal.

2.10 Character Selection Function

(See figure 6-10.)

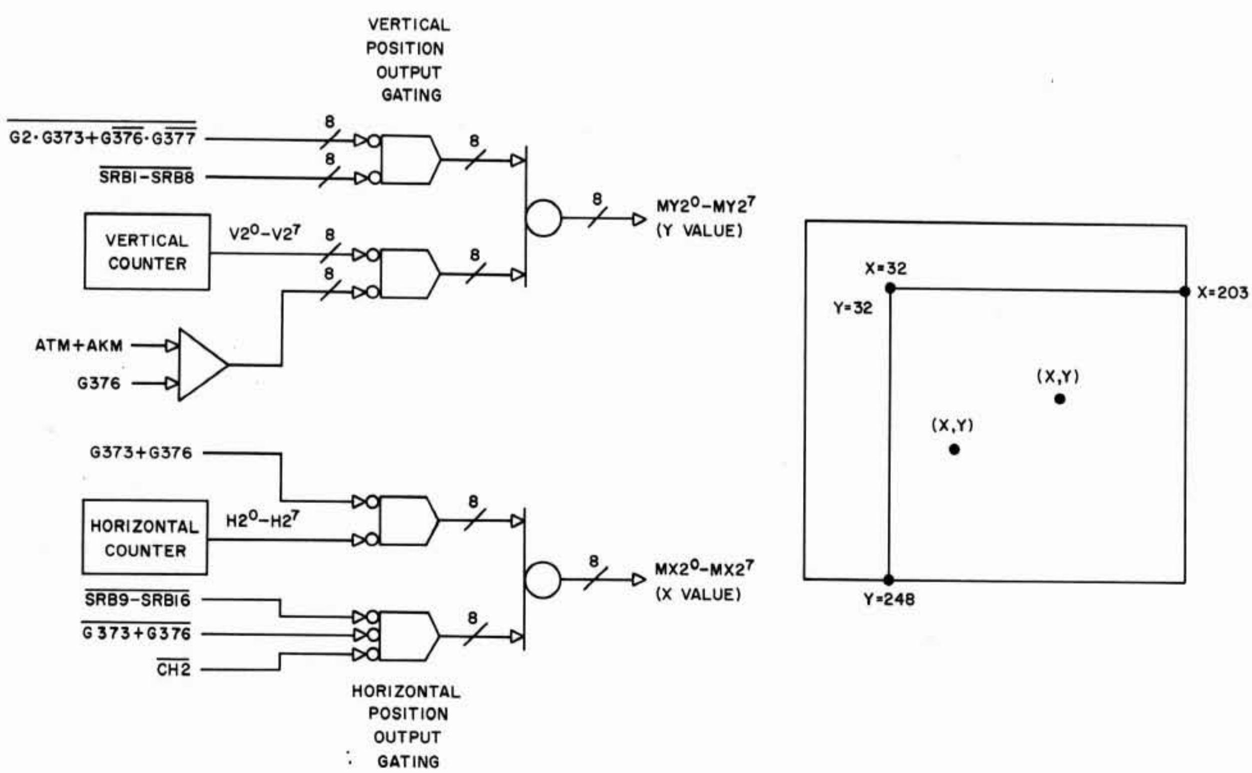
Coded digital information representing a particular symbol or alphanumeric character is converted to analog voltages and amplified by the character selection circuits. The analog signals are applied to the electrostatic plates of the Typotron tube, causing the write gun beam to be channeled through one of the character-forming stencils in the character matrix. The resulting shaped beam reproduces the selected character on the face of the display tube.

In tabular or keyboard modes, four 6-bit characters (figure 4-16) are transferred from the 24-bit register to selection gates as TK1, TK2, TK3, and TK4 characters. In graph modes the selection output gates receive the coded graph symbol. At the addressed console $\overline{CONSOLE}$



4166–33

Figure 4-14. Graph Plotting Submode, Simplified Logic Diagram



4166–34

Figure 4-15. Graph Jump Scan Submode, Simplified Logic Diagram

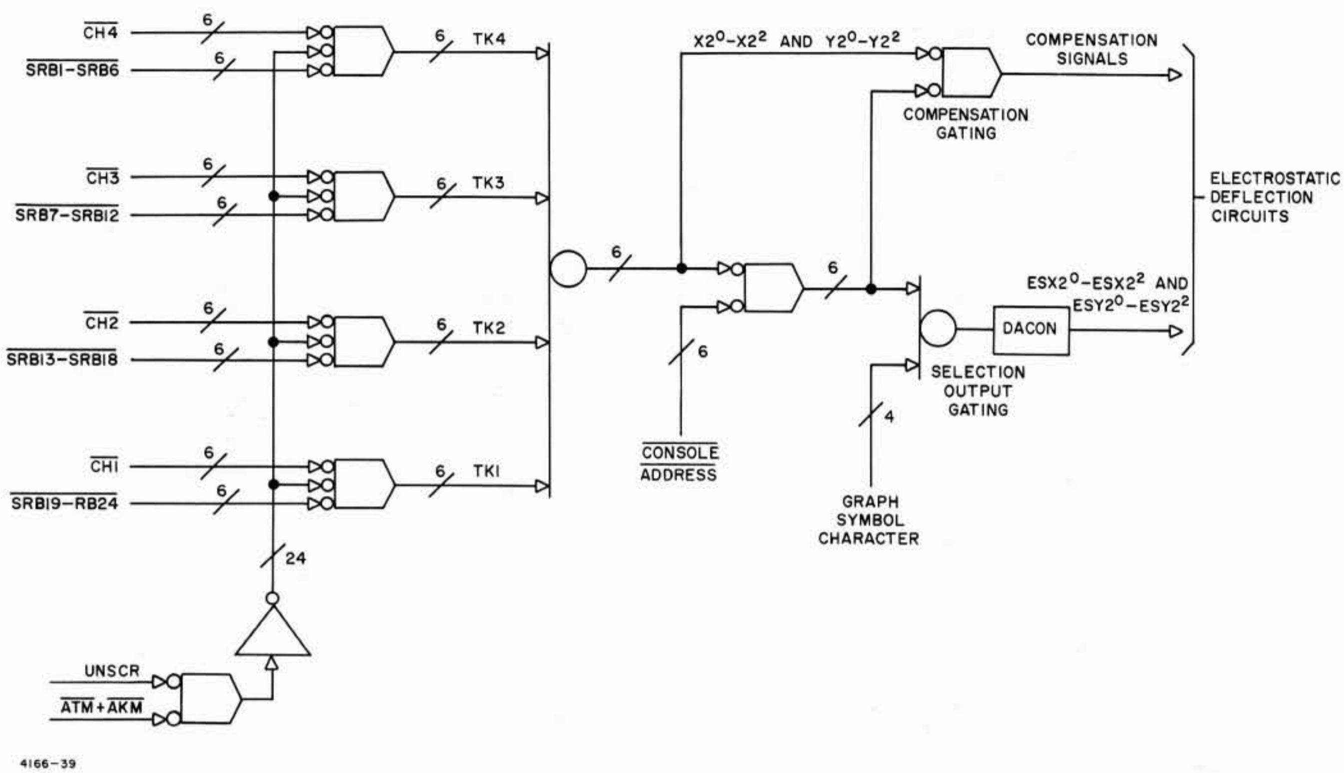


Figure 4-16. Character Selection, Simplified Logic Diagram

ADDRESS gates the digital character to digital-to-analog converters (DACON) where it is converted, amplified, and applied to the selection and compensation plates of the Typotron tube. Compensation gating is provided to correct for any positional displacement of characters located at the corners of the matrix resulting from compensation lens distortion in the Typotron tube.

2.11 Clear/Erase and Unblanking Function

(See figure 6-5)

2.11.1 CLEAR/ERASE LOGIC

The clear/erase logic provides the circuits to erase the storage tube display when the ERASE switch on the console is pressed or a CLEAR DISPLAY signal is received from the computer system. Logic is provided to reduce the output of the positive high voltage supply (view screen voltage of 8500V) when erasing the tube display to prevent a white flash on the screen. The positive high voltage is also reduced when a card is not inserted in the card reader or by using the HV DOWN switch on the non-storage mode panel of the electrostatic deflection assembly. Storage registers in the display system are reset by MAIN CLEAR A which is generated when power sequencing is complete (figure 6-5) and MAIN CLEAR B which is generated each time MAIN CLEAR A is active or a CLEAR DISPLAY signal is received from the computer system.

A CLEAR DISPLAY signal from the computer system is enabled by a CONSOLE ADDRESS signal and gate E-20 (figure 6-5) is not inhibited by the non-store signal. The output of E-20 sets flip-flop E-22. The ERASE switch (7, figure 3-4) ground signal also sets flip-flop E-22. When set, flip-flop E-22 starts the clear/erase sequence. See figure 4-17 for the clear/erase operational sequence. A composite clear/erase pulse is generated jointly by the clear and erase amplifiers and applied to the Typotron tube backing electrode. Refer to paragraph 3.2 of Section II for a detailed description of the clear and erase amplifiers.

2.11.2 UNBLANKING LOGIC

Unblank logic contains the control circuits to unblank the tube while writing graphic or tabular characters. The output of the unblanking logic is applied to the unblank amplifier which turns on the writing beam of the tube.

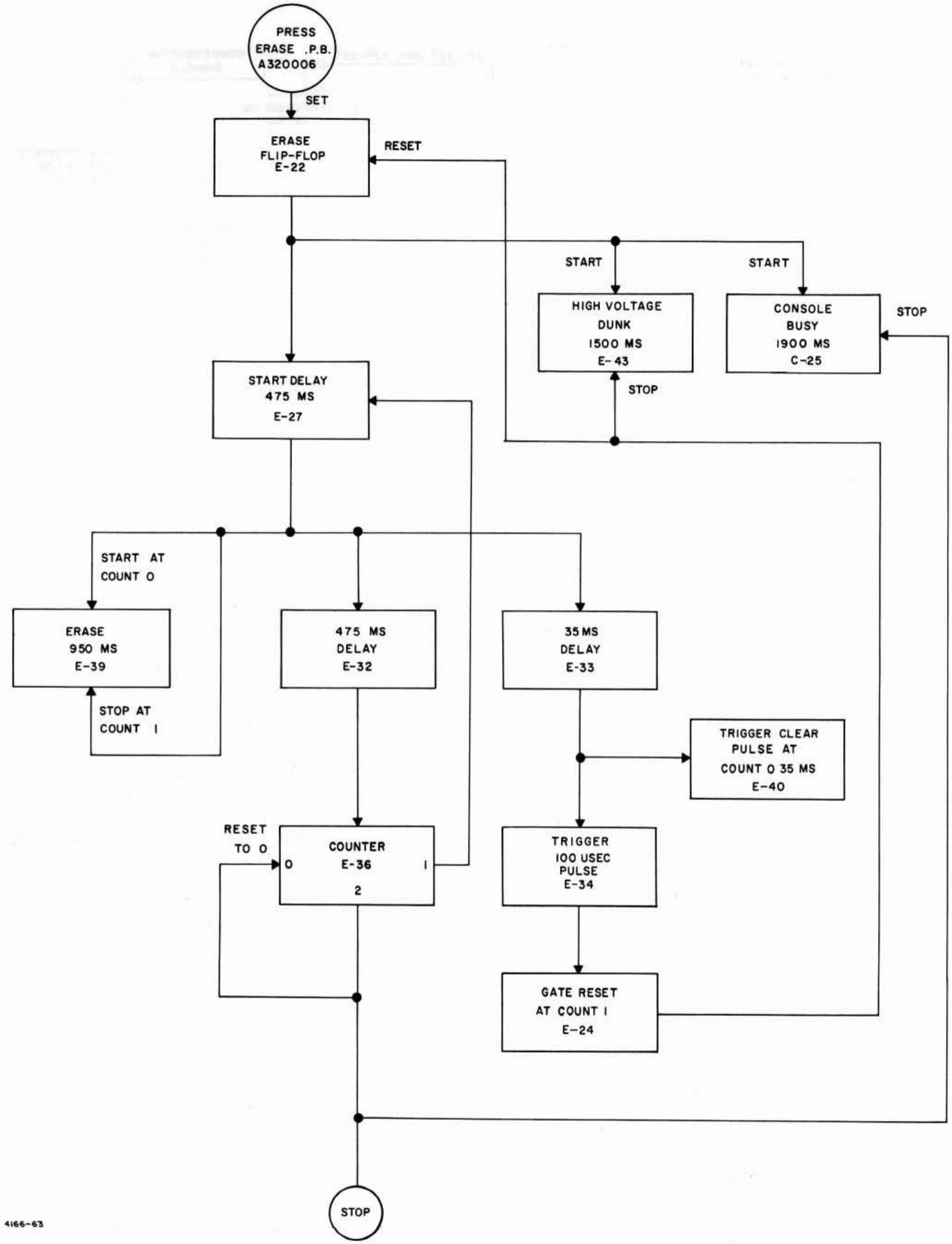


Figure 4-17. Clear/Erase Sequence, Flow Chart

Unblanking signals are provided by either gate E-9 or E-10 (figure 6-5) depending on the mode of operation. Gate E-9 is enabled by any tabular mode (ATM) signal during phase counts ϕ11-ϕ14 as denoted by ($\overline{\phi 11\text{-}14}$)A. This represents approximately 50 μsec unblanking time since the clock is operating at the C/2 rate (figure 4-5). Gate E-10 is enabled during any tabular mode and phase counts ϕ7-ϕ14 as denoted by ($\overline{\phi 11\text{-}14}$) B + ($\overline{\phi 7\text{-}14}$). Since the clock is operating at the C rate (figure 4-5), this again represents approximately 50 μsec.

Unblanking is inhibited by gate E-12 during any of the following conditions:

a. The console is busy (CSL BUSY) when the Typotron tube has not been turned on or the Typotron tube is being erased.

b. When an underscore is not to be written following the displayed character in the keyboard compose and keyboard self-check modes (INH UNBC UNSCR).

c. Horizontal end of line (HEL) is decoded.

d. During character count 1 when in the jump scan submode or the x-coordinate or y-coordinate submodes [CH1 (G373 + G376 + G377)].

e. Vertical last line (VLL) is decoded.

The unblank signal is applied through gate E-19 to the unblank amplifier when CRT Power Switch is on ($\overline{\text{CRT POWER ON}}$) and the display console is addressed ($\overline{\text{CONSOLE ADDRESS}}$).

2.12 Display Tube Power and Bias Control Function

(See figure 6-13.)

The display tube, power and bias control function controls the filament, high voltage, bias, ac sense, and extended storage circuits for the display tube.

2.12.1 FILAMENT CONTROL

Primary power is applied to the filament transformer T1 when the console power circuit breakers on the Power Sequencer Assembly and Auxiliary Sequencer Assembly are activated. Transformer T1 supplies 6.3 vac filament power directly to the x-, y- selection and x-, y-compensation power amplifier tubes of the Electrostatic Deflection Assembly and to the flood gun of the display tube when relay K3 of the Power Control Assembly is energized. The special filament operating voltage required by the electrostatic deflection clear amplifier is provided by returning the secondary winding center tap T1-6 to 80 volts dc. Relay K3 also controls the application of primary power to the High Voltage Power Supplies, PS323101 and PS323201, and to the ac sensing isolation transformer T2. When the display system power on sequence has been completed, and the delayed -28 volts routed through the interlocking circuit is present, the CRT POWER indicator (2, figure 3-4) lights yellow. The display tube power on sequence is initiated by pressing the CRT POWER switch (2). This supplies -28 volts through interlock switch S3 to energize relays K1 and K3, and applies -28 volts to light the CRT POWER indicator white. Relay K3 applies filament voltage to the Typotron tube flood gun, primary power to the high voltage power supplies, and running time meter (M321001), and primary power to the ac sensing isolation transformer. Relay K1 (2 minute time delay) delays the application of primary power to the high voltage filament transformer, which supplies filament power to the display tube write gun, until the display tube operating voltages have stabilized. After filament power has been applied to the write gun, an additional 1 minute delay is generated by Relay K2 before the Typotron tube becomes operational. At the end of this 1 minute delay, the $\overline{\text{DVST READY}}$ signal is generated and the CRT POWER indicator lights green.

2.12.2 HIGH VOLTAGE AND BIAS CONTROL

The positive and negative high voltage power supplies provide operating dc voltages to the display tube. These operating voltages are applied through the display tube bias adjustment circuits consisting of control potentiometers R320001 through R320008 and resistor, capacitor, and rectifier networks located on terminal boards TB320002 and TB320003. A switch S320001 and meter M320001 are provided which aid in the adjustment of bias voltage circuits.

2.12.3 AC SENSING

The ac sensing circuit provides indication to the logic circuits of the status of the high voltage power supplies primary power. Output of the isolation transformer T2 is rectified by CR15 and applied across ac sense sensitivity potentiometer R14 to the base of transistor Q2 causing Q2 to cut-off. Placing Q2 into cut-off biases transistor Q3 into conduction to complete the dc path to dc return and energize relay K7. Contacts of relay K7 close to allow capacitor C1 to charge to +26 volts through CR16 and R15. Other contacts of relay K7 enable the energizing of K2 which energizes after the two minute time delay relay K1 energizes. Relay K2, a one minute time delay, which when energized, causes the CRT POWER indicator to change from white (CRT power in sequence) to green (CRT power sequence complete), and provides a display tube ready ($\overline{\text{DVST READY}}$) signal to the logic circuits. If the primary power to the display tube circuits should fail transistor Q2 will conduct when loss of ac power at transformer T2 is sensed. When transistor Q2 conducts relay K7 deenergizes which changes indication of CRT POWER indicator from green to yellow, energizes relay K5, and applies +26 volt discharge potential from C1 to the magnetic deflection circuits to off-set the write beam to the left of the display area to prevent overwriting on the display tube storage surface. When relay K5 is energized it turns off the flood gun by connecting -300 volts to the control grid of the flood gun through the view bias control network of R0008 and R0011.

2.12.4 EXTENDED STORAGE

Extended storage is provided by amplifier A1, backing electrode dc level potentiometer R8, clamp level potentiometer R5, decay rate input potentiometer R2, and associated circuits. Amplifier A1, functioning as an integrator, supplies a decreasing voltage through the backing electrode dc level potentiometer R8 to the display tube backing electrode. The output of amplifier A1 is decreased at a rate determined by decay rate potentiometer R2 and the minimum voltage level is determined by clamp level potentiometer R5. A RESET EXTENDED STORAGE or INHIBIT DURING NON-STORAGE signal cuts-off transistor Q1. When Q1 cuts off, relay K8 deenergizes causing amplifier A1 to be reset. An INHIBIT DURING NON-STORAGE signal is produced by the operation of the non-storage mode select switches of the Electrostatic Deflection Assembly. A RESET EXTENDED STORAGE signal is generated each time high voltage is cut off (DUNK HIV) when erasing the display or card is not inserted in the card reader.

2.13 Ac Power Distribution Function

(See figure 6-14.)

Primary ac power to the display set is coupled through radio frequency interference filters FL000030 through FL000033 to the MAIN POWER circuit breaker CB9. The MAIN POWER circuit breaker applies ac power to the Power Sequencer Assembly and Auxiliary Sequencer Assembly circuit breakers located in cabinets 30 and 31. The Power Sequencer Assembly circuit breakers CB1 through CB4 connect ac power to the cabinet 30 power supply power sequencing relays K22 through K25; circuit breaker CB5 applies ac power to the assemblies and blower of display console 1; circuit breaker CB6 applies ac power to the cabinet 30 blowers, sequencer, running time meter, and -28 volt control power supply; circuit breaker CB7 applies ac power to the convenience outlets of display console 1; and circuit breaker CB8 applies ac power to the convenience outlets of display cabinet 30. The Auxiliary Sequencer Assembly circuit breakers CB1, CB2, and CB3 connect ac power to the cabinet 31 power supply power sequencing relays K1, K2, and K3; circuit breakers CB4 and CB7 apply ac power to the assemblies, blowers and convenience outlets of cabinet 31 and console No. 2; circuit breakers CB5 and CB8 apply ac power to assemblies, blowers, and convenience outlets of consoles No. 3 and No. 4; and circuit breakers CB6 and CB9 apply ac power to assemblies, blowers, and convenience outlets of consoles No. 5 and No. 6.

2.14 Power Supply Sequencing Function

(See figure 6-15.)

The power supply sequencer assembly controls the automatic on-off sequencing of the display set power supplies and provides continual indication of power supply operation. Over and under voltage detection circuits also monitor the power supplies to provide protection for the modules in the event of power supply malfunction.

2. 14. 1 TURN-ON SEQUENCE

MAIN POWER circuit breaker CB9, power supply and blower circuit breakers CB1 through CB6 of the Power Sequencer Assembly, and power supply and blower circuit breakers CB1 through CB6 of the Auxiliary Sequencer Assembly control the primary ac power to the display set power supplies and blowers. When these circuit breakers are activated, and the blowers of the display cabinet and display consoles are operating correctly, -28 volt dc power is available at the Power Sequencer Assembly control and indicator circuits. The -28 volt dc power from the Power Sequencer Assembly is coupled through the circuit breaker interlock switches of the display cabinet to energize relays K28 and K18. Contacts of relay K18 complete the circuit to energize relays K8 and K9 which place the display set in standby condition. Relay K8 enables the sequencer controls and relays K28 and K9 complete the dc path to the DC POWER ON switch-indicator, lighting it yellow.

2. 14. 2 POWER-ON SEQUENCE

When the DC POWER ON indicator is lighted yellow, activation of the DC POWER ON switch initiates the power on sequence, by energizing relays K7 and K26. Relay K7 energizes, causing the DC POWER ON indicator to light white to indicate that power-on sequence is in progress. Relay K7 also energizes relays K1 (Auxiliary Sequencer Assembly) and K22 (Power Sequencer Assembly). Relay K22 locks-up relay K26 and applies ac power to -6. 5 VDC Power Supplies 1 and 2; relay K1 applies ac power to -6. 5 VDC Power Supplies 3 and 4. The output of the -6. 5v power supplies energize relays K12 through K15, completing the circuit to energize relays K2 (Auxiliary Sequencer Assembly) and K23 (Power Sequencer Assembly) and light the POWER SUPPLY STATUS -6. 5 VDC indicators (21, figure 3-1). Relay K23 applies ac power to -26 VDC Power Supplies 1 and 2, and relay K2 applies ac power to -26 VDC Power Supplies 3 and 4. The output of the -26 v power supplies energize relays K1 through K4, completing the circuit to energize relays K3 (Auxiliary Sequencer Assembly) and K24 (Power Sequencer Assembly) and light the POWER SUPPLY STATUS -26 VDC indicators (20). Relay K23 applies ac power to +26 VDC Power Supply No. 1 and relay K3 applies ac power to +26 VDC Power Supply No. 2. The output of the +26 v power supplies energize relays K5 and K6, completing the circuit to relay K25 and light the POWER SUPPLY STATUS +26 VDC indicators (19). Relay K25 applies ac power to the +300 VDC Power Supply and -300 VDC Power Supply. The output of the 300v power supplies energize relays K16 and K17, completing the circuit to energize relays K10 and K21, and light the POWER SUPPLY STATUS -300 VDC and +300 VDC indicators (17 and 18). Energizing relay K10 causes the DC POWER ON indicator to light green to indicate completion of the power-on sequence, and starts the display set clock T-3 (figure 6-11). Relay K10 also inhibits the deenergizing of relay K18 when time delay relay K26 energizes. Relay K21 deenergizes relay K7 which extinguishes the DC POWER ON white light, and removes the parallel power path to relay K22 to enable the power turn-off sequence. Relay K26 is a six-second time delay relay which limits the time allotted to the power-on sequence. If relay K26 energizes before the power-on sequence has been completed, a short circuit is placed across relay K18. When relay K18 is deenergized the power-on sequence is terminated and a power-off sequence is initiated, thereby setting the sequence back to standby condition (DC POWER ON indicator lights yellow).

2. 14. 3 POWER-OFF SEQUENCE

The power-off sequence is the reverse of the power-on sequence; the 300 v power supplies are turned off first, the +26 v power second, the -26 v power supplies third, and the -6. 5 v power supplies last. When the DC POWER OFF switch is activated it short circuits relay K18 which deenergizes and causes the DC POWER OFF indicator to light red. With relay K18 deenergized the circuit to relays K8 and K9 is opened which in turn deenergize relays K10, and K21. Relay K21 deenergizes relay K25 which removes ac power from the +300 and -300 volt power supplies, causing relay K16 and K17 to deenergize. Relays K16 and K17 deenergize relays K3 (Auxiliary Sequencer Assembly) and (K24 Power Sequencer Assembly) and extinguish POWER SUPPLY STATUS indicators -300 VDC and +300 VDC (17 and 18, figure 3-1). Relay K3 removes ac power from +26 VDC Power Supply No. 2 and relay K24 removes ac power from +26 VDC Power Supply No. 1 which deenergizes relays K5 and K6. Relays K5 and K6 deenergize relays K2 (Auxiliary Sequencer Assembly) and K23 (Power Sequencer Assembly) and extinguish POWER SUPPLY STATUS indicators +26 VDC (19). Relay K2 removes ac power from -26 VDC Power Supplies No. 3 and No. 4 and relay K23 removes ac power from -26 VDC Power Supplies No. 1 and No. 2, which in turn deenergize relays K1 through K4.

Relays K1 through K4 deenergize relays K1 (Auxiliary Sequencer Assembly) and K22 (Power Sequencer Assembly) and extinguish POWER SUPPLY STATUS indicators -26 VDC (20). Relay K1 removes ac power from -6.5 VDC Power Supplies No. 3 and No. 4 and relay K22 removes ac power from -6.5 VDC Power Supplies No. 1 and No. 2, which in turn deenergize relays K12 through K15. Relays K12 through K15 extinguish POWER SUPPLY STATUS indicators -6.5 VDC (21). After the power-off sequence is complete it is necessary to press the DC POWER OFF switch again to set the equipment in the standby condition. If the power-off sequence is initiated from one of the display consoles the console DC POWER OFF indicator lights red, the Power Sequencer Assembly DC POWER OFF indicator lights yellow, and the CONSOLE POWER OFF SWITCH STATUS indicator (15) for the respective console lights red. Then to reestablish the standby status it is necessary to press the DC POWER OFF switch of the indicated console. If the INHIBIT switch (16) has been activated power cannot be turned off at the console until the INHIBIT switch has been reset. The INHIBIT switch also prevents any blower vane switch failure from turning off power.

2.14.4 DC POWER MONITORING

The power sequencer dc power monitoring circuits provide circuit protection against erratic dc voltage fluctuations of all dc power sources after the power-on sequence has been completed. With the exception of the 300 volt supplies, all dc power supplies are monitored by each differential amplifier OR gate input. An overvoltage differential amplifier consisting of transistors Q1 and Q2 controls relay K19, and an undervoltage differential amplifier consisting of transistors Q4 and Q5 controls relay K20. Each amplifier has an adjustable reference voltage input and a voltage sensing OR gate input. Normally transistors Q2 and Q4 are conducting keeping relays K19 and K20 energized, and transistors Q1 and Q5 are cut-off. Any input to the overvoltage OR gate (diodes CR37 through CR45) of a potential more negative than -7.3 volts, constitutes an over voltage condition and turns on transistor Q1. Transistor Q2 is turned off, causing relay K19 to deenergize. Any input to the under voltage OR gate (diodes CR48 through CR56) of a potential less negative than -5.5 volts causes transistor Q4 to turn off and relay K20 to deenergize. Deenergizing either relay K19 or K20 completes the circuit to relay K11 which removes the dc return from relay K22 through K25 causing shut down of all dc power supplies. Relay kill discharges +26V PS1 and 2 thru R67, R68 to assure that this voltage decays more rapidly than the negative voltages.

2.14.5 BLOWER VANE PROTECTION

The cabinets and consoles are equipped with air circulation sensing protective devices which remove dc power from the cabinets and consoles when the blower air stream diminishes below operate-safe minimum. This protection circuit comprises air vane switches in each cabinet and console blower, a time delay relay, and isolation diodes for console power off indicators. The blower vane switches sense fluctuations and loss of air stream, the time delay relay distinguishes between air stream fluctuations and damaging loss, and the isolation diodes separate the indicator circuits to provide individual indication of defective console. The sensing switches in cabinet blowers B300001, B300002, B310001, and B310002 are connected in parallel to apply -28 VDC return to the coil of time delay relay K310001, when the air stream is insufficient to provide adequate cooling. When relay K310001 energizes, contacts 2-4 close and connect -28 VDC return to terminal 1 of relay K300318 which causes relay K300318 to deenergize and thereby sequence the dc power supplies off. This returns the system to a standby condition. The isolation diodes CR2 through CR7 provide an OR circuit for the console power off indicators to provide individual indication of console conditions. If a console blower vane switch remains closed for a period in excess of the time delay relay K310001 setting the time delay relay will energize by the conduction path setup through the defective consoles respective diode and the associated power off indicator will light red.

2.15 Dc Power Distribution Function

(See figure 6-16.)

All display set dc power is generated by power supplies PS0101, PS1301, PS1501, PS1701, PS1901, PS2101, and PS2301 locate in the Logic and Power Supply Cabinet 30; and power supplies PS1501, PS1701, PS1901, PS2101 and PS2301 locate in the Simulator and Power Supply Cabinet 31. DC power is distributed to all logic and analog circuits in the display cabinets and consoles.

3. FLOW DIAGRAMS

Flow charts which systematically illustrate the sequence of logic events required to produce the graphic and tabular modes of operation are provided by figures 4-18 through 4-26. Figures 4-18 and 4-19 illustrate the graph mode submode routines which determine the submode and the coordinate values of graphic display. Figures 4-20 through 4-26 illustrate the tabular mode keyboard operating characteristics.

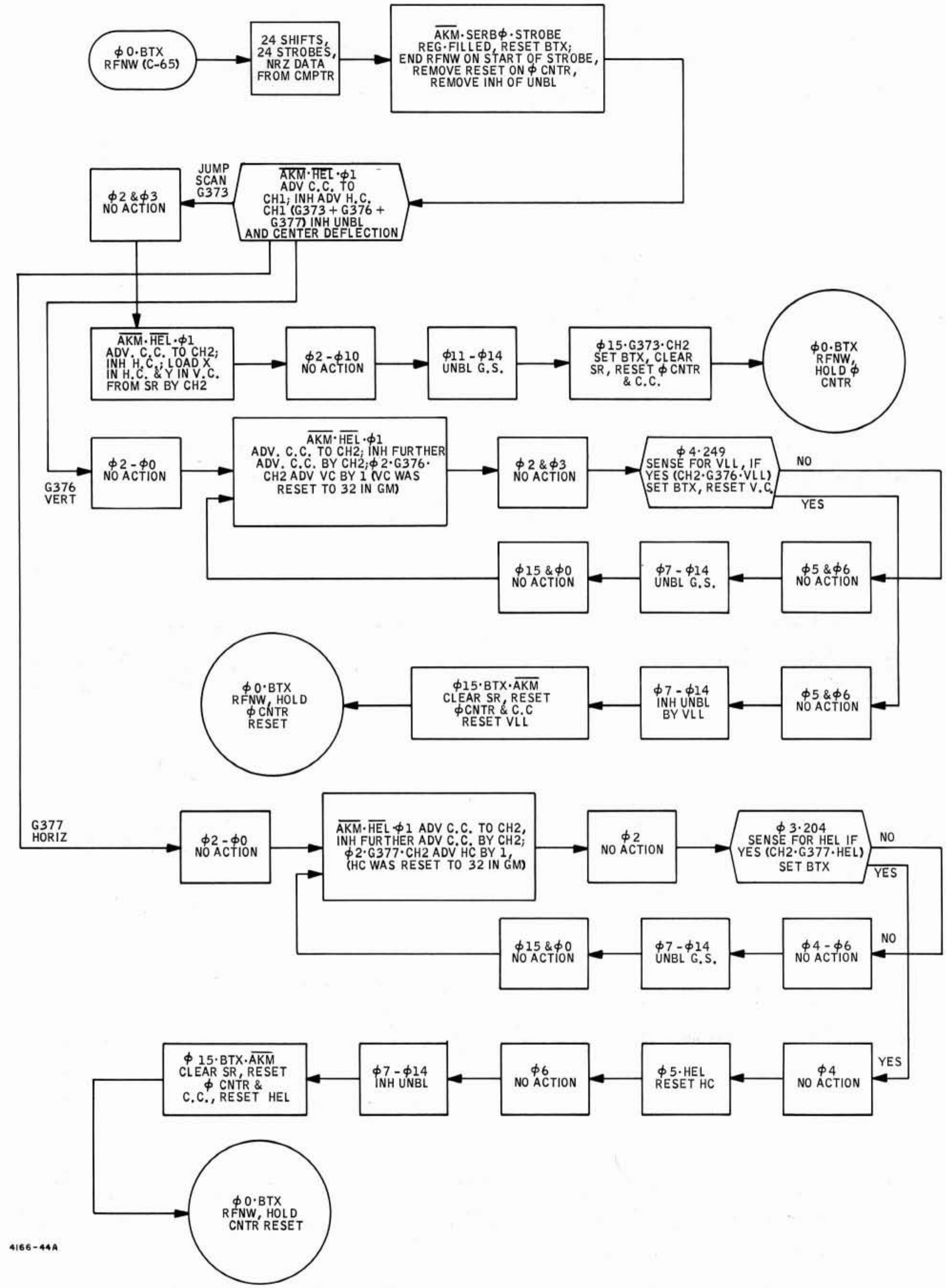


Figure 4-18. Graph Mode; Jump Scan, Vertical, and Horizontal Coordinate Submodes, Display Logic Flow Chart

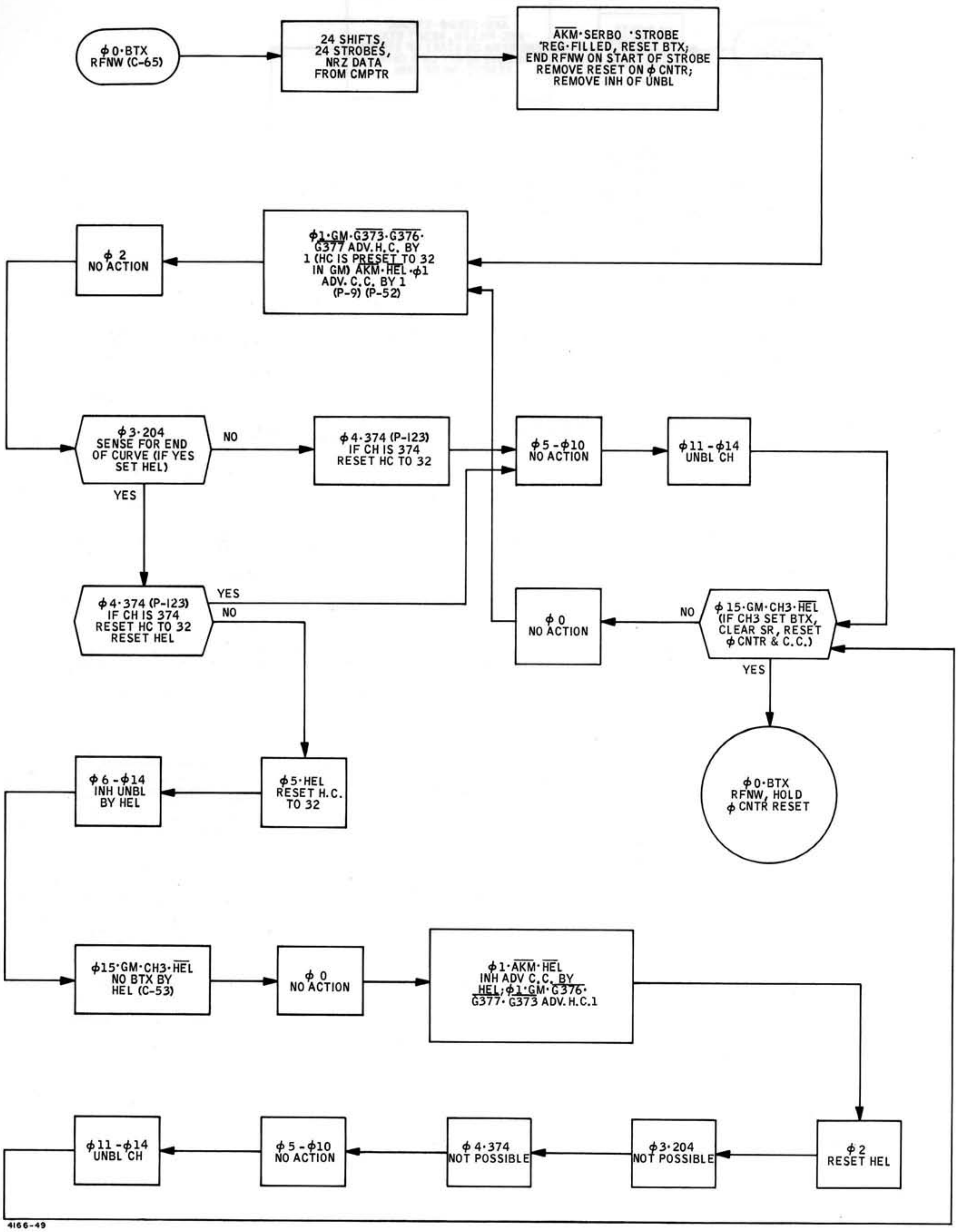


Figure 4-19. Graph Mode, No Submode, Display Logic Flow Chart.

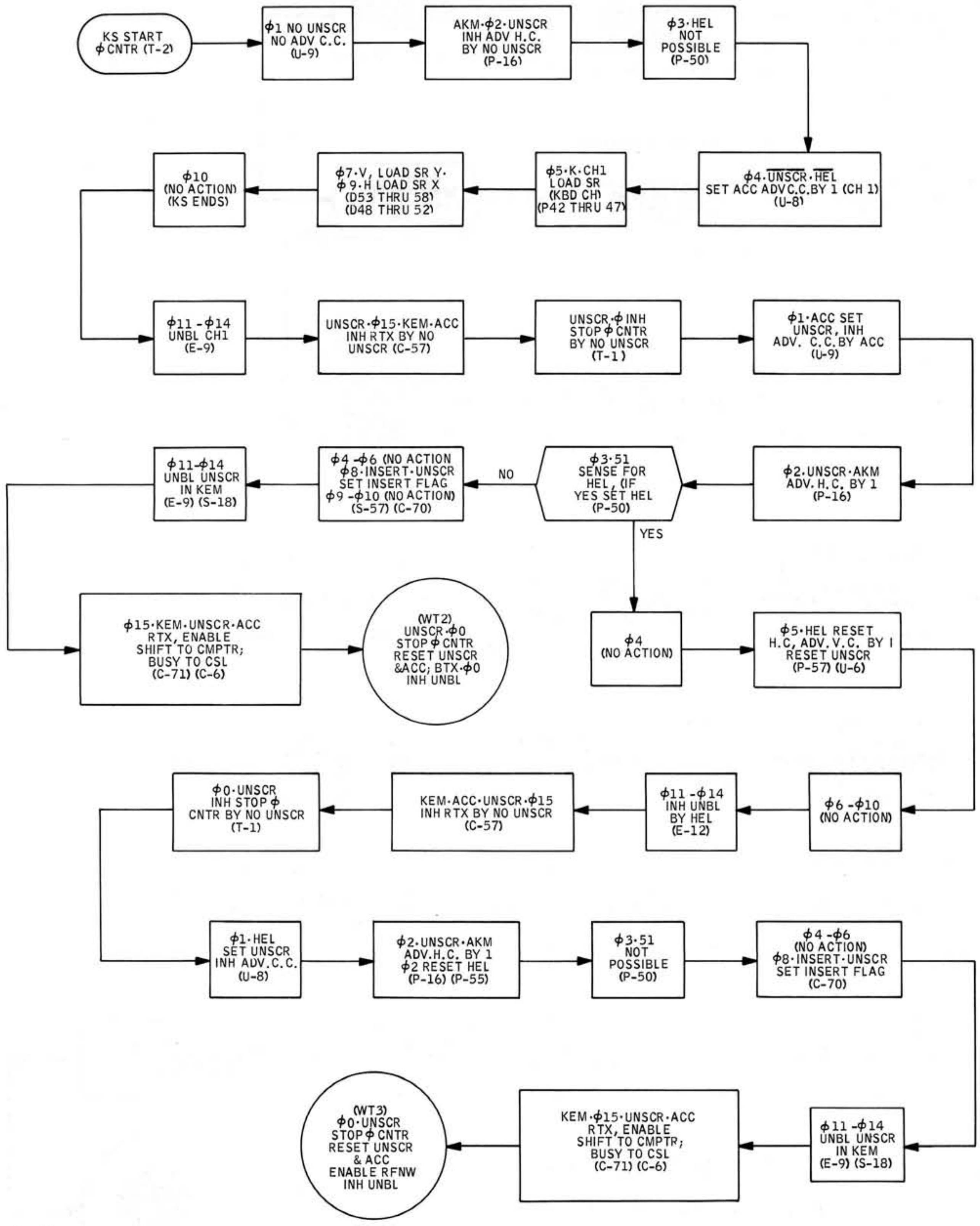


Figure 4-20. Keyboard Edit Mode, Any Key Other than Space Bar and End-of-Line, Display Logic Flow Chart

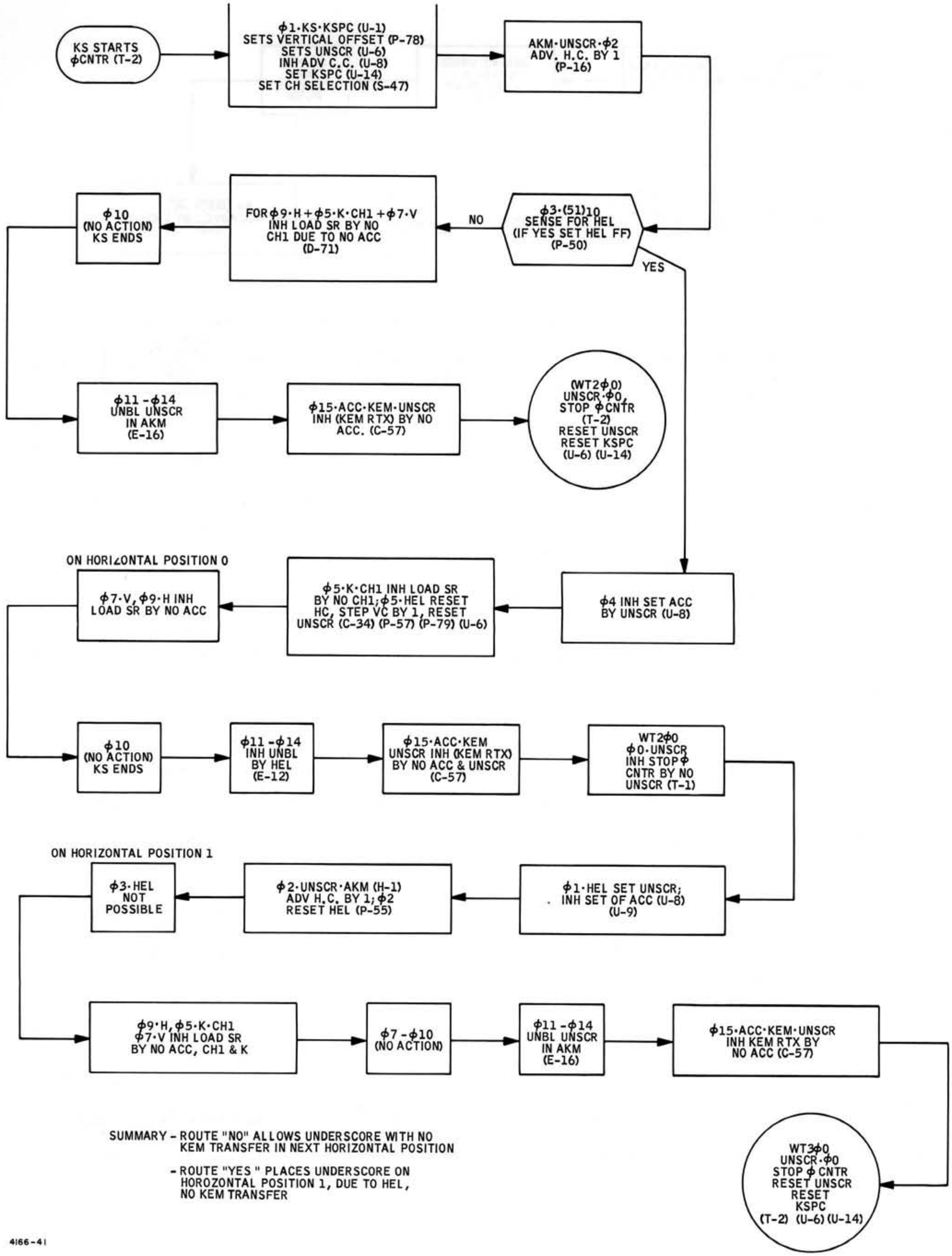


Figure 4-21. Keyboard Edit Mode, Space Bar, Display Logic Flow Chart

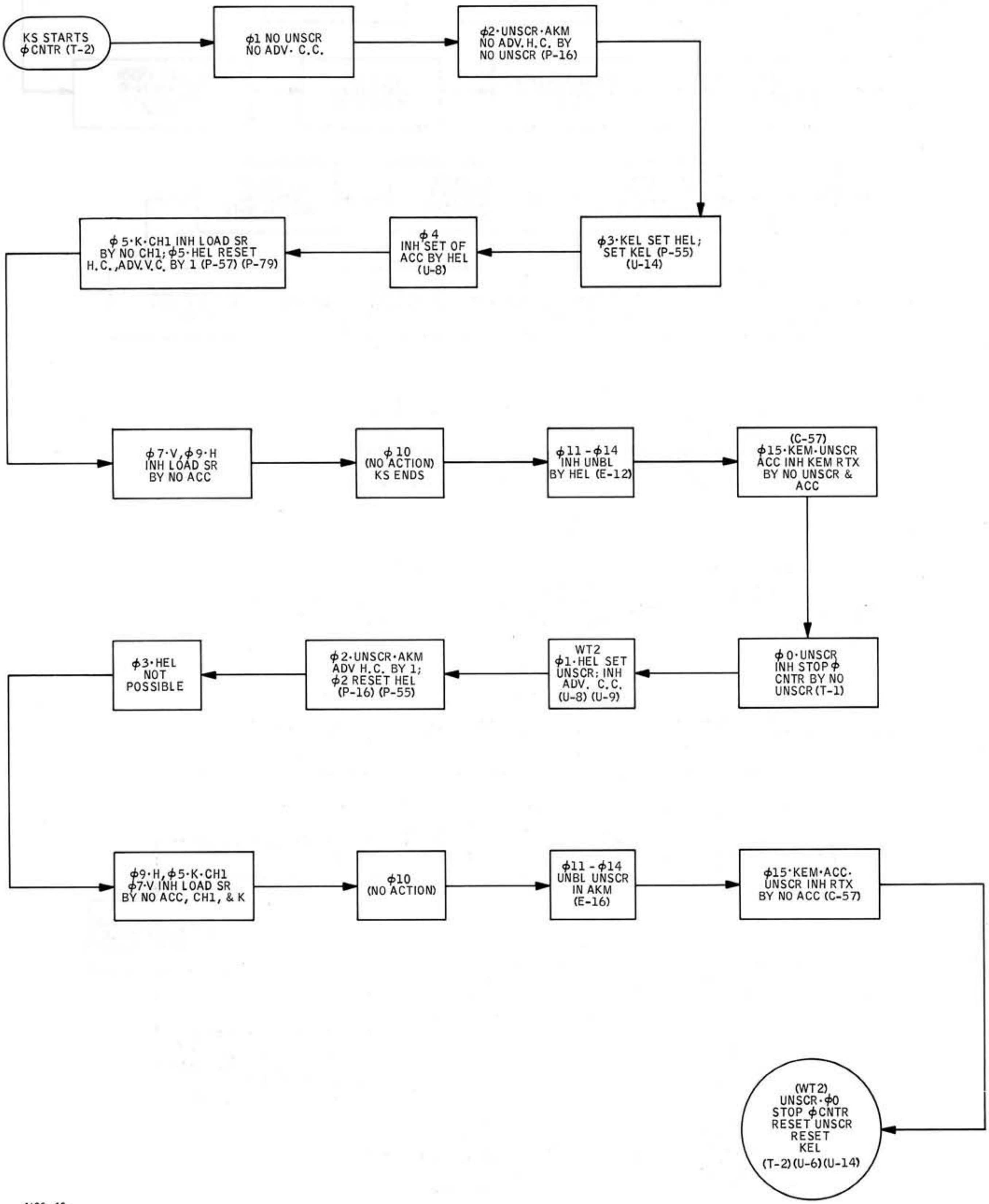


Figure 4-22. Keyboard Edit Mode, End-of-Line Key, Display Logic Flow Chart.

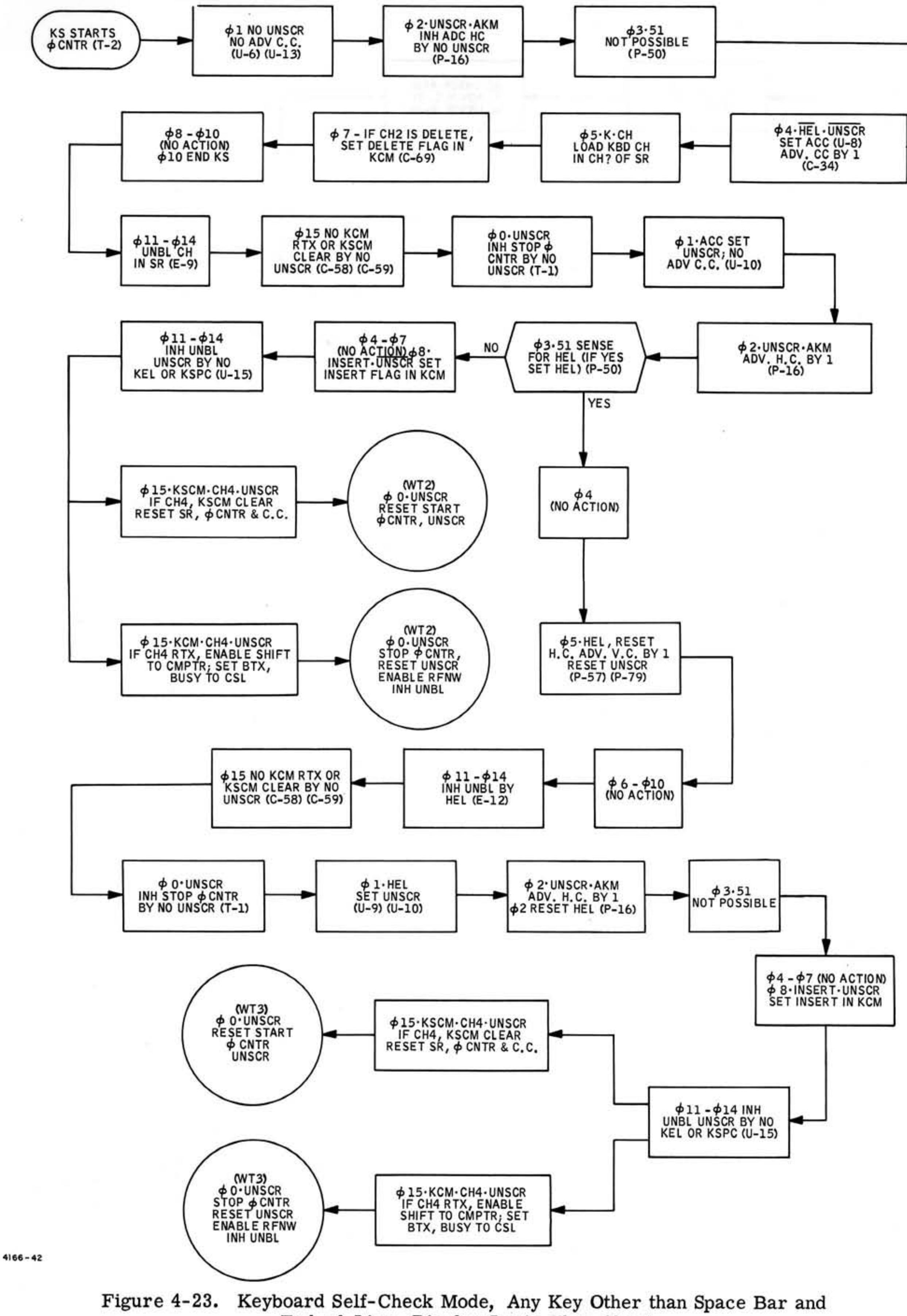


Figure 4-23. Keyboard Self-Check Mode, Any Key Other than Space Bar and End-of-Line, Display Logic Flow Chart

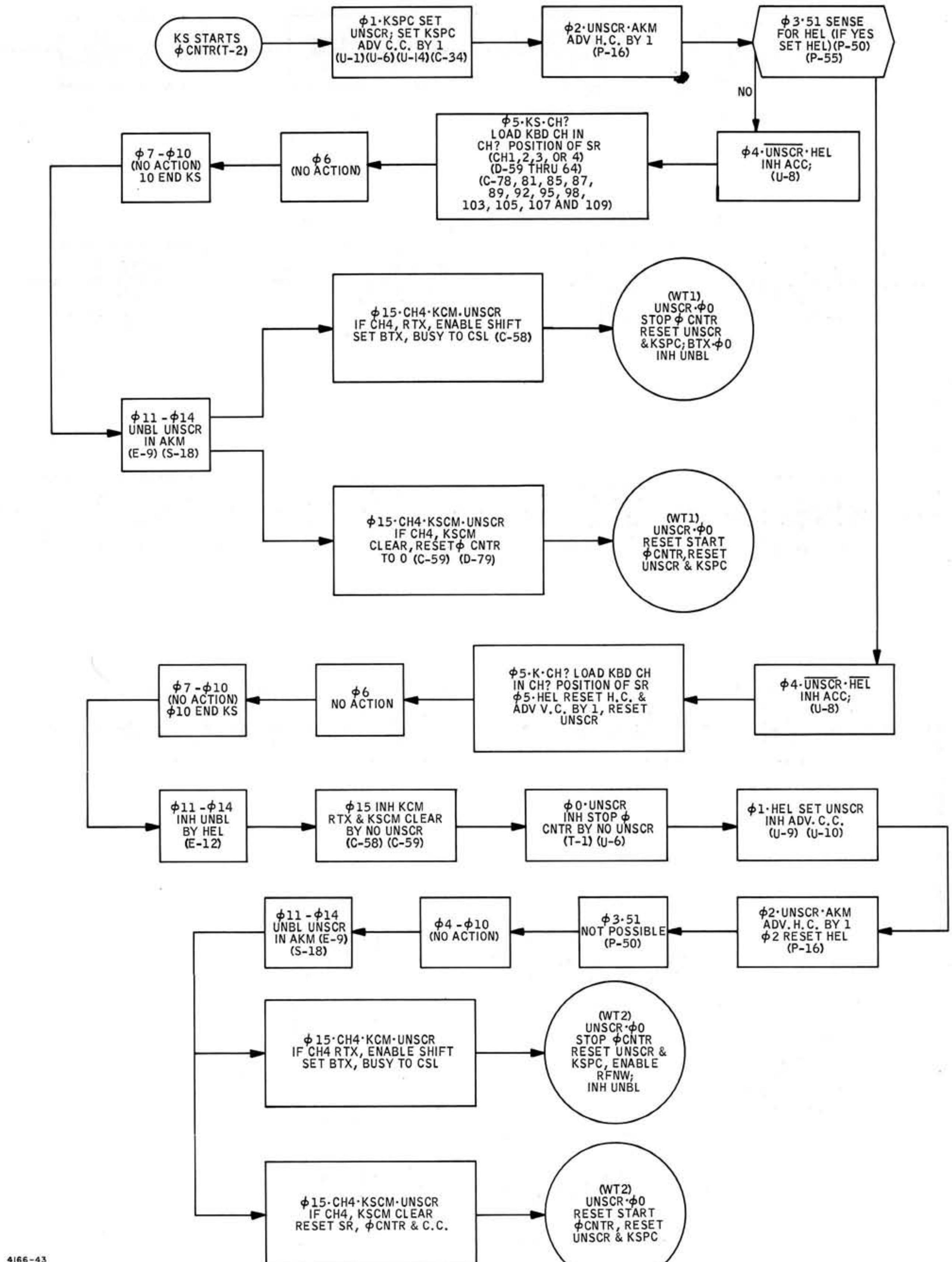


Figure 4-24. Keyboard Self-Check Mode, Space Bar, Display Logic Flow Chart.

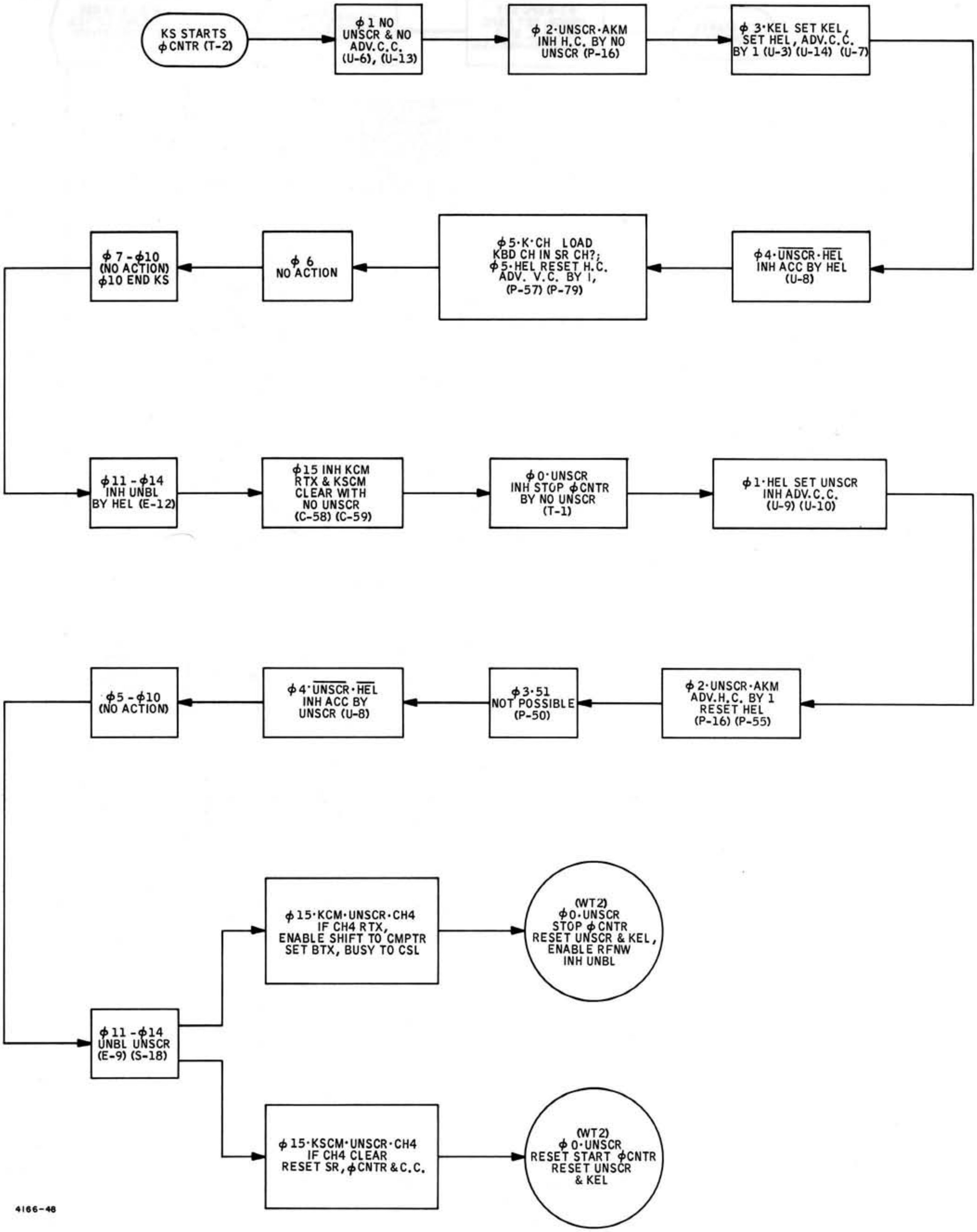


Figure 4-25. Keyboard Self-Check Mode, End-of-Line Key, Display Logic Flow Chart.

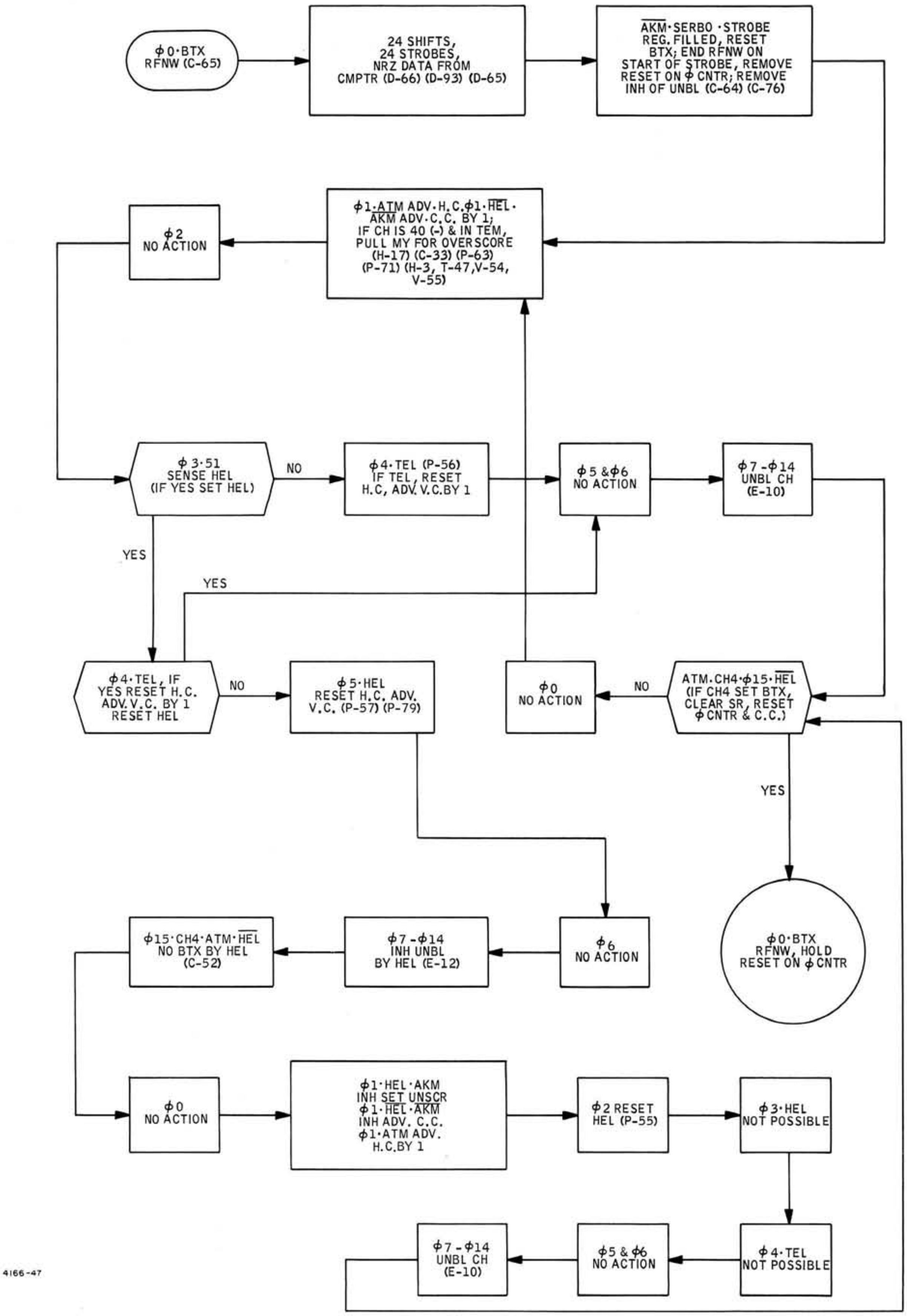


Figure 4-26. Any Tabular Mode, Display Logic Flow Chart

SECTION II

CIRCUIT ANALYSIS OF ELECTRONIC ASSEMBLIES

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SECTION II

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SECTION II
CIRCUIT ANALYSIS OF ELECTRONIC ASSEMBLIES

1. GENERAL

This section contains the detailed circuit description of the major assemblies. The circuit description is prepared to aid you in understanding the individual assembly operation. Detailed theory of common and simple switching circuits has not been included.

2. KEYBOARD CIRCUITS

(See figure 6-23.)

The keyboard is a photoelectric binary coded character selector. These binary codes are transmitted to the logic circuits to position the display tube beam at the corresponding character stencil of the display tube character matrix. When the keys are depressed they actuate shutters which interrupt a light beam produced by lamps DS1 through DS6 which are focused on respective photoconductors. Interruption of the light beam effects a resistance change in the photoconductors V1 through V6. The resistance change controls the conduction of the inverter amplifiers Q9 through Q14 to produce logic signals (-6.5 volt-logical 1 and 0 volts logical 0) which formulate character coded data bits 2^0 through 2^5. These data bits are then processed through the logic circuits to display the selected character. Depressing the character key also activates the strobe pulse generating circuits. The light beam of DS10 changes the resistance of photoconductor V10 which produces a logical signal at the base of transistor Q1. Turning Q1 on and off energizes the pulse forming network consisting of transistor circuits Q2 and Q3 to produce a square pulse with a rise and fall time of nanoseconds and amplitude of -6.5 volts.

The power assist circuits consisting of transistors Q4 through Q8 and solenoids L1 and L2 provide a hold down mechanism which holds each key in the down position for a minimum of 70 milliseconds. This insures proper binary coded outputs by restraining the key lever until the code generated by the depressed shutter is strobed out of the system. The power assist circuit is activated by the strobe pulse output generated by photoconductor circuit of V10. The keyboard strobe circuit output is 70 millisecond minimum pulse width which begins when the key is depressed. At the end of 70 milliseconds the solenoids are de-energized to release the key lever and permit activation of next key.

A keyboard interlock mechanism functions to prevent multiple key lever actuation. The mechanism consists of a slotted channel which freely permits lateral motion of ball bearings contained within the assembly. When a key is depressed the key lever pushes the shutter down into its associated interlock slot. The ball bearings in the interlock are displaced to block all remaining slots and thereby prevent the depression of any other keylever except the shift key until the first keylever is returned to normal position.

3. ELECTROSTATIC DEFLECTION CIRCUITS

(See figure 6-17.)

The electrostatic deflection assembly contains the unblank, clear, and erase amplifiers, digital-to-analog (D/A) conversion circuits, non-store mode switches and relays, and four similar deflection amplifiers used to drive the electrostatic selection and compensation deflection plates of the typotron tube.

3.1 Unblank Amplifier

The unblank amplifier (figure 6-17, sheet 1) generates a positive pulse of sufficient amplitude to overcome the negative control grid bias of the typotron tube write gun, enabling emission of the high-energy write beam. The unblanking pulse is coupled to the write gun control grid through capacitor C0001 (TB320003, figure 6-13) and superimposed on the dc voltage level established at resistor R0014 by the setting of R0007. Zener diodes CR0005 and CR0006 establish voltage reference level of DVST cathode. Maximum positive excursion of the control grid voltage is limited by diode CR0001. Peak-to-peak amplitude of the unblanking pulse is adjustable under control of potentiometer R209. Pulse duration is established by the display system logic.

With no signal input (0 vdc), transistors Q29 and Q30 are biased into conduction. The no-output unblank level assumes the voltage determined by the setting of R209. A negative UNBLANK input signal cuts off transistors Q29 and Q30 and the output unblanking pulse rises to an amplitude limited by the resistor network and potentiometer R209. Zener diode CR77 provides over-voltage protection for the unblank amplifiers Q29 and Q30.

3.2 Clear and Erase Amplifiers

(See figure 6-17, sheet 7.)

To erase information stored by the typotron tube, a shaped pulse is generated jointly by the clear and erase amplifiers and applied to the typotron backing electrode. The changes in backing electrode potential are capacitively coupled to the tube's storage surface, driving the storage surface alternately positive and negative, completing the erase operation. The composite erase pulse is of 1000 ms duration: approximately +157 volts for 35 ms and +10 volts for 965 ms (figure 4-27). The quiescent level is +5 volts. CLEAR IN and ERASE IN signals are generated simultaneously by console logic and applied to transistors Q31 and Q32, initiating an erase sequence. The CLEAR IN signal is a positive pulse of 35 ms duration. ERASE IN is a 1000 ms negative pulse.

With the CLEAR IN signal at its negative level, transistor Q31 is forward biased into conduction. The zero volts at the Q31 collector allows tube V7A to conduct, while diode CR53 holds cathode follower V7B at cutoff. No current flows in the V7B cathode circuit and diode CR52 is reverse biased. The ERASE IN signal, at its positive level, causes transistor Q32 to conduct. The Q32 collector approaches 0 volts and reverse biases diode CR56. With diodes CR52 and CR56 reverse biased, the backing electrode dc level is +5 volts, as determined by the setting of potentiometer R8, backing electrode dc level adjust in the Power Control Assembly.

When the CLEAR IN pulse rises to 0 volts, transistor Q31 is cut off and the Q31 collector voltage drops to approximately -26 volts, causing tube V7A to cut off. The V7A plate voltage increases and the positive change is coupled to the grid of tube V7B through diode CR53. Tube V7B conducts. The voltage developed across cathode resistor R230 causes CR52 to conduct and the voltage developed across R230 (series parallel circuit) is coupled through CR52 to R229 and the backing electrode. The degree of conduction of cathode follower V7B, and hence, the output pulse amplitude, is determined by the setting of CLEAR AMPLITUDE potentiometer R216.

The ERASE IN signal dropped to -6.5 volts at the same time that CLEAR IN rose to 0 volts. After 35 ms, CLEAR IN returns to -6.5 volts and the output erase pulse attempts to return to the 5-volt backing electrode dc level. The ERASE IN signal, however, is still negative and cuts off transistor Q32. With Q32 cut off, diode CR56 conducts and holds the backing electrode at +10 volts as determined by the setting of ERASE AMPLITUDE potentiometer R240. When the ERASE IN signal finally returns to 0 volts, transistor Q32 conducts, the Q32 collector voltage reverse biases diode CR56 and the backing electrode potential returns to the nominal dc level (+5 volts).

Because the cathode voltage of tube V7B swings from -26 volts to as high as +163.8 volts, the filaments of tube V7 are operated at an 80 vdc level to reduce the possibility of voltage breakdown between cathode and filaments.

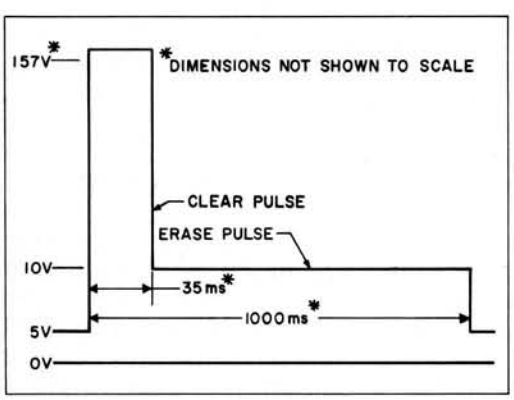

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Figure 4-27. Composite Clear/Erase Pulse

3.3 D/A Converters

(See figure 6-17, sheet 2.)

The D/A conversion circuits consist of three 4.3 volt power supply submodules, six transistor switches, two resistor ladders and a -12.75 volt reference power supply. A six-bit digital character input is converted to X and Y analog voltages and applied to transistors Q2 and Q1 of the X and Y emitter followers, respectively. The regenerative emitter followers provide buffered inputs to the electrostatic deflection plate driver circuits.

3.4 Deflection Plate Driver Circuits

(See figure 6-17, sheets 3, 4, 5, and 6.)

The deflection plate driver circuits are identified as follows: X selection driver, X compensation driver, Y selection driver and Y compensation driver. Since all four deflection plate drivers are similar, only the Y compensation driver is described.

The Y compensation driver circuit operates as a high-gain differential feedback amplifier. A Y signal input is applied to the base of transistors Q23 and Q24 through resistors R140 and R141. With transistor Q24 establishing a reference input through resistor R155, transistors Q23 and Q24 provide emitter follower inputs to the differential amplifier composed of transistors Q25 and Q26. The differential outputs of Q25 and Q26, proportional to each other due to constant current generator Q27, are applied to the grids of tubes V5 and V6. V5 and V6 form another differential amplifier stage and employ transistor Q28 as a constant current generator. The differential outputs of tubes V5 and V6 drive the Y compensation plates of the typotron tube and also provide cross-coupled feedback to the input of the deflection plate driver. The output of tubes V5A and V6A, +Y COMPENSATION, is coupled to the base of transistor Q24 through resistor R151. The output of tubes V5B and V6B, -Y COMPENSATION, is coupled to the base of transistor Q23 through resistor R150.

The average dc voltage level of a pair of deflection plates is defined as one-half the algebraic sum of the two plate voltages. The differential voltage of a pair of deflection plates is defined as the algebraic difference. The single ended voltage of a pair of deflection plates is defined as the voltage of either plate with respect to ground. In the Saturn Display Set, the average dc level for both compensation and selection plates is 50 volts. The maximum required peak-to-peak single ended output of the compensation plates is 143.5 vdc and the selection plates is 105 vdc.

3.5 Alignment Controls

The alignment controls of the electrostatic deflection circuits are described in the subsequent paragraphs.

3.5.1 COMMON MODE (X AND Y SELECTION AND COMPENSATION).

This adjustment does not produce an obvious change to the displayed characters and hence should not be adjusted for visual effect. It is related to the shape of the write beam as it passes through the respective selection or compensation plates. Its operation is similar to that of the astigmatism control on an oscilloscope. If set properly (50 v average) the beam that leaves the selection plates will be circular in cross-section. Misadjustment of the control will change the cross-section of the write beam to that of an ellipse, major in either the X or Y axis depending upon which plate signals are out of adjustment. Correspondingly the beam that passes through the compensation plates can also be distorted. However, now the beam has passed through the matrix and is in the shape of the character selected. Thus, misalignment will cause the character to be distorted by elongation in either the X or Y axis. It must be noted, however, that all character distortion is not produced by misalignment of the common mode adjustments. More often, character distortion is produced by: 1. External fields passing through the write gun structure, either not shielded or at best ineffectively shielded by the write gun shield (perhaps even originating in the write gun shield material itself). 2. Improper matrix voltage causing pin cushioning (voltage too high) or barrelling (voltage too low) of the selected character matrix. 3. Mounting of the deflection yoke too close to the compensation plates allowing the magnetic field of the yoke to interact with the compensation and imaging signals.

3.5.2 X-SELECTION GAIN

This control is adjusted for visual effect and is used in selecting characters on any horizontal row of the matrix. Neglecting the centering and mixing controls or assuming that they are set correctly the operation of the gain control is as follows: Using horizontal row 2 (T, S, /, 0, X, W, V, U) of figure 1-6 as an example, if the gain is set at a minimum (CCW) and characters on this line are selected from the keyboard 0 will be written when T, S, / and 0 are struck and X will be written when X, W, V, and U are struck. With a small increase in gain, it will be found that when T is struck, / is written and when U is struck W is written. Hence, the object is to increase the gain until the T is written when struck, the U is written when struck and the rest of the characters are in turn written when struck. If the gain is increased too far, the + marks (or portions thereof) at each side of the matrix may be written. The gain must be adjusted critically; if it is slightly too large, portions of the next character out may be written along with the selected character;

if it is slightly too small, portions of the next character in may be written along with the selected character. For example, if the gain is too large and the S is struck, the S and portions of the T may be written. If the gain is too small and the S is struck, the S and portions of the / may be written.

3.5.3 Y-SELECTION GAIN

Operation of this control is identical with that of X-Selection Gain control except that its effect is along any vertical column instead of any horizontal row. Using vertical column 1 as an example, when the gain is at minimum, J and / will be selected whenever I, R, A, or J and /, 1, Z or 9 is struck respectively. The gain must be increased from this point until each character (I, R, A, J, /, 1, Z and 9) is written when struck on the keyboard.

3.5.4 X-COMPENSATION GAIN

This control is adjusted for visual effect and is used in setting the horizontal spacing (of any horizontal row of characters of the matrix) between adjacent characters as they are written. With minimum gain the selected row of characters would be written as they appear in the matrix. Again using horizontal row 2 as an example, if the characters were struck in the order they appear (T, S, /, 0, X, W, V, U) in the matrix, they would be written on the tube in that order and appear equally spaced. (Assuming for the time being that X-Compensation Centering and Mixing and Y-Compensation Gain, Centering and Mixing have previously been set properly.) However if T and U were struck alternately, they would not be written equally spaced as TUTUTU, but would have a large displacement between the corresponding T's and U's such as TTT UUU. As the gain is increased, the displacement would be reduced to the point where they finally would become equally spaced, TUTUTU. If the gain is increased beyond this point, cross-over will be reached where the T and U will be written in the same position, U̅ U̅ U̅, and a further increase will result in UUUTTT.

3.5.5 Y-COMPENSATION GAIN

This control has a similar effect to that of the X-Compensation Gain control except it is used to control the vertical displacement (of any vertical column of characters of the matrix) between adjacent characters as they are written. Using vertical column 1 as an example, with minimum gain alternately striking the I and 9 keys would produce I_9 I_9 I_9. The gain should be increased until I9I9I9 is written in a horizontal line with minimum vertical displacement. A further increase in gain from this point will produce I^9 I^9 I^9.

3.5.6 X-SELECTION CENTERING

This control is adjusted for visual effect and is used to center the X selection signal about the proper point in the horizontal direction. Assuming that the horizontal row 2 of characters has been properly selected, turning the control CW will cause a horizontal displacement to the right of the character selected so that with enough centering change the W would be written when the X key is struck, the S written when the T is struck, etc. Turning the control CCW would cause a shift to the left of the character selected, the 0 would be written when the X key is struck, the V written when the U is struck, etc. Thus it is seen that when X-Select Gain is adjusted, X-Select Centering must also be checked for proper alignment.

3.5.7 Y-SELECTION CENTERING

This control has an identical effect to that of the X-Select Centering except that it is used to center the Y selection signal about the proper point in the vertical direction. Assuming that the vertical column 1 has been properly selected, turning the control CW will cause a vertical displacement up and turning the control CCW will cause a vertical displacement down. In the first case an I would be written when the R key is struck; in the second case an A would be written when the R key is struck.

3.5.8 X-COMPENSATION CENTERING

This control can be set up using either an oscilloscope or the visual effect produced on the typotron tube, however, much care must be used when using the latter method. Since the proper setting of the X-Compensation Gain causes all the characters on any horizontal matrix row to be returned to the center line of the write gun, the centering adjustment varies this point of superimposition along the horizontal axis (orthogonal to the centerline). This is seen as a horizontal displacement on the tube of all characters written. Improper adjustment of this control can cause two problems which appear on the typotron tube either independently or together. The first is an inability to completely compensate because the centering adjustment has shifted the output signal out of the linear operating range of the amplifier. This appears as lack of sufficient gain to complete compensation, because an increase in gain does not result in an improvement in compensation. The second is distortion of the written character caused by too great a displacement of the point of superimposition from the centerline of the write gun structure. The centering control can be adjusted visually for minimum character distortion as long as the output signal remains within the linear operating range of the amplifier. Only the centering of the output signal within this linear range of operation can be observed on the oscilloscope.

3.5.9 Y-COMPENSATION CENTERING

The operation of this control is similar to that of the X-Compensation Centering control except that the point of superimposition for characters in any vertical matrix column is shifted along the vertical axis (orthogonal to the centerline) of the write gun and appears on the tube as a vertical displacement of all characters written.

3.5.10 X-SELECTION Y-MIXING

This control is adjusted for visual effect and is used to correct for horizontal skew in the selection of characters in any vertical matrix column caused by mechanical misalignment of the horizontal selection plates. The effects are as follows: Assume that the X-Select Gain and Centering have been adjusted for proper selection of each character in horizontal row 7 of the matrix and Y-Select Gain and Centering have been adjusted for proper selection of each character in vertical column 3. Then as any column is written, a skew to the right or left will be caused by adjustment of the mixing control. Using vertical column 1 as an example, if there is a skew right, the further the selection progresses from horizontal row 7 the worse the selection becomes, the I and R may be properly selected but portions of the left sides of the A, J and / characters may be missing and at the extreme end where the 9 should be selected, only part of the right side of the 9 and almost all of the left side of the 8 would be written whenever the 9 key is struck. Correspondingly with a skew left, the left side of the 9 and almost all of the + would be written when the 9 key is struck. The mixing control is connected such that when adjusted to the middle of its range, no skew correction is made, as the control is adjusted CW or CCW from this point, correction is made for right or left skewing. Hence, this control should be set to the middle of its range when first adjusting gain and centering.

3.5.11 Y-SELECTION X-MIXING

The operation of this control is similar to that of the X-Selection Y-Mixing control except that it is used to correct for vertical skew in the selection of characters in any horizontal matrix row caused by mechanical misalignment of the vertical selection plates. Using horizontal row 2 as an example, if there is a skew up, the top of the U and the bottom of the M may be written whenever the U key is struck. If there is skew down, the bottom of the U and the top of the 4 may be written whenever the U key is struck. This skew would be corrected by adjusting the mixing control either CW or CCW from its center position.

3.5.12 X-COMPENSATION Y-MIXING

This control is adjusted for visual effect and is used to correct for horizontal skew in the compensation of the characters in any vertical matrix column caused by mechanical misalignment of the horizontal compensation plates. The effects are as follows: Assume that the X-Compensation Gain and Centering have been adjusted for proper compensation of each character in horizontal row 7 of the matrix and Y-Compensation Gain and Centering have been adjusted for proper compensation of each character in vertical column 3. Then as any column is written, a skew to the right or left will be caused by adjustment of the mixing control. Using vertical column 1 as an example, if there is a skew right, this will appear on the typotron tube as unequal spacing between the I and 9 characters when alternately struck on the keyboard, I 9I 9I 9. A skew left will produce I9 I9 I9. Thus with the proper adjustment of the mixing control either CW or CCW from its center position the following may be obtained: I 9 I 9 I 9. This adjustment should be made (starting from the center of the control's range) after the horizontal matrix rows have been correctly compensated.

NOTE

It has been assumed that the corner correction controls have been properly set. An attempt to correct corner character miscompensation should not be made using the mixing controls; this should be left the corner correction controls.

3.5.13 Y-COMPENSATION X-MIXING

This control is similar in operation to that of the X-Compensation Y-Mixing except that it is used to correct for vertical skew in the compensation of characters in any horizontal matrix row caused by mechanical misalignment of the vertical compensation plates. Using horizontal row 2 as an example, if there is skew up, alternately striking T and U will produce $T^U T^U T^U$. Skew down will produce $T_U T_U T_U$. This can be corrected by adjusting either CW or CCW from the controls center position to obtain TUTUTU.

3.5.14 CORNER CORRECTION CONTROLS

The corner correction controls provide character positioning adjustment for the characters located in the extreme corner positions of the character matrix. These controls are designated by direction of motion, (Horizontal -X and Vertical -Y) and the corner location (Top, Bottom, Right, and Left). The character matrix locations affected are as follows:

TOP LEFT CHARACTERS

) ■ ↓

BOTTOM LEFT CHARACTERS

, ▶| +

TOP RIGHT CHARACTERS

-¦- ↑ •

BOTTOM RIGHT CHARACTERS

> |◀ ⏀

The X-COMPENSATION corner controls move their corresponding compensated characters to the right for the TOP and BOTTOM LEFT sides and to the left for the TOP and BOTTOM RIGHT sides. The Y-COMPENSATION corner controls move their corresponding compensated characters down for the TOP RIGHT and LEFT sides and up for the BOTTOM RIGHT and LEFT sides. These controls are used to compensate for any residual pin cushioning in the written matrix after the matrix voltage has been properly adjusted. Normally, adjustment of the corner controls is not required and the controls are set to maximum CCW positions.

3.5.15 NON-STORE MODE

This mode is used primarily as a method of checking the electronic lens systems within the typotron tube and should be used only by personnel experienced in its operation. Extreme care must be exercised when in this mode because permanent tube damage can easily result by either burning the viewscreen phosphor or destroying the dielectric (and consequently the storage properties) of the backing electrode through over dissipation. Since the light output in this mode is much lower than in the stored mode, provision should be made to shield out the external ambient light or to operate in a reduced light ambient. The natural reaction of increasing the light output of the unblanked character by reducing the write bias and thus writing harder must be carefully controlled, for it is this over writing which causes the damage. The proper sequence of operating changes required to switch from the stored to the non-stored mode is insured through the non-store mode switches and relays in the electrostatic deflection chassis and the relays in the power control chassis. These switches are in the OFF position during operation in the stored mode. To switch to the non-stored mode, the unblank pulse amplitude should be reduced to a minimum (full CCW), the write bias increased to a maximum (full CW), the magnetic deflection chassis disabled by removing the 4 fuses, and then the non-store mode switches turned ON in order of their switch number designation (S1, S2, S3, and S4). For optimum operation each character in the matrix should be sequentially selected with the sequence being constantly repeated so that the matrix is being continuously scanned. Then the unblank amplitude is slowly increased and if necessary the write bias decreased until the selected characters are visible. If the compensation had previously been adjusted, all selected characters will be compensated to one spot, therefore to see the matrix and any selection lens distortion, the compensation gains should be reduced to a minimum. On the other hand, if compensation lens distortion (which is more prevalent) is to be observed, the selected characters should be correctly compensated to one spot and the magnetic deflection chassis enabled, but at minimum gain. With the magnetic deflection enabled, however, 17_8 (insert) and 56_8 (end of line) cannot be selected as characters but must be used to position the Matrix on the face of the typotron tube because theses characters are decoded and used by the common logic. To switch from the non-stored to the stored mode, switches S1 through S4 are turned OFF in reverse order (S4, S3, S2, S1).

4. MAGNETIC DEFLECTION CIRCUITS

(See figure 6-18.)

The magnetic deflection assembly consists of two identical magnetic deflection yoke drivers used to position the writing beam of a cathode-ray charge-storage display tube. The X driver positions the writing beam horizontally and the Y driver positions the beam vertically. Since the two driver circuits are identical, only the X deflection driver will be discussed.

The magnetic deflection preamplifier provides the input signal to the deflection yoke driver which, in turn, supplies deflection current to the storage tube yoke. A voltage proportional to the yoke current is fed back to the input of the deflection preamplifier, and is used to establish the final resting position of the character displayed on the face of the storage tube.

The magnetic deflection yoke driver operates as a push pull amplifier with a single-ended input. Transistors Q2 and Q4 form a regenerative emitter follower circuit. A positive input signal from the preamplifier causes transistor Q2 to conduct. As the emitter of transistor Q2 becomes more positive, the Q2 collector becomes more negative, causing transistor Q4 to conduct. The positive change in the Q4 collector voltage increases the voltage at the emitter of transistor Q2. A current path is completed from the Q2 emitter through the storage tube yoke, through feedback resistor R14 to the dc voltage return.

Transistors Q1 and Q3 form a compound-connected emitter follower, and maintain maximum current amplification at high values of emitter current. A negative input signal causes transistor Q1 to conduct, lowering the voltage at the base of transistor Q3. Transistor Q3 conducts. The deflection current path is completed through R14 and the storage tube yoke to the emitters of transistors Q1 and Q3.

BIAS CURRENT ADJUST potentiometer R1 establishes bias for transistors Q1 and Q2, and causes current to flow through the magnetic deflection yoke driver even if the storage tube yoke current is zero. This action produces class AB operation of the push-pull driver circuit instead of the usual class B.

5. TYPOTRON TUBE

The typotron tube is a 21-inch character forming cathode-ray charge storage display tube which provides a bright visual presentation for direct viewing of electrically stored information. The typotron tube is capable of displaying characters or spots in tabular or graphic format with sufficient brightness to be viewed under conditions of high ambient illumination. Electrostatic character selection and focus and magnetic deflection are used.

The principle elements of the typotron tube are:

a. Storage display assembly

b. Flood gun

c. Collimating assembly

d. Write gun

e. Character selection assembly

f. Externally mounted deflection yoke.

The storage display assembly consists of an aluminized phosphor screen, a fine mesh backing electrode upon which a thin film dielectric storage surface has been deposited, and a collector electrode. Operation of the typotron tube is based primarily on the property of the storage surface to charge in a positive or negative direction depending upon the energy of the incident electron beam. Such property is made possible by the secondary emission characteristics of the storage surface dielectric.

The flood gun, a simple electron gun without deflection plates, emits a continuous diffused stream of low-velocity electrons toward the storage surface (A, figure 4-28.) The collimating assembly organizes the random motion of the electrons, causing the electrons to approach the storage surface orthoganally, uniformly over the entire surface area in parallel paths. Whether these electrons pass through each of the many storage elements that comprise the storage surface depends upon the potential present at each element. Operating voltages and signals cause the storage

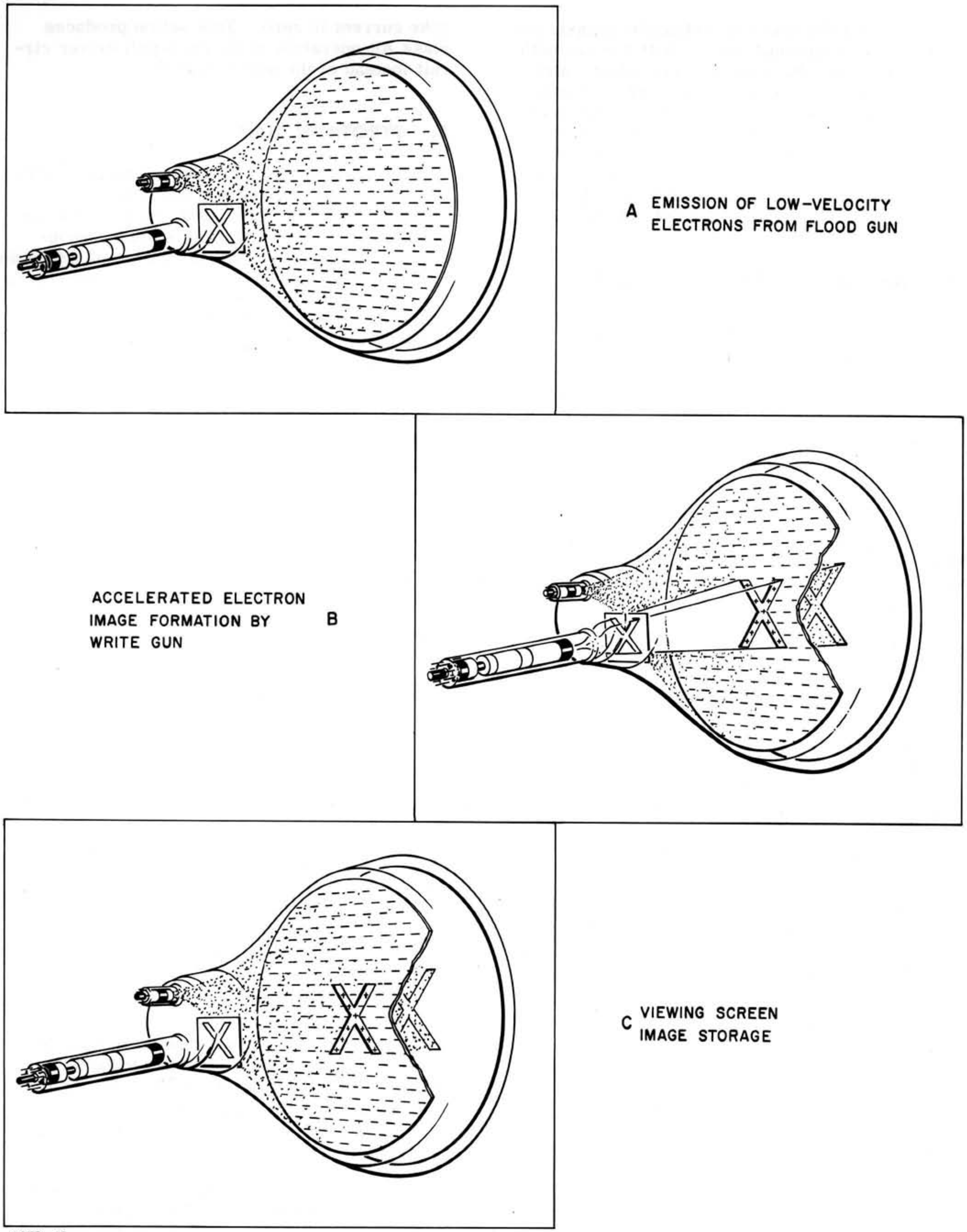

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Figure 4-28. Typotron Tube Operation

surface to charge to a negative potential sufficient to repel the flood gun electrons toward the collector electrode. The collector electrode is located between the flood gun cathode and the storage surface (backing electrode).

Writing occurs when a shaped beam of high-velocity electrons emitted by the write gun strikes the storage surface producing secondary emission. The points bombarded by the write gun electrons assume the ground potential of the flood gun cathode, while the other storage surface elements retain their negative charge. The collimated flood gun electrons pass through the more positive areas and are accelerated onto the viewing screen, duplicating the image described by the write gun on the storage surface (B, figure 4-28.)

When the writing beam is turned off, the image on the storage surface and on the viewing screen persist (C, figure 4-28.) The length of time after writing, during which an acceptable image can be read is termed "storage retention time" (or "storage time"), and is limited chiefly by the presence of residual gas molecules within the tube. These gas molecules collide with flood gun electrons, producing positive ions which land on the storage surface and gradually discharge the negative storage surface. Flood gun electrons pass through these less negative areas, resulting in gradual brightening of the display background and corresponding loss of display contrast. The display image deteriorates as flood gun electrons gradually discharge the points not discharged by writing, this action determines the background deterioration rate. Storage retention time for the typotron tube is approximately two minutes, during which time good image contrast is retained. Extended storage circuits increase the effective storage time of the system to four minutes. Upon completion of a writing operation, the storage surface may be erased at any time and a new cycle started.

Erasure of stored information takes place when an erase voltage causes the backing electrode to become more positive. This positive increase is coupled capacitively to the storage surface, allowing all points on the storage surface to accumulate electrons rapidly and be clamped to ground. When the erase voltage is removed, the backing electrode returns to its original potential, and the negative change is again capacitively coupled to the storage surface. The storage surface is driven below ground potential, making it capable of repelling flood gun electrons. Erasure is complete and the tube is ready for subsequent writing operations.

Character selection is accomplished by electrostatically guiding the write beam through a stencil matrix. As the beam passes through the matrix it assumes the shape of the character selected. The shaped beam is then electrostatically returned to the write gun axis (compensated) and magnetically deflected to a predetermined location on the storage tube.

6. POWER CONTROL ASSEMBLY

(See figure 6-19.)

The Power Control Assembly controls the application of ac power to the display storage tube filaments and the storage tube high voltage power supply and bias circuits. The Power Control Assembly also contains ac sense and extended storage circuits.

The application of primary power to the display console energizes transformer T1. Transformer T1 supplies 6.3 vac to the tubes of the electrostatic deflection assembly. The special filament operating voltage required by V7 of the electrostatic deflection assembly is provided by returning the secondary winding center-tap T1-6 to 80 volts dc.

When the display system power-on sequence has been completed, and interlocking signal SEQ COMPLETE CONNECTOR LOOP THRU, is routed through the power control and deflection assemblies to the display console panel, causing the CRT POWER switch indicator (2, figure 3-4) to light yellow.

The storage tube power-on sequence is initiated by pressing the CRT POWER switch-indicator (2, figure 3-4.) The CRT SW ON signal is applied through interlock switch S3 which lights the CRT POWER switch-indicator white and energizes relays K1 and K3.

Relay K3 controls the application of filament voltage to the flood gun, and 120 vac to the high voltage power supplies and isolation transformer T2. Relay K2 delays the application of 120 vac to the HV filament transformer (write gun filament) until the storage tube operating voltages have stabilized.

The output of isolation transformer T2 is rectified by CR15 and applied across ac sense sensitivity potentiometer R14 to the base of transistor Q2 causing Q2 to be cut-off. When cut-off, Q2 biases transistor Q3 causing Q3 to conduct. When conducting, Q3 completes a circuit to dc return and relay K7 energizes.

When energized, relay K7 provides a dc return path for relay K2 and a +26 v path to capacitor C1. Relay K2, a one minute time delay, delays the direct view storage tube ready (DVST READY) signal to the logic circuits. When energized, K2 changes the CRT POWER switch indicator (2, figure 3-4) from white to green and disconnects a ground signal (open contacts of K2) to the common logic circuits indicating the DVST is ready.

Transistor Q2 turns on when loss of ac voltage is sensed by the ac sense circuits. The sensitivity of the ac sense circuits is adjusted by potentiometer R14. When Q2 turns on, relay K7 deenergizes causing relay K2 to deenergize which turns the CRT POWER switch indicator (2, figure 3-4) white.

When deenergized, K7 connects a dc return path through normally closed contacts of runaway discharge switch S1 to relay K5. Relay K5 energized turns off the flood gun by connecting -300 v to the base of the view bias control network. The resulting -300 v on the control grid biases the flood gun to cutoff. Also when CRT POWER switch is off, the collector is tied to the backing electrode by K6. A voltage of +26 is applied from capacitor C1 through K7 contacts to the magnetic deflection assembly (MAG DEF RC OFFSET) off-setting the write beam to the left side of the tube to prevent overwriting on the storage surface by the write gun.

Relay K5 is also energized to turn the flood gun off when non-storage mode switches S1, HV DOWN and S2, FLOOD GUN OFF are set to the on position (figure 6-17, sheet 8). Tie collector to backing electrode (TIE COLL TO BE) switch S3 is set to the on position to energize relay K6 during the non-storage mode. Relay K6 energized ties the tube collector through RUNAWAY DISCHARGE switch S1 contacts and K6 contacts to the tube backing electrode.

When runaway charging is observed, the RUNAWAY DISCHARGE switch is pressed to tie the tube BACKING ELECTRODE directly to the tube COLLECTOR (figure 6-19) to discharge the runaway condition. CRT SW ON and CRT SW OFF signals are applied through the runaway discharge door interlock switches S3 and S4 to energize relay K4. K4 energized connects the filament voltage from T1 to the flood gun filament while K3 is deenergized.

Extended storage is provided by operational amplifier A1, BACKING ELECTRODE DC LEVEL potentiometer R8, CLAMP LEVEL potentiometer R5, DECAY RATE INPUT potentiometer R2, and associated circuits. (See Volume 3 for Burr-Brown model 9587 Operational Amplifier instruction manual.) Amplifier A1, functioning as an integrator, supplies a decreasing voltage through BACKING ELECT DC LEVEL potentiometer R8 to the tube backing electrode. BACKING ELECT DC LEVEL potentiometer is adjusted for +5 ± 0.05 v. The output from amplifier A1 is decreased at a rate determined by DECAY RATE potentiometer R2. The final decreased voltage level from amplifier A1 is determined by CLAMP LEVEL potentiometer R5. A RESET EXTENDED STORAGE or INHIBIT DURING NON-STORAGE signal cuts off transistor Q1. When Q1 cuts off, relay K8 deenergizes causing amplifier A1 to be reset. An INHIBIT DURING NON-STORAGE signal is generated by the non-storage mode switches. A RESET EXTENDED STORAGE signal is generated each time high voltage is cut off (DUNK HV) when erasing the display or a card is not inserted in the card reader.

7. DC POWER SUPPLIES

The twelve regulated dc power supplies in the logic and power supply cabinet and simulator and power supply cabinet provide the -6.5 v, -26 v, +26 v, -300 v, and +300 v operating voltages for the display system logic circuits, magnetic deflection circuits, electrostatic deflection circuits and the typotron tube (See table 1-3 for power supply ratings). The -28 v power supply in the power sequencer (figure 6-15) provides control relay and indicator power. A -12.75 v reference voltage power supply is provided in the Electrostatic Deflection Assembly (figure 6-17, sheet 1) for the digital to analog converters. (See Volume 3 power supply instruction manuals for information regarding the twelve regulated power supplies and the reference voltage power supply.)

8. HIGH VOLTAGE POWER SUPPLIES

Positive and negative high voltage power supplies are provided to supply operating voltages to the storage tube (See figure 6-13.) The outputs of the high voltage supplies are applied through the tube bias adjustment circuits to the storage tube.

9. POWER CONTROLS AND INDICATORS

Power controls and indicators are provided on the power sequencer and display console to apply power to the display system and monitor the power status. POWER ON and OFF switches on the power sequencer and the display console are interlocked so the power can be turned on or off at both locations. An INHIBIT switch is provided on the power sequencer to prevent turning off power at the console OFF switch. The CRT POWER switch is provided on the console to control the high voltage power supplies and filament voltages. Interlock circuits are provided in the electrostatic deflection assembly (figure 6-17), magnetic deflection assembly (figure 6-18 and the power control unit (figure 6-19) to prevent application of CRT power until these assemblies are connected properly to the system.

CHAPTER 5
MAINTENANCE

INTRODUCTION

This chapter contains information to aid in ensuring continuous maximum performance of the Saturn Display Set. The chapter is divided into three sections. Section I contains requirements for standard test equipment, information on the computer simulator, and equipment diagrams. Section II contains preventive maintenance routines and performance test procedures. Section III contains information for adjusting, aligning, troubleshooting, removing and replacing the assemblies and subassemblies of the display set.

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Section II.	Preventive Maintenance
Section III.	Corrective Maintenance

SECTION I
GENERAL INFORMATION

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SECTION I

GENERAL INFORMATION

1. GENERAL

Section I contains information about the special test equipment required to test the display system. This section also contains information pertaining to the controls and circuits of the display system simulator.

2. TEST EQUIPMENT

This section contains a list of recommended standard test equipment required for maintaining the display set, and information describing the computer simulator controls, indicators, theory of operation, flow charts, and simplified diagrams. The simulator information should aid the maintenance personnel to perform off-line equipment operability tests.

2.1 Standard Test Equipment

The recommended test equipment required to perform maintenance procedures after installation of the display equipment is listed in table 5-1. When listed equipment is not available, equivalent test equipment may be substituted.

2.2 Display Set Test Equipment

The Saturn Display Set contains a Computer Simulator which can be used for off-line testing of the display set circuit operation. The Computer Simulator provides logic signals, which during on-line operation are provided by the display IODC computer equipment.

3. COMPUTER SIMULATOR

The Saturn Display-Computer Simulator contains the controls, indicators and logic to simulate computer interface signals allowing complete checkout of the display system without use of the computer. The simulator controls and indicators are illustrated in figure 5-1 and described in table 5-2. Performance tests for checking the display equipment using the simulator are detailed in Section II.

Table 5-1. Standard Test Equipment

TEST EQUIPMENT	MANUFACTURER	MODEL
Digital Voltmeter	Kintel	502B
Electrostatic Voltmeter	Sensitive Research Instrument Corp.	ESH
Multimeter	Simpson	260
Oscilloscope	Tektronix	545A
Preamplifier	Tektronix	CA
Portable Potentiometer	Wheelco Instruments	311
Vacuum Tube Voltmeter	Hewlett-Packard	410B

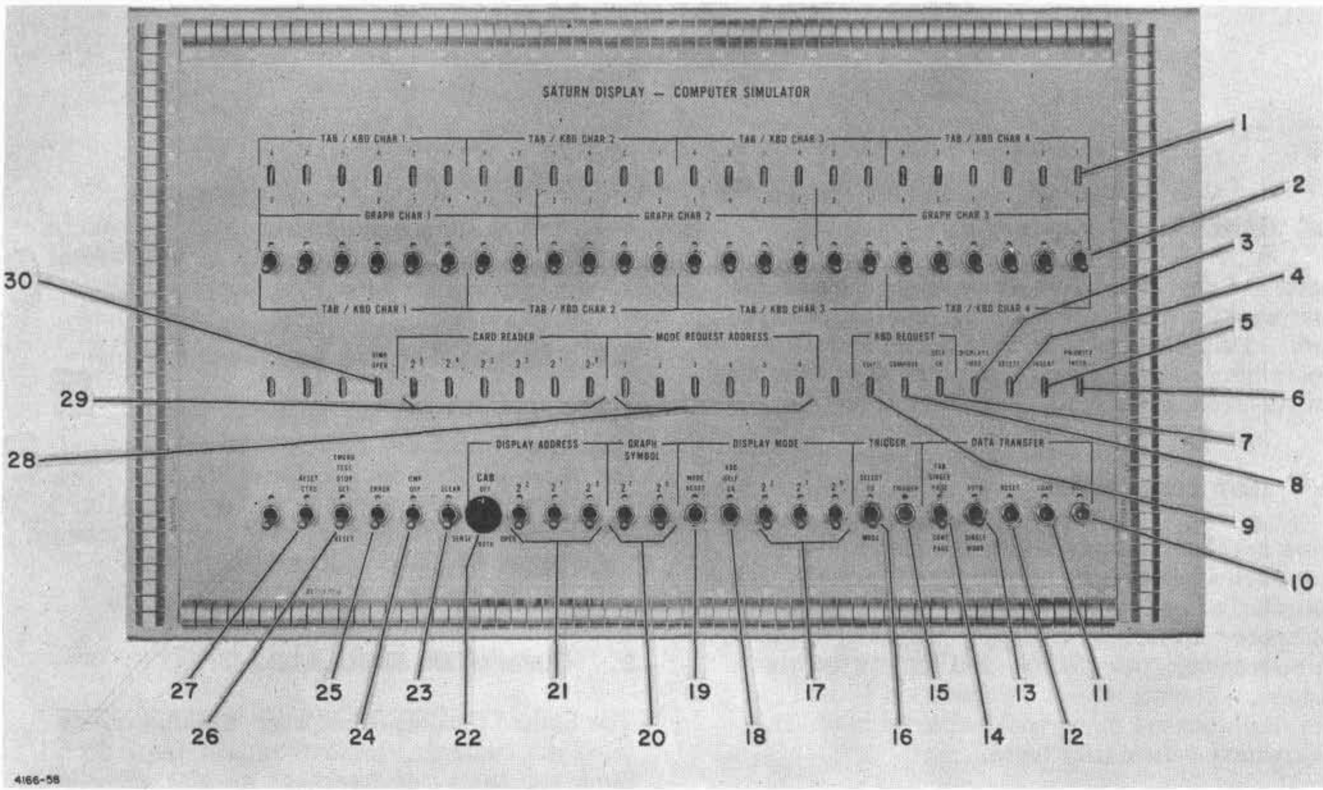

Figure 5-1. Computer Simulator, Controls and Indicators

Table 5-2. Computer Simulator Panel, Controls and Indicators

FIGURE 5-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	Tabular, keyboard and graph character indicators (TAB/ KBD CHAR 1, 2, 3, and 4; GRAPH CHAR 1, 2, and 3	VI thru V24	Light to indicate the contents of the simulator 24-bit register
2	Tabular and graph character switches (TAB/KBD CHAR 1, 2, 3, and 4; GRAPH CHAR 1, 2 and 3)	S1 thru S24	Used to set-up coded display data to be loaded into the simulator 24-bit register
3	DISPLAYS INOP indicator	V45	Lights when power sequencing is incomplete or when the addressed console DVST is not ready to operate

Table 5-2. Computer Simulator Panel, Controls and Indicators (Cont)

FIGURE 5-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
4	DELETE indicator	V46	Lights when DELETE key is pressed on the display console keyboard (Keyboard Compose Mode only)
5	INSERT indicator	V47	Lights when INSERT or DELETE key is pressed on the display console keyboard (Keyboard Edit or Compose Modes)
6	PRIORITY INTER indicator	V48	Lights when a priority interrupt signal is generated by the displays logic
		KBD REQUEST	
7	SELF CK indicator	V44	Lights when a keyboard self-check mode request is made at the display console
8	COMPOSE indicator	V43	Lights when a keyboard compose mode request is made at the display console
9	EDIT indicator	V42	Lights when a keyboard edit mode request is made at the display console
		DATA TRANSFER	
10	READ pushbutton switch	S48	When pressed, starts data transfer between the simulator and displays logic
11	LOAD pushbutton switch	S47	When pressed, strobes coded bits set-up by the tabular and graph character switches (2, figure 5-1) into the simulator 24-bit register
12	RESET pushbutton switch	S46	When pressed, resets the simulator 24-bit register, sets the 24 shift counter to all "1's" and sets the loadstart counter to the reset condition
13	AUTO/SINGLE WORD switch	S45	a. When set to the SINGLE WORD position, allow only 24 data bits to be shifted into or from the simulator each time READ is pressed b. When set to the AUTO position, allows repetitive shifting of display data words between the simulator and display equipment

Table 5-2. Computer Simulator Panel, Controls and Indicators (Cont)

FIGURE 5-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
14	TAB SINGLE PAGE/ CONT PAGE switch	S44	a. When set to the TAB SINGLE PAGE position, allows the writing of only one page (1600 characters) b. When set to the CONT PAGE position, allows continuous writing
		TRIGGER	
15	TRIGGER pushbutton switch	S43	When pressed, generates a trigger pulse for a CC strobe or mode trigger
16	SELECT CC STROBE/MODE switch	S42	a. When set to the CC STROBE position and the TRIGGER pushbutton switch (15, figure 5-1) is pressed a CC STROBE TRIGGER pulse is applied to the display system b. When set to the MODE position and the TRIGGER pushbutton switch (15) is pressed, a MODE TRIGGER pulse is applied to the displays logic
		DISPLAY MODE	
17	2^2, 2^1, and 2^0 switches	S39, S40, and S41	Used to set-up binary code of the display operating modes (See table 1-12)
18	KBD SELF CK pushbutton switch	S38	When pressed, places the display system in the keyboard self-check mode.
19	MODE RESET pushbutton switch	S37	When pressed, resets display mode flip-flops in the displays logic
20	GRAPH SYMBOL 2^1 and 2^0 switches	S35 and S36	Used to set-up binary codes of the graph symbols (See table 1-10)
		DISPLAY ADDRESS	
21	2^2, 2^1, and 2^0 switches	S32, S33, and S36	Used to set-up binary code of the console to be addressed (See table 1-11)

Table 5-2. Computer Simulator Panel, Controls and Indicators (Cont)

FIGURE 5-1 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
22	CAB OPER/SENSE/ BOTH selector switch	S31	a. When set to the OPER position, applies a cabinet address operate signal to the displays logic b. When set to the SENSE position, applies a cabinet address sense signal to the displays logic c. When set to the BOTH position, applies both the operate and SENSE signals to the displays logic
23	CLEAR switch	S30	When set to the CLEAR position, clears and erases the display
24	CMP OFF switch	S29	When set to CMP OFF, provides a computer off signal to the displays logic
25	ERROR switch	S28	When set to ERROR, lights ERROR indicator on display console
26	EMERG TEST STOP SET/RESET switch	S27	a. When set to the SET position, lights EMERGENCY TEST STOPPED indicator on display console b. When set to the RESET position, EMERGENCY TEST STOPPED indicator goes out
27	RESET CTRS switch	S26	When set to RESET CTRS position, resets the horizontal and vertical counters in the displays logic
28	MODE REQUEST ADDRESS 1, 2, 3, 4, 5, and 6 indicators	V35, V36, V37, V38, V39, and V40	Indicates which console is making a keyboard mode request
29	CARD READER 2^5, 2^4, 2^3, 2^2, 2^1, and 2^0 indicators	V29, V30, V31, V32, V33, and V34	Light to indicate binary code for card inserted in the card reader (see table 1-9)
30	SIMU OPER indicator	V28	Lights to indicate power is applied to simulator

3.1 Theory of Operation

(See figure 5-2.)

The Computer Simulator consists of a timing section, register section, interface signal control section, interface signal indicator section, and power section. The timing section controls data transfer between the simulator and display equipment. The register section contains the switches, indicators, and 24-bit register to generate, display, and store coded display data. The interface signal control section contains the switches to generate simulated computer-to-display interface signals and the interface signal indicator section provides visual indications of display-to-computer interface signals as they occur.

3.1.1 TIMING SECTION

(See figure 6-25, sheet 3.)

The timing section contains the clock pulse generator, control switches, transfer control circuits, and a shift counter to regulate data transfer between the simulator and display equipment.

Timing. CLOCK ST1 (figure 6-25, sheet 3) starts when a power sequence complete (START CLOCK) ground signal is received from the display equipment power sequencer. Square wave clock outputs at 312KC are inverted to provide $\phi 1$ and $\phi 2$ clock pulses. Data transfer from and to the simulator is regulated by $\phi 1$ and $\phi 2$ clock pulses. A timing diagram of the simulator timing section is provided in figure 5-3.

Operation. Data transfer during tabular, graphic, or keyboard output modes of operation is started by pressing READ pushbutton switch S48 (figure 6-25, sheet 3). Pressing the READ pushbutton switch causes the control counter (ST17 and ST18) to automatically advance through the reset, load, and start transfer cycle provided than an enable shift or ready for next word (RFNW) are present. If S46, RESET pushbutton switch, and S47, LOAD pushbutton switch, are manually operated, the control counter is forced to the start transfer count when the READ pushbutton switch is pressed. When the READ pushbutton is released, ST8 is triggered and ST14 is set. The next $\phi 1$ clock pulse enables ST5 which sets ST15. ST15 - ST16 enable $\phi 2$ clock pulses through ST12 to trigger the control counter (ST17 and ST18). The control counter is advanced through the reset, load, and start transfer cycle by clock pulses from ST12. Start transfer resets ST16 which stops trigger pulses from ST12 and enables gate ST6. Clock pulses from ST6 provide shift pulses to the simulator register and data

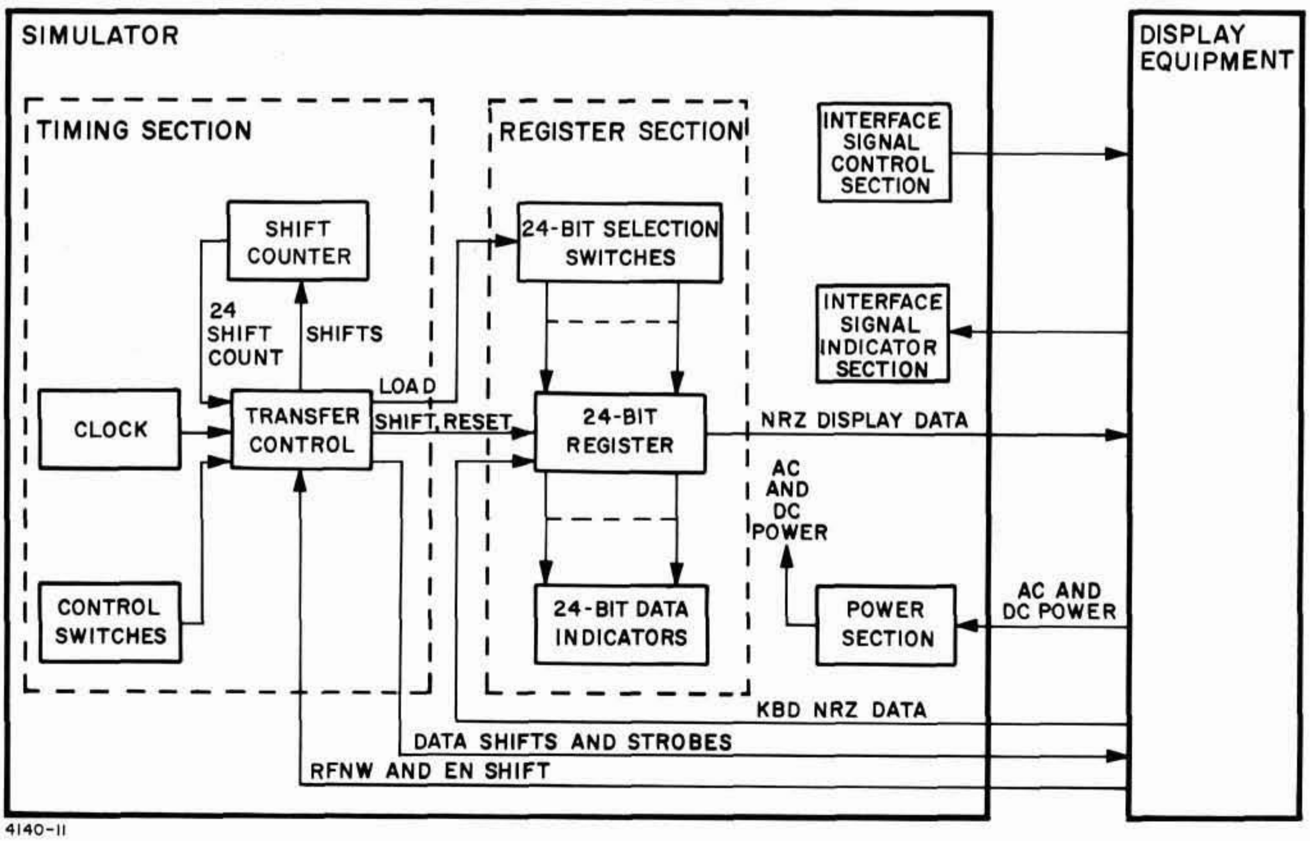

Figure 5-2. Simulator, Block Diagram

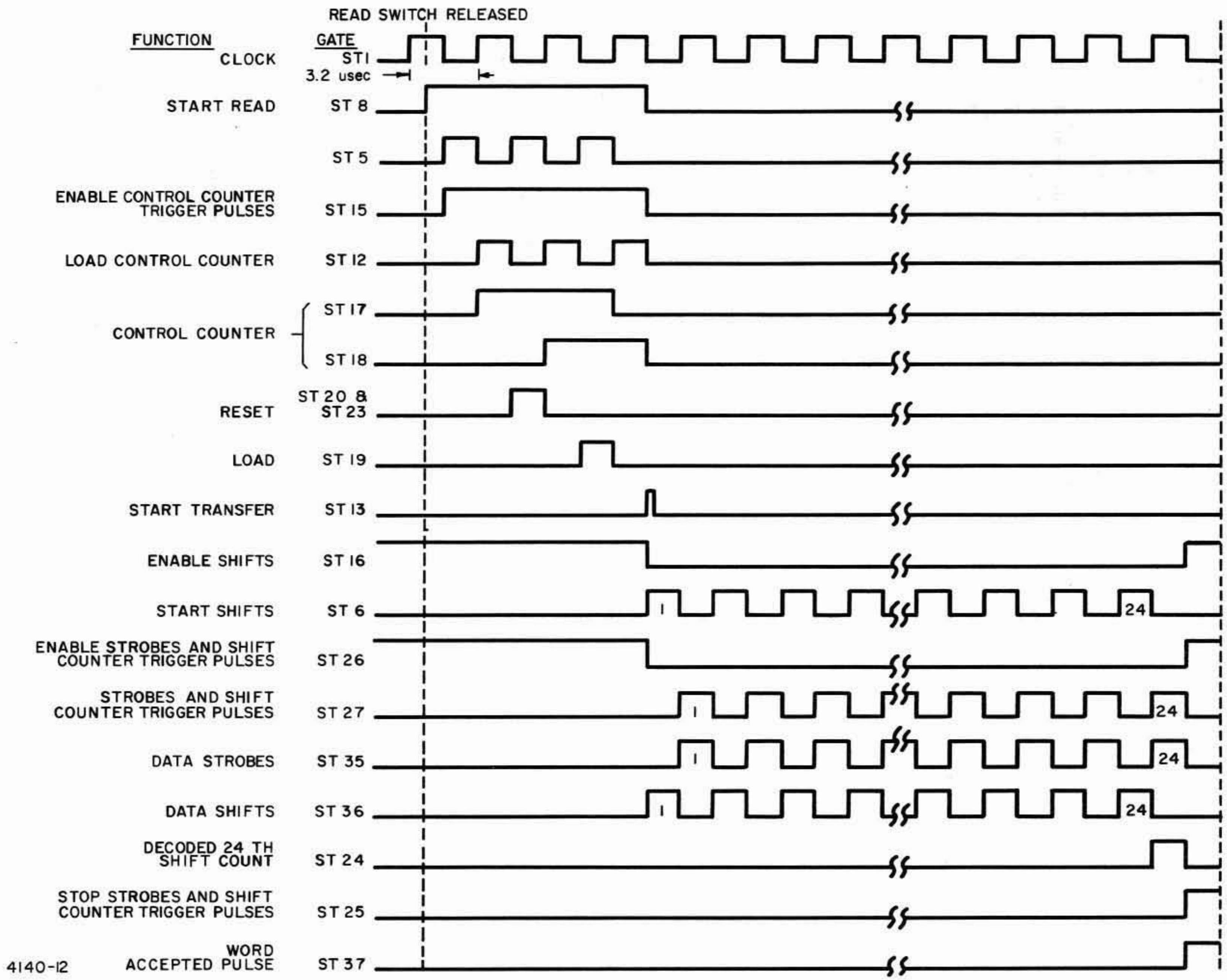

Figure 5-3. Simulator Timing Section, Timing Diagram

shift pulses through ST36 to the display register. Data strobe pulses are sent to the display system from ST25 only during simulated tabular or graphic operations. The first shift pulse from ST6 resets ST26 which enables clock pulses through ST27 to trigger the shift counter (ST30 through ST34). The 24th shift pulse is decoded by ST24 which sets ST16 and ST25 which sets ST26. ST6 is disabled stopping the shift pulses and ST27 is disabled stopping the shift counter trigger pulses. If S45 is in the AUTO position, ST8 is set and the data transfer cycle repeats.

If S44 is in the SINGLE PAGE position, the display is limited to one page by the SINGLE PAGE signal which triggers ST14 when the end of the 32nd display line count is triggered into the display vertical counter. Flip-flop ST14 is reset which disables ST6 to stop the shift pulses.

The enable shift and strobe signals enable keyboard data (KBD DATA) through gate SR27 or SR30 (figure 6-25, sheet 4) during keyboard output modes. A word accepted signal is generated at gate ST27 only during keyboard output modes when single shot multivibrator (SSMV) ST28 is triggered after the 24th shift pulse by ST26 and a $\overline{\text{ESS}}$ signal from enable shift flip-flop ST38.

Operation Flow Charts. Simulator timing section flow charts for tabular or graphic modes of operation and keyboard output modes of operation are shown in figures 5-4 and 5-5 respectively.

3.1.2 REGISTER SECTION

(See figure 6-25, sheet 4.)

The register section contains a 24-bit register, data selection switches, and data indicators. Prior to accepting data, the register is reset by the reset pulse generated in the timing section.

In simulated tabular or graphic operations, the binary code of each character (See table 1-4.) in the display data is manually set by data selection switches S1 through S24. A data selection switch set to the up position inserts a logical "1" into the corresponding register flip-flop of the 24-bit register (figure 5-6). The load pulse from the timing section inserts the binary coded data into the 24-bit register through the data selection switches when the system display is ready for first display word (RFNW). Display data is shifted serially from the simulator by SHIFT pulses generated by the timing section into the displays 24-bit register. Display data is strobed and shifted into the displays 24-bit register by data strobes and data shifts from the timing section.

In keyboard output operations, NRZ keyboard data is strobed through gates SR27 and SR30 by strobe pulses from the timing section and enable shift (EN SHIFT) from the system display (figure 5-6). The keyboard data is shifted serially into the simulator 24-bit register by shift pulses from the timing section. A word accepted pulse is generated by the timing section when the 24th keyboard bit has been shifted into the simulator register.

The contents of the simulator register during any operation are visually displayed by data indicators V1 through V24 (figure 5-6).

3.1.3 INTERFACE SIGNAL CONTROL SECTION

(See figure 6-25, sheet 1.)

The interface signal control section contains the switches to generate simulated computer-to-display interface signals. Each interface signal control switch is individually positioned to generate the interface signal required during checkout of the display equipment. Refer to table 5-2 for the function of each control switch.

3.1.4 INTERFACE SIGNAL INDICATOR SECTION

(See figure 6-25, sheet 2.)

The interface signal indicator section provides visually indication of display-to-computer interface signals as they occur. Interface signal indicators are monitored for a particular indication during checkout of the display equipment. Refer to table 5-2 for the function of each indicator.

3.2 Triode Indicator Operation

(See figure 5-7.)

The simulator contains data indicators and interface signal indicators. The indicators are identical triode vacuum tube indicators which have phosphor deposited on their plates. When the tube is conducting, the electrons bombard the phosphor coated plate and cause a green glow.

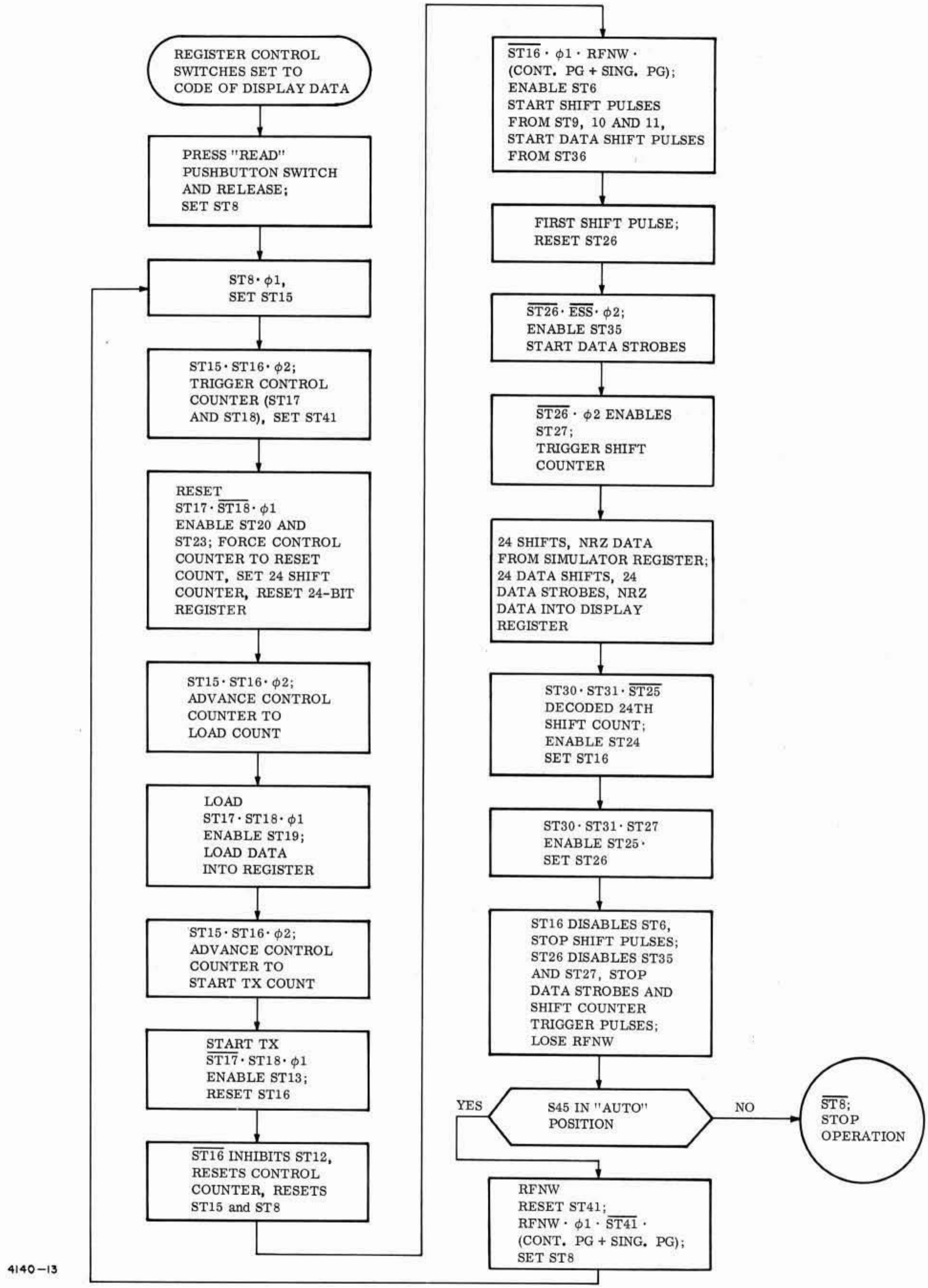

Figure 5-4. Simulator Timing Flow Chart, Tabular or Graphic Modes of Operation

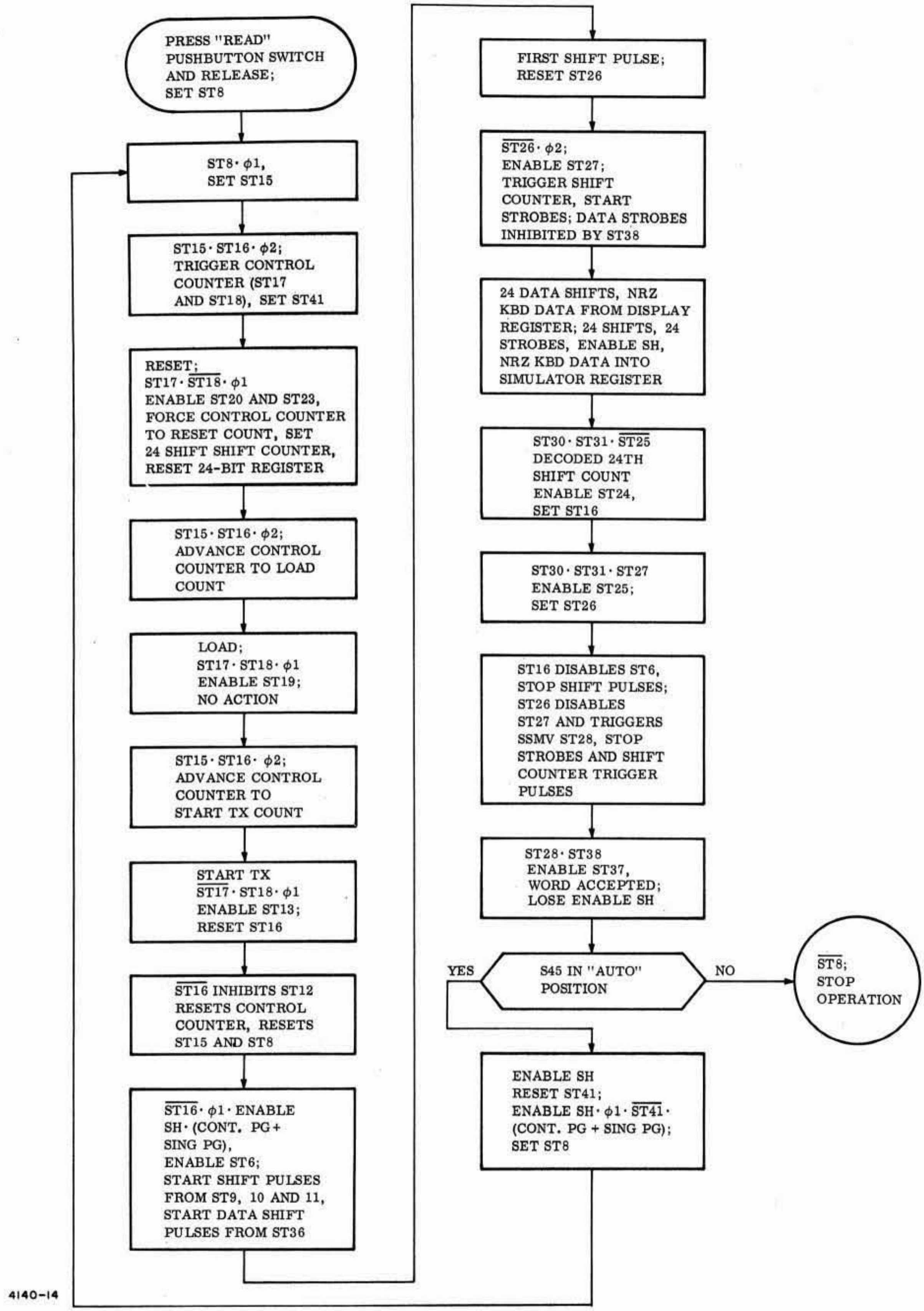

Figure 5-5. Simulator Timing Section Flow Chart, Keyboard Output Modes of Operation

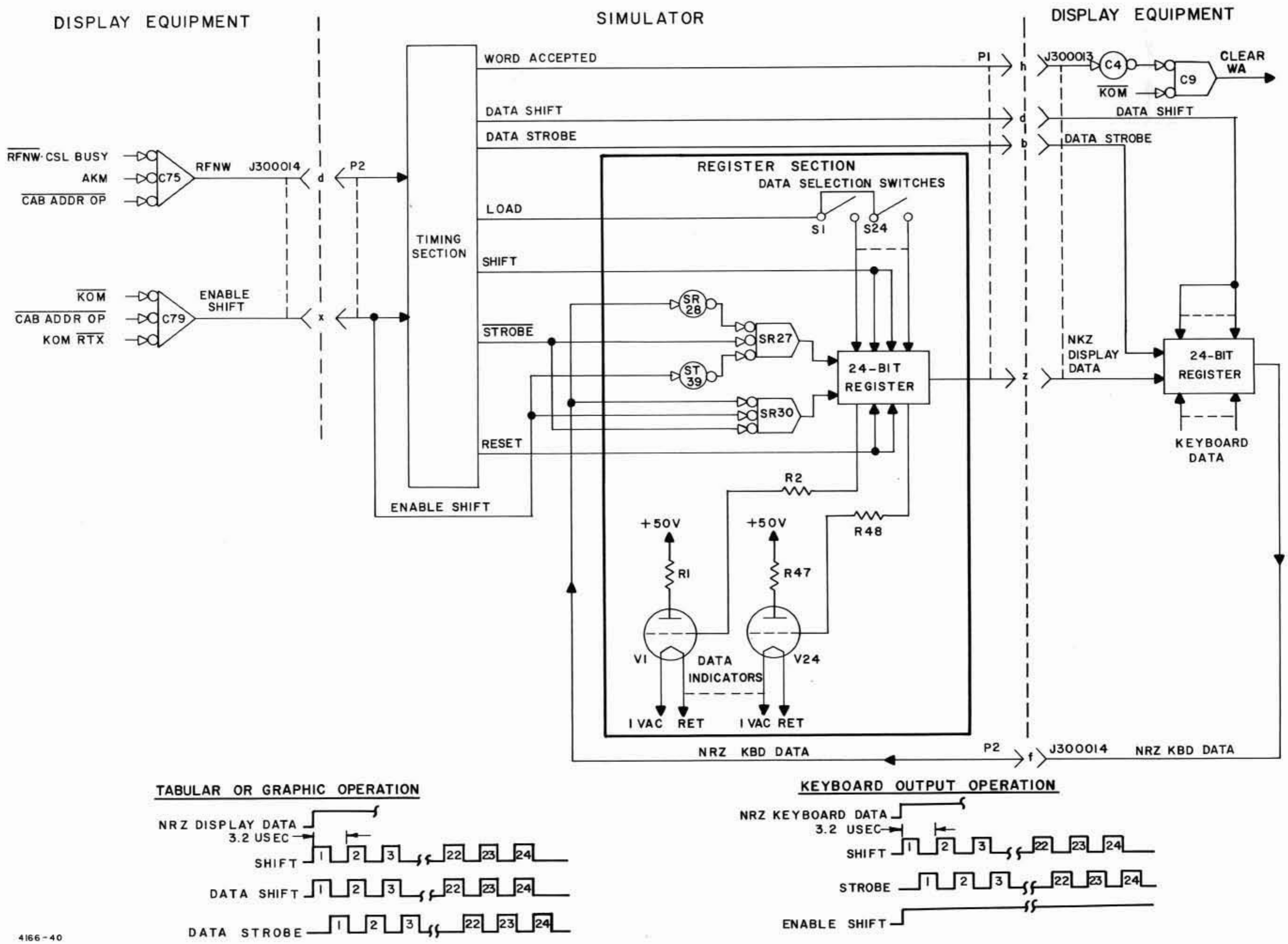

Figure 5-6. Simulator Display Equipment Data Transfer, Simplified Logic Diagram

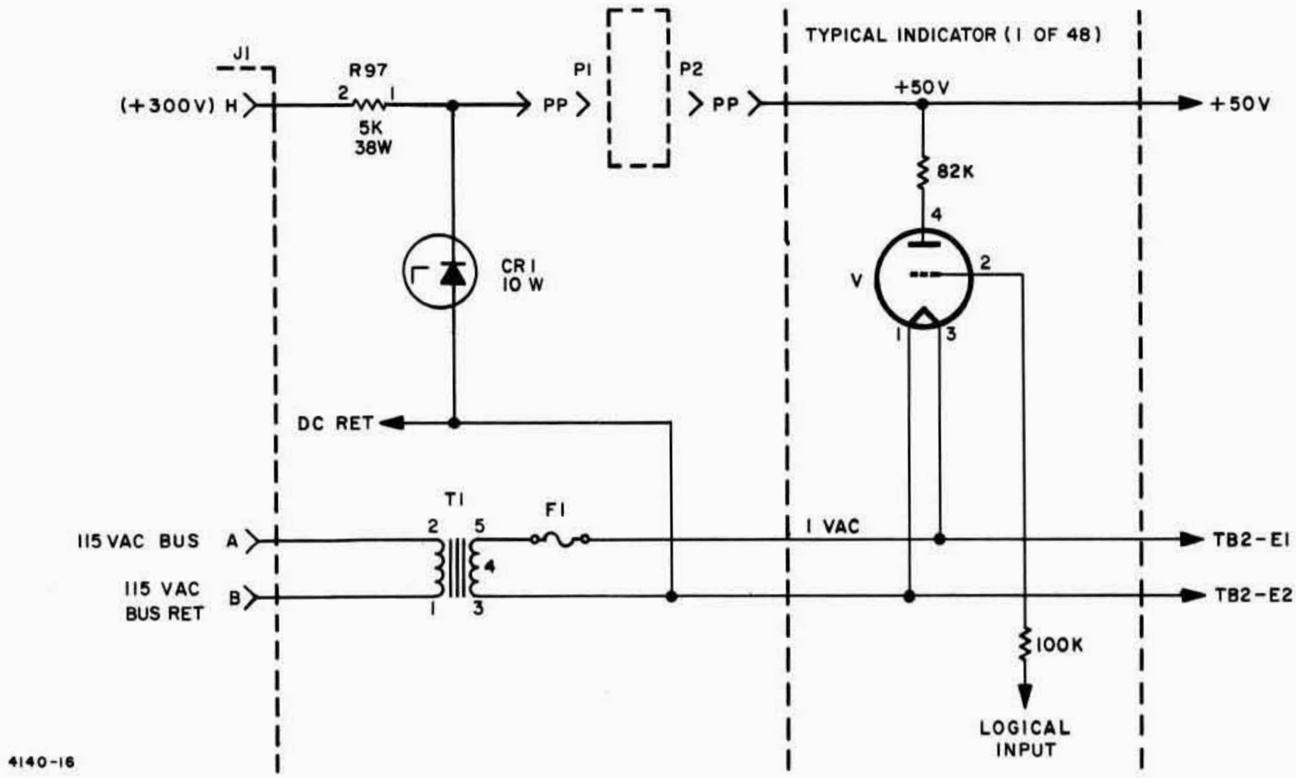

Figure 5-7. Triode Indicator Operation, Simplified Schematic Diagram

Transformer T1 supplies 1 vac to the directly heated cathode of each indicator. The anode circuit of each indicator is connected through an interlock path (P1-PP to P2-PP) to +50 volts. Zener diode CR1 holds the voltage applied to the anode circuit of each indicator at +50 v. The control grid circuit of each indicator is connected to a specific logic function in the simulator or system display. A logical 1 (0 volts) signal applied to the control grid drives the tube into conduction and the indicator lights green. A logical 0 (-6. 5v) signal applied to the control grid cuts off cathode to anode current, and the indicator goes out.

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PREVENTIVE MAINTENANCE

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SECTION II

PREVENTIVE MAINTENANCE

1. GENERAL

This section contains preventive maintenance procedures consisting of inspection, cleaning, and testing schedules and routines.

2. PREVENTIVE MAINTENANCE

Preventive maintenance procedures should be performed on a regularly scheduled basis to keep the equipment appearance, usability, and performance in the best operational condition. This includes inspection of housings, cables, and assemblies; cleaning of display tube, indicators, air filters, components and housings; lubrication of mechanical assemblies; and checking of power sources. Tables 5-3 through 5-6 outline the schedules and routines for performing the preventive maintenance procedures.

3. LUBRICATION OF KEYBOARD ASSEMBLIES

Remove the keyboard assembly from the Manual Input Assembly in accordance with procedure outlined in Section III of this chapter. Remove the keyboard cover and lubricate as follows:

NOTE

Be extra careful to avoid getting oil on solenoid plunger.

a. Apply a film of light machine oil (Gulf Crest C or equivalent) on all spring hooks (2, figure 5-8).

b. Apply one drop of light machine oil on top of each key lever directly above interlock (6).

c. Apply two drops of light machine oil on each power assist bail pivot (5).

d. Apply a film of light machine oil on key lever bottom (1) and shutter shaft (9).

e. Apply light coating of "lubriplate" on shutter top (8), key lever bottom (7), edges of comb (10), and power assist bail (3).

Table 5-3. Daily Preventive Maintenance Procedures

ITEM	PROCEDURE
OUTPUT VOLTAGE meter indication of -6.5v, -26v, +26v, -300v, and +300v power supplies	Check meter indication is within operating limits listed in table 1-3
RUNNING TIME meter indication in each console and Power Sequence Assembly	Observe that meter is operating whenever power is on
External cleaning of display equipment (excluding console display screen)	Clean external surface with vacuum cleaner, lint free cloth, and soft brush as required to remove dirt and dust from external surfaces
Cleaning of console display screen (implosion shield)	Clean display screen surface with a lint free cloth and alcohol or water.

Table 5-4. Weekly Preventive Maintenance Procedure

ITEM	PROCEDURE
Cleaning of blower air filters	Remove air filters from cabinets and consoles; clean with vacuum cleaner and wash with soap and water; replace air filters when dry

Table 5-5. Monthly Preventive Maintenance procedures

ITEM	PROCEDURE
Inspection of equipment conditions	a. Inspect all cable connectors for mechanical tightness b. Inspect all cables for fraying and chafing c. Inspect all plug-in modules for proper seating
Cleaning of display cabinet	Clean internal wiring, power supplies, and back of module nests with vacuum cleaner and soft brush
Cleaning of display console	Clean internal wiring, electrostatic and magnetic deflection assemblies, high voltage power supply, and keyboard assembly with vacuum cleaner and soft brush
Power supply voltage check	Measure output voltage of the -6.5v, -26v, +26v, -300v, and +300v power supplies under normal load and adjust as necessary in accordance with procedure of paragraph 2.6 Section III
Under-over voltage check	Refer to paragraph 4.8
Electrostatic Deflection Reference Voltage Power Supply	See Voltage Reference Power Supply Manual, Volume 3

Table 5-6. Semi-annual Preventive Maintenance Procedures

ITEM	PROCEDURE
Lubrication of cabinet and console hardware	Lubricate door hinges and latches with a molybdenum-disulphate lubricating oil; wipe off excess oil with soft lint free cloth
Lubrication of keyboard assemblies	Lubricate in accordance with paragraph 3
Multivibrator adjustments	Refer to paragraph 2.11 of Section III
Performance test	Refer to paragraph 4 of this section

f. Apply two drops of "bemol" paste to solenoid plungers (4).

4. PERFORMANCE TEST

Two performance test options are available for determining the operability of the Saturn Display Set. One performance test option consists of an automatic on-line testing of the display set circuits by the Saturn 110 Ground Computer System in accordance with program procedures outlined in the Display Control Console Test and Maintenance/Demonstration Programs, technical publication TP1281. These programmed performance tests will aid you in determining the day by day operability of the display set components. The second option consists of a detailed exercising of circuits when malfunctions have been detected and corrective maintenance is necessary. This second option also provides a means of off-line testing after major repairs have been completed and operating analysis is required. These performance tests are tabulated in tables 5-8 through 5-15. Before starting the tests the following conditions should be noted.

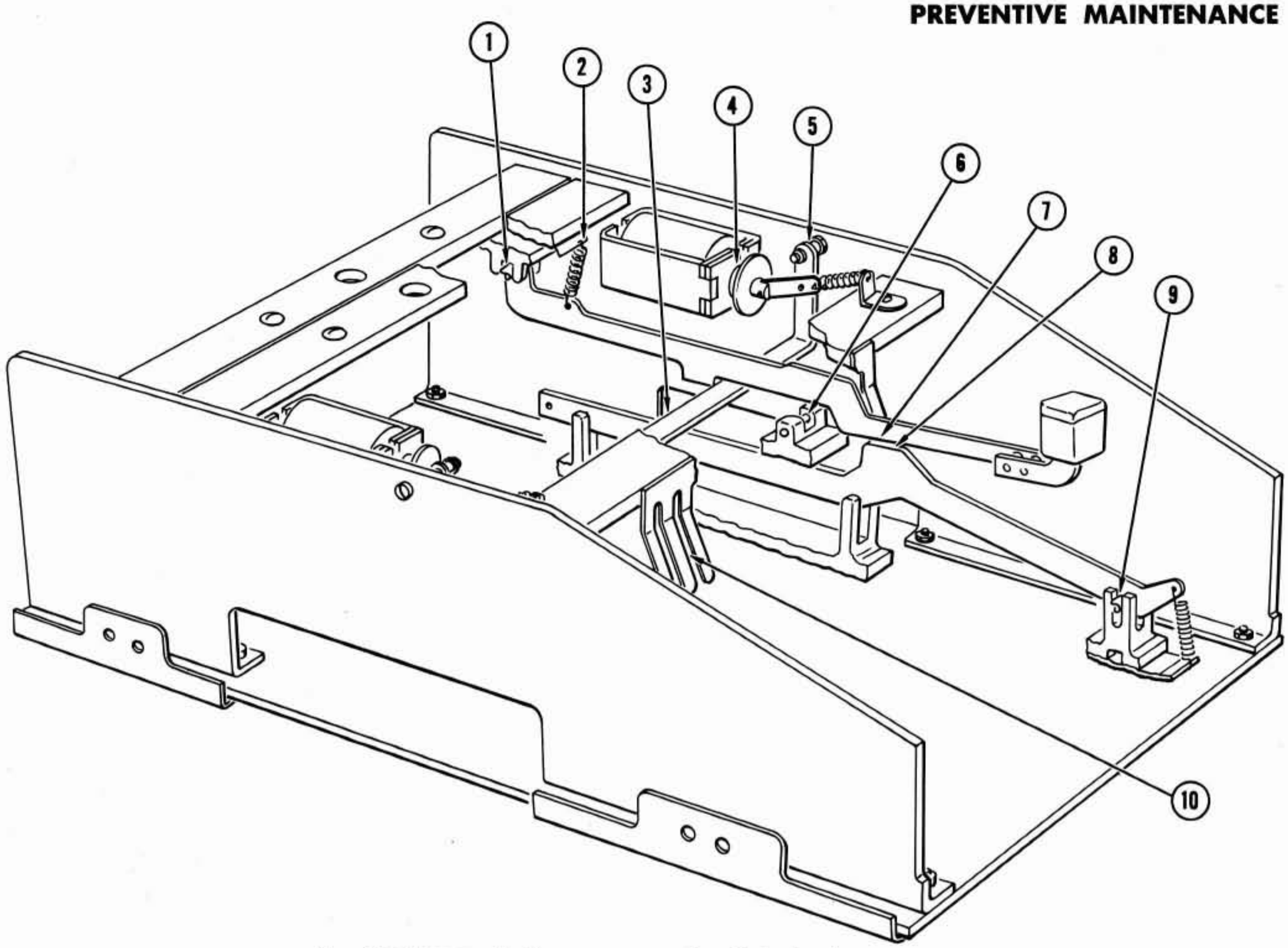
a. Circuit breakers control AC power and functions of more than one console.

b. DC POWER OFF switches interact and any switch can turn power off.

c. DC POWER ON switches are all paralleled and any one can turn power on.

d. If any DISPLAYS BUSY indicator is lighted, all will be lighted. The addressed console lights green and all others light yellow.

e. KEYBOARD INOPERABLE indicator will be lighted on all non-addressed consoles, or if not in a keyboard mode, or if the console is busy.



1. Keylever shaft
2. Spring hook
3. Power assist bail
4. Solenoid plunger
5. Power assist bail pivot
6. Interlock
7. Keylever bottom
8. Shutter top
9. Shutter shaft
10. Comb

Figure 5-8. Keyboard Assembly, Breakdown Diagram

f. Ability to use keyboard for writing of displays shall not occur on any console other than the addressed console.

g. The computer simulator is connected to perform off-line performance test, by interchanging the computer cable and computer simulator cable connections at connector receptacles J300013 and J300014 and the DUMMY connector receptacles.

4.1 Power Sequencer Test

The power sequencer provides the manual controls and automatic circuitry for energizing and monitoring the dc power application and removal to and from the logic and display circuits. The power sequencer performance test is outlined in table 5-8 which includes a planned turn on sequence to aid in trouble shooting each procedural step.

4.2 Card Reader Test

When the display console is addressed and a properly coded identification or test card is inserted into the card reader, the card bits will be displayed by the CARD READER indicators (29, figure 5-1) of the Saturn Display-Computer Simulator. If an improperly coded card is inserted or no card is in the card reader, the Typotron tube remains dunked, keyboard request controls are inhibited, and no card bit indications are displayed by the simulator. The card reader performance test procedure is outlined in table 5-9.

4.3 Keyboard Compose Mode Test

In keyboard compose mode of operation, character keys actuated at the keyboard are duplicated on the display screen. When four characters have been accumulated in the shift register or an insert or delete has been inserted the keyboard becomes inoperable and a ready for transfer signal is sent to the simulator. After characters have been accepted by the simulator the keyboard becomes operable and four more characters can be produced. Table 5-10 outlines the procedural steps necessary to fully check the keyboard compose mode of operation.

4.4 Keyboard Edit Mode Test

In the keyboard edit mode only one character at a time may be transferred to the simulator. The character logic plus the horizontal and vertical position logic for each character are transferred to the simulator, but no spaces on end of line symbols are transferred. After each character is displayed an underscore is placed beneath the space where the next character provided will appear. In this mode only TAB/CHAR positions 1, 2, and 3 display character data. Table 5-11 outlines the keyboard edit mode test procedure.

4.5 Tabular Mode Test

In tabular mode four characters at a time are transferred to the display screen from the simulator. These characters are displayed on the screen in tabular form in a space 50 characters wide by 32 lines long. The tabular mode test procedure is outlined in table 5-12.

4.6 Tabular Edit Mode Test

The tabular edit mode of operation is similar to the tabular mode; the only difference is that in this mode a tab symbol (. . .) is placed below the normal character as an underscore. Table 5-13 outlines the tabular edit mode test procedures.

4.7 Graph Mode Test

The graph mode consists of three submodes; coordinate tracing, plotting, and jump scan plotting. In this mode each word consists of three characters of eight bits each. Character one of a graph word defines the submode as coordinate trace if the octal value is 376 or 377, jump scan if the octal value is 373, and plotting if the octal value is not one of these. In jump scan the second character is the X position and the third character is the Y position. The second character of a horizontal or vertical coordinate word is the vertical placement of the horizontal coordinate or the horizontal placement of the vertical coordinate; the third character in the coordinate mode contains no information. Table 5-14 outlines the test procedure for checking the graph submode circuitry.

4.8 Overvoltage and Undervoltage Test

CAUTION

Remove cabinet modules and disconnect dc power cables to the consoles to prevent equipment damage.

An external 0-34 volts, 5 amp power supply is required to simulate over and under voltage conditions of the -6.5v, -26v and +26v power supplies. Test the over and under voltage circuits as follows:

a. Disconnect the dc output wires of a -6.5v power supply. Connect the external supply to these wires in the proper polarity.

b. Set the external power supply to -6.5v and sequence the power on.

c. Vary the external power supply slowly to provide an overvoltage condition, but do not exceed 7.5 volts during overvoltage test or 5.0 volts during under voltage test.

d. When power sequences off, measure the output of the external supply with a digital voltmeter and record the reading. Power off sequence trip should occur at 7.3 volts.

e. Repeat steps c and d for an undervoltage condition.

f. If the readings in step d and e do not agree with table 5-7 refer to paragraph 4.7 of Section III for overvoltage and undervoltage adjustment procedures.

g. Repeat steps a through e for each of the -26v, +26v and the remaining -6.5v power supplies. When testing the -26 volt protection circuit, set the external supply to -19.5 volts.

The conditions recorded in performing steps a through g should be as listed in table 5-7. Once set do not readjust but check all other voltages to fall within range of table 5-7.

Table 5-7. Overvoltage and Undervoltage Trip Ranges

NOMINAL VOLTAGE	TRIP RANGE	
	OVERVOLTAGE	UNDERVOLTAGE
-6.5 V	-7.0 to -8.0	-4.5 to -6.0
-26 V	-29 to -35	-17 to -23
+26 V	+29 to +35	+17 to +23

NOTE: For the OVERVOLTAGE readings, the lower value is the "may trip" value and the higher value is the "must trip" value. For the UNDERVOLTAGE readings the lower value is the "must trip" value and the higher is the "may trip" value.

Table 5-8. Power Sequence Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
CAUTION To prevent damage to modules, before proceeding with this test, remove all modules from display cabinets and display consoles			
1	Set all circuit breakers to OFF		
2	Set MAIN POWER circuit breaker to ON		
3	Set CONSOLE 1 CONVENIENCE OUTLETS circuit breaker to ON	Verify that 120 VAC is present at all convenience outlets of console No. 1	Check circuit breakers CB300307, CB300309 rfi filter FL000031, convenience outlets J321001, J321002 and associated power lines
4	Set CABINET CONVENIENCE OUTLETS circuit breaker to ON	Verify that 120 VAC is present at all convenience outlets of cabinet 30	Check circuit breakers CB300308, CB300309, rfi filter FL000031, convenience outlets J300016, J300017, and associated power lines
5	Set CONSOLE 3 and 4 CONVENIENCE OUTLETS circuit breaker to ON	Verify that 120 VAC is present at all convenience outlets of consoles No. 3 and No. 4	Check circuit breakers CB310308, CB300309, rfi filter FL000032, con- convenience outlets J321001 and J321002 of each console, and associated power lines
6	Set CABINET 2 and CONSOLE 2 CONVENIENCE OUTLETS circuit breaker to ON	Verify that 120 VAC is present at convenience outlets of cabinet 31 and console No. 2	Check circuit breakers CB310307, J310021 and J310022 of cabinet 31, convenience outlets J321001 and J321002 of console No. 2, and associated power lines
7	Set CONSOLE 5 and 6 CONVENIENCE OUTLETS circuit breaker to ON	Verify that 120 VAC is present at all convenience outlets of consoles No. 5 and No. 6	Check circuit breaker CB310309, convenience outlets J321001 and J321002 of consoles No. 5 and No. 6 and associated power lines
8	Set CONSOLE 3 and 4 POWER and BLOWERS circuit breaker to ON	Observe that blowers of consoles No. 3 and No. 4 are operating	Check circuit breaker CB310305, blowers B321001 of consoles No. 3 and No. 4 and associated power lines

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
9	Set CONSOLE 5 and 6 POWER and BLOWERS circuit breaker to ON	Observe that blowers of consoles No. 5 and No. 6 are operating	Check circuit breaker CB310306, blowers B321001 of consoles No. 5 and No. 6 and associated power lines Check time delay relay K310001 and blower air vane switches
10	Set CABINET 2 and CONSOLE 2 POWER and BLOWER circuit breaker to ON	Observe that blowers of cabinet No. 31 and console No. 2 are operating	Check circuit breaker CB3010304, blowers B310001 and B310002, blower B321001 of Console No. 2, and associated power lines
11	Set CONSOLE 1 POWER circuit breaker to ON		
12	Set BLOWERS and 28V P. S. circuit breaker to ON, and start stop watch or note position of sweep-second hand of clock	a. Observe that blowers of cabinet 30 are operating b. RUNNING TIME meter is operating	a. Check circuit breaker CB300306, blowers B300001 and B300002 and associated power lines b. Check meter M300301
13	Press DC POWER OFF switch on each console to set in safe position	CONSOLE DC POWER OFF SWITCH/ BLOWER STATUS 1 2 3 4 5 6 indicators (15, figure 3-1) light red	Check DC POWER OFF switch of associated indicator, bulb and resistor, fuse F300301, unregulated -28 VDC power supply of Power Sequencer Assembly A300301, and continuity of wiring (see figure 6-15)
14	Press DC POWER OFF switch on each console to set in standby position	CONSOLE DC POWER OFF SWITCH/ BLOWER STATUS 1 2 3 4 5 6 indicators go out	Same as step 13
15	Set circuit breakers that control console blowers alternately OFF and ON individually in sequence while allowing blower to completely stop; observe associated CONSOLE DC POWER OFF SWITCH/ BLOWER STATUS 1 2 3 4 5 6 indicators	Associated indicator lights red when blower is stopped and goes out when blower reaches operating speed	Check blower and air vane switch of associated console Check time delay relay K310001 and associated diode circuit

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
16	Set -6.5 VDC POWER SUPPLIES 1 and 2, -26 VDC POWER SUPPLIES 1 and 2, +26 VDC POWER SUPPLY 1, -300 VDC, +300 VDC POWER SUPPLIES 3 and 4, and +26 VDC POWER SUPPLY circuit breakers to ON		
17	Press DC POWER OFF switch of the Power Sequencer Assembly to set it in the safe position	DC POWER OFF indictor lights red and DC POWER OFF indicators of all consoles light yellow	Check switch-indicator assemblies A300302 and A320002, relay K300318, resistors R300301 and R300303, and resistors R320017 of the associated console
18	Press DC POWER OFF switch of the Power Sequencer Assembly to set it in the caution position	DC POWER OFF indicators of sequencer and consoles go out	Check switch-indicator assembly A300302, relay K300318, and relay K300326
19	Press DC POWER OFF switches of each console in succession to set in safe condition, and after observing correct performance set switch back to standby	DC POWER OFF indicator of operated console lights red; DC POWER OFF indicator of all other consoles and sequencer light yellow	Same as step 17
20	Observe time noted in step 12, if 30 seconds have not elapsed, wait	DC POWER ON indicator lights red and after 30 seconds lights yellow (timed from application of 28 v relay power)	Check switch-indicator assembly A300301, relay K300328, and relay K300309
21	Connect a copper-constantan thermocouple to Portable Potentiometer, place junction adjacent to thermal switch at top of cabinet 30; and place heated soldering iron in close proximity to thermocouple switch	When meter indicates 125 degrees Fahrenheit OVERHEAT indicator lights red	Check thermocouple switch S300001, relay K300327, and indicator DS300319
22	Allow time for OVERHEAT indicator to extinguish and place thermocouple adjacent to thermal switch at top of cabinet 31 and heat with soldering iron as in step 21	Same as step 21	Check thermal switch S310001

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
23	Press DC POWER ON switch and hold depressed momentarily	DC POWER ON indicators light white to indicate sequence is incomplete	Check relay 30K300307
		DC POWER SUPPLY STATUS -6. 5 VDC indicators (21, figure 3-1) light, and POWER ON indicator of associated (4, figure 3-6) power supplies light green	Check lamps 30DS300307 through 30DS300310, relays 30K300312 through 30K300315, 30K300322, 30K310301, and power supplies 30PS301701, 30PS301901, 30PS311701, and 30PS311901
		DC POWER SUPPLY STATUS -26 VDC indicators (20, figure 3-1) light and POWER ON indicator (4, figure 3-6) of associated power supplies light green	Check lamps 30DS300311 through 30DS300314, relays 30K300301 through 30K300304, 30K300301 through 30K300304, 30K300323, 30K310302, and power supplies 30PS302101, 30PS302301, and 30PS312101
		DC POWER SUPPLY STATUS +26 VDC indicators (19, figure 3-1) light, and POWER ON indicator (4, figure 3- 6) of associated power supplies light green	Check lamps 30DS300315, 30DS300316, relays 30K300305, 30K300306, 30K300324, 30K310303, and power supplies 30PS301501, 30PS311501
		DC POWER SUPPLY STATUS -300 VDC and +300 VDC indicators (17 and 18, figure 3-1) light and POWER ON indicator (4, figure 3-5) of associated power supplies light green	Check lamps 30DS300317, 30DS300318, relays 30K300316, 30K3003K17, 30K300325, and power supplies 30PS300101, 30PS301301
		DC POWER ON indicators (1, figure 3-1) and (3, figure 3-4) light green	Check relays 30K300310, 30K300321
		Power on warning indicator on each console lights red, CRT POWER indicator lights yellow	Check lamp DS320001 and associated circuit check switch-indicator assembly A320003

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
24	Attach external power supply in place of -300 VDC Power Supply, connect digital voltmeter across output, and reduce power output until equipment turns off; record voltage level at time when turn off occurred	Power turn off sequence removes power in following sequence: ±300 VDC +26 VDC -26 VDC -6.5 VDC	Check 30CR300317, 30CR300335, 30K300317, and 30R300324
25	Remove external supply and reconnect -300 VDC Power Supply		
26	Repeat action of step 24 for the +300 VDC Power Supply	Same as step 24	Check circuit consisting of 30CR300316, 30CR300333, 30K300316, and 30R300323
27	Remove external supply and reconnect +300 VDC Power Supply		
28	Repeat action of step 24 for all -26 VDC Power Supplies and check for both increase and decrease of voltage (output voltage is -19.5 volts)	Same as step 24	Check over voltage protection circuit alignment and components
29	Repeat action of step 24 for all +26 VDC Power Supplies and check for both increase and decrease of voltage	Same as step 24	Check under voltage protection circuit alignment and components
30	Repeat action of step 24 for all -6.5 VDC Power Supplies and check for both increase and decrease of power	Same as step 24	Check under voltage protection circuit alignment and components
31	Set +300 VDC -300 VDC Power Supplies circuit breaker (7, figure 3-1) to OFF and sequence equipment ON	Power turn on sequence progresses until the 300 volt supply is energized, sequence stops and after six second time elapse the off sequence is initiated	Check time delay relay 30K300326
32	Check voltages recorded during steps 24 through 30	Should agree with voltage limits of under/over voltage protection alignment	Align under/over voltage protection circuits, refer to paragraph 5-
33	Press INHIBITED switch	INHIBITED indicator lights yellow	Check switch-indicator assembly A300303
34	Press DC POWER OFF switches of consoles	DC POWER OFF switch has no affect	Check circuit according to figure 6-15

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
35	Replace modules, reset circuit breaker to ON, and sequence equipment ON	DC POWER ON STATUS indicators light in following sequence -6.5 VDC (21), -26 VDC (20), +26 VDC (19), ±300 VDC (17-18); DC POWER ON indicator (1) lights green; warning light (3, figure 5-) lights red; KEYBOARD INOPERABLE indicator (4, figure 3-3) lights yellow; and CRT POWER ON indicator (6, figure 3-4) lights yellow	Same as step 16
36	Set DISPLAY ADDRESS CAB switch (22, figure 5-1) to BOTH		
37	Set DISPLAY ADDRESS switches (21) for addressing console No. 1 (table 1-11), set TRIGGER SELECT (16) to CC, momentarily press TRIGGER SWITCH (15)	DISPLAYS INOP indicator (3) lights, and DISPLAYS BUSY indicator (4, figure 3-4) of the addressed console lights green	Check address logic per figure 6-2 of Volume II
38	Set DISPLAY ADDRESS switches (21, figure 5-1) for addressing the other consoles of the system individually in sequence and momentarily press TRIGGER switch (15) for each new address switch arrangement	Same as step 37	Same as step 37
39	Insert test card No. 1 into card reader (1, figure 3-3) and momentarily press CRT POWER switch (6, figure 3-4) of each console in the system	CRT POWER indicator lights white, approximately 50 seconds later check that following voltage indications (±300 vdc) are present at high voltage meter of tube control panel voltage meter of tube control panel position 1 8700 VDC position 2 3250 VDC position 3 2750 VDC position 4 3400 VDC Approximately three minutes after CRT POWER switch has been activated the CRT POWER	Check display tube power circuit per figure 6-13, and check high voltage power supply alignment per procedure of paragraph 5-

Table 5-8. Power Sequence Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
39 (Cont)		indicator (2, figure 3-4) lights green, and DISPLAYS INOP indicator (3, figure 5-1) goes out	

Table 5-9. Card Reader Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Place all switches on simulator (figure 5-1) to down position, place TRIGGER SELECT switch (16) up, momentarily press TRIGGER switch (15), place TRIGGER SELECT switch (16) down, and momentarily press MODE RESET switch (19)		
2	Remove test card from card reader at operating console	Display screen voltage is removed resulting in no light output on screen surface (Typotron DUNK)	Check card reader circuit per figure 6-9, clear/erase and unblank circuit per figure 6-5, and tube bias control circuits per figure 6-13
3	Place test card 1 in card reader (2, figure 3-3)	Light output may be observed on display screen surface (Typotron UNDUNKED)	Same as step 2
4	Press KEYBOARD COMPOSE switch (7, figure 3-3)	KEYBOARD COMPOSE indicator (7) lights yellow, PRIORITY INTER indicator (6, figure 5-1) lights, and MODE REQUEST ADDRESS indicator (28) associated with operating console lights	Check mode selection and control circuits per figure 6-7

Table 5-9. Card Reader Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
5	Set DISPLAY ADDRESS switches (21, figure 5-1) to address of operating console (See table 1-11.) Set TRIGGER SELECT switch (16) and CLEAR switch (23) up, and momentarily press TRIGGER switch (15); then place operated switches down	PRIORITY INTER indicator (6) goes out, KBD REQUEST COMPOSE indicator (8) lights, CARD READER indicators (29) light in accordance with figure 5-9, and display screen erases	Same as step 4
6	Place DISPLAY ADDRESS switches (21) to address a different console, momentarily press TRIGGER switch (15); then place operated switches down	CARD READER indicators (29) and KBD REQUEST COMPOSE indicator (8) goes out; since the proper console has not been addressed	Check addressing circuits per figure 6-2
7	Repeat step 6 for all console addresses	Same as step 6	Same as step 6
8	Remove test card from card reader	KEYBOARD COMPOSE indicator (7, figure 3-3) goes out, Typotron tube DUNKS, and appropriate MODE REQUEST ADDRESS indicator (28, figure 5-1) goes out	Same as step 2
9	Repeat steps 3 through 8 using test cards 2 and 3	Same as steps 3 through 8	Same as steps 3 through 8
10	Insert test card 4 into card reader (2, figure 3-3) and press KEYBOARD COMPOSE switch (7)	Typotron tube remains DUNKED, KEYBOARD COMPOSE indicator (7) does not light, and PRIORITY INTER indicator (6, figure 5-1) does not light	Check clear/erase and unblank circuit per figure 6-5
11	Remove test card 4, insert test card 5, and press KEYBOARD EDIT switch (6, figure 3-3)	Typotron tube UNDUNKS, KEYBOARD EDIT indicator (6, figure 3-3) lights yellow, PRIORITY INTER indicator (6, figure 5-1) and MODE REQUEST ADDRESS indicators (28) light	Same as step 4

Table 5-9. Card Reader Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
12	Set DISPLAY ADDRESS switch (21, figure 5-1) to address proper console, as in step 5	PRIORITY INTER indicator (6, figure 5-1) lights, KBD REQUEST EDIT indicator (9) lights, and CARD READER indicators (29) light in accordance with figure 5-9	Same as step 5
13	Place DISPLAY MODE 2^2 and 2^1 switches (17) up, momentarily press TRIGGER switch (15), and momentarily press READ switch (10); place operated switches down	KBD REQUEST EDIT indicator (9) and MODE REQUEST ADDRESS indicator (28) go out, KEYBOARD EDIT indicator (6, figure 3-3) changes from yellow to green, DISPLAYS BUSY indicator (6, figure 3-4) lights green; DISPLAYS BUSY indicator (6) and KEYBOARD INOPERABLE indicator (4, figure 3-3) of other consoles in the system light yellow	Same as step 4
14	Place DISPLAY ADDRESS switches (21, figure 5-1) to address different console, set TRIGGER SELECT switch (16) up	CARD READER indicators (29, figure 5-1) go out, KEYBOARD EDIT indicator (6, figure 3-3) goes out, KEYBOARD INOPERABLE indicator (4) and DISPLAYS BUSY indicator (6, figure 3-4) light yellow	Same as step 6
15	Repeat step 14 for all console addresses	KEYBOARD INOPERABLE indicator (4, figure 3-3) and DISPLAYS BUSY indicator (6, figure 3-4) light yellow	Same as step 6
16	Momentarily press MODE RESET switch (19, figure 5-1) and remove test card from card reader	DISPLAYS BUSY indicator (6, figure 3-4) goes out and Typotron tube DUNKS	Same as step 2

Table 5-9. Card Reader Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
17	Repeat steps 11 through 16 using test cards 6 and 7; leave card 7 in card reader for subsequent tests and place operated switches down	Same as steps 11 through 16	
18	Repeat preceding procedure for all consoles in the system		

Card Number	"Card Reader" Lamps on Simulator						Octal Equivalent
	2^5	2^4	2^3	2^2	2^1	2^0	
1	ON	ON	ON	ON	ON	ON	(77)
2	ON	ON	ON	ON	ON	ON	(77)
3	ON	ON	ON	ON	ON	ON	(77)
4	OFF	OFF	OFF	OFF	OFF	OFF	(00 Dunk)
5	OFF	ON	ON	OFF	ON	ON	(33)
6	ON	OFF	ON	ON	OFF	ON	(55)
7	ON	ON	OFF	ON	ON	OFF	(66)
8	OFF	OFF	OFF	OFF	OFF	OFF	(00)
9	OFF	OFF	OFF	OFF	OFF	OFF	(00)
10	OFF	OFF	OFF	OFF	OFF	OFF	(00)
11	OFF	OFF	ON	OFF	OFF	ON	(11)
12	OFF	ON	OFF	OFF	ON	OFF	(22)
13	ON	OFF	OFF	ON	OFF	OFF	(44)

Figure 5-9. Card Reader Indications on the Simulator

Table 5-10. Keyboard Compose Mode, Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in Table 5-8.		
1	Press KEYBOARD COMPOSE switch (7, figure 3-3)	KEYBOARD COMPOSE indicator (7) lights yellow, MODE REQUEST ADDRESS indicator (28, figure 5-1) lights, and PRIORITY INTER (6) indicator lights	Check mode selection circuits per figure 6-7
2	Set DISPLAY ADDRESS switches (21, figure 5-1), TRIGGER SELECT switch (16), CLEAR switch (23) up; momentarily press TRIGGER switch (15); then place operated switches down	KBD REQUEST COMPOSE indicator (8, figure 5-1) lights, CARD READER indicators (29) light in accordance with figure 5-9, and PRIORITY INTER indicator (6) goes out	Check addressing circuits per figure 6-2
3	Set DISPLAY MODE 2^2 and 2^0 switches (17, figure 5-1) up, set RESET CTRS switch (27) up, and momentarily press TRIGGER switch (15); then set operated switches down	MODE REQUEST ADDRESS indicator (28) and KBD REQUEST COMPOSE indicator (8) go out, KEYBOARD COMPOSE indicator (7, figure 3-3) changes from yellow to green and DISPLAYS BUSY indicator (6, figure 3-4) lights green	Same as step 1
4	Type line 1 of figure 5-10 After KEYBOARD INOPERABLE indicator lights momentarily press DATA TRANSFER READ switch (10), figure 5-1)	Typed characters appear at top left of display screen display area and KEYBOARD INOPERABLE indicator (4, figure 3-3) lights TAB/KBD CHAR 1, 2, 3, 4 indicators (1, figure 5-1) light in accordance with binary codes of figure 5-10 and KEYBOARD INOPERABLE indicator goes out	Check data transfer circuits per figure 6-4, character position circuits per 6-8, and character selection circuits per figure 6-10, and clear/erase and unblank circuit figure 6-5

Table 5-10. Keyboard Compose Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
5	Type line two of figure 5-10 After KEYBOARD INOPERABLE indicator lights momentarily press DATA TRANSFER READ switch (10, figure 5-1)	Typed characters appear on display screen immediately after characters typed in step 4 and KEYBOARD INOPERABLE indicator (4, figure 3-3) lights TAB/KBD CHAR 1, 2, 3, 4 indicators (1, figure 5-1) light in accordance with binary codes of figure 5-10 and KEYBOARD INOPERABLE indicator goes out	Same as step 4
6	Repeat steps 4 and 5 for lines three and four of figure 5-10	Same as step 5 except INSERT indicator (5, figure 5-1) lights when last key of line four is pressed	Same as step 4
7	Set DISPLAY MODE 2^2 and 2^0 switches (17) up and momentarily press TRIGGER switch (15); then set operated switches down	INSERT indicator (5) goes out and KEYBOARD INOPERABLE indicator (4, figure 3-3) goes out	Same as step 1
8	Momentarily press ERASE switch (7, figure 3-4)	Display screen erases and KEYBOARD INOPERABLE indicator (4, figure 3-3) lights while display screen is erasing	Check clear/erase and unblank circuits per figure 6-5
9	Set DATA TRANSFER switch (13, figure 5-1) to AUTO and type line five of figure 5-10	KEYBOARD INOPERABLE indicator (4, figure 3-3) does not light, typed characters appear at top left of display screen display area, as in step 4; and TAB/KBD CHAR 1, 2, 3, 4 indicators (1, figure 5-1) light in accordance with binary codes of figure 5-10	Same as step 4
10	Type lines six through twelve of figure 5-10	Same as step 9 except when END of LINE key is pressed an underscore (–) appears at the position of the next character on line below the one just typed and at left hand margin	Same as step 4

Table 5-10. Keyboard Compose Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
11	Type lines thirteen through sixteen of figure 5-10	Same as step 9 except when space bar is pressed an underscore appears where the next character will be written, and when DELETE key is pressed the DELETE indicator (4, figure 5-1) and INSERT indicator (5) light	Same as step 4
12	Set DATA TRANSFER switch (13) to SINGLE WORD and DISPLAY MODE 2^2 and 2^0 switches (17) up	DELETE indicator (4) and INSERT indicator (5) go out	
13	Type line seventeen of figure 5-10 After KEYBOARD INOPERABLE indicator lights momentarily press DATA TRANSFER READ switch (10, figure 5-1) TAB/KBD CHAR 1, 2, 3, indicators (1) light in accordance with binary codes of figure 5-10 and KEYBOARD INOPERABLE indicator (4, figure 3-3) goes out	Typed characters appear on display screen, KEYBOARD INOPERABLE indicator (4, figure 3-3) lights, DELETE indicator (4, figure 5-1) lights, and INSERT indicator (5) lights	Same as step 4
14	Type lines eighteen and nineteen of figure 5-10	Same as step 13	Same as step 4
15	Type line twenty of figure 5-10 After KEYBOARD INOPERABLE indicator lights, momentarily press DATA TRANSFER READ switch (10, figure 5-1)	Typed characters appear on display screen, KEYBOARD INOPERABLE indicator (4, figure 3-3) lights, and INSERT indicator (5, figure 5-1) lights TAB/KBD CHAR 1, 2 indicators (1) light in accordance with binary code of figure 5-10	Same as step 4
16	Repeat step 7	Same as step 7	Same as step 1
17	Same as step 8	Same as step 8	Same as step 8

Table 5-10. Keyboard Compose Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
18	Type line twenty-one of figure 5-10 After KEYBOARD INOPERABLE indicator lights, momentarily press DATA TRANSFER READ switch (10, figure 5-1)	Character is written at top left hand margin of display screen display area, KEYBOARD INOPERABLE indicator (4, figure 3-3) lights, and INSERT indicator (5, figure 5-1) lights TAB/KBD CHAR 1, 2 indicators (1) light in accordance with binary codes of figure 5-10 and KEYBOARD INOPERABLE indicator (4, figure 3-3) goes out	Same as step 4
19	Repeat steps 7 and 8	Same as steps 7 and 8	
20	Type line twenty-two of figure 5-10. After KEYBOARD INOPERABLE indicator lights, momentarily press DATA TRANSFER READ switch (10, figure 5-1)	No character appears on display screen, KEYBOARD INOPERABLE indicator (4) lights, and INSERT indicator (5, figure 5-1) lights TAB/KBD CHAR 1 indicators (1) light in accordance with binary code of figure 5-10 and KEYBOARD INOPERABLE indicator (4, figure 3-3) goes out	Same as step 4
21	Repeat step 7	Same as step 7	Same as step 1
22	Momentarily press MODE RESET switch (19, figure 5-1)	KEYBOARD COMPOSE indicator (7, figure 3-3) goes out, DISPLAYS BUSY indicator (6, figure 3-4) goes out, and KEYBOARD INOPERABLE indicator (4, figure 3-3) lights	Same as step 1

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR				CHARACTERS DISPLAYED ON THE TYPOTRON CHARACTERS TO BE TYPED			
	CH 1	CH 2	CH 3	CH 4				
1	(01) 000001	(02) 000010	(03) 000011	(04) 000100	1	2	3	4
2	(05) 000101	(06) 000110	(07) 000111	(10) 001000	5	6	7	8
3	(11) 001001	(12) 001010	(13) 001011	(14) 001100	9	+	▶	◀
4	(15) 001101	(16) 001110	(20) 010000	(17) 001111	†	=	Ø	insert (no symbol)
5	(21) 010001	(22) 010010	(23) 010011	(24) 010100	/	S	T	U
6	(25) 010101	(26) 010110	(27) 010111	(30) 011000	V	W	X	Y
7	(31) 011001	(32) 011010	(33) 011011	(34) 011100	Z	÷	,	>
8	(36) 011110	(35) 011101	(37) 011111	(40) 100000	•••	<	⊣⊢	–
9	(41) 100001	(42) 100010	(43) 100011	(44) 100100	J	K	L	M
10	(45) 100101	(46) 100110	(47) 100111	(50) 101000	N	O	P	Q
11	(51) 101001	(52) 101010	(53) 101011	(54) 101100	R	*	)	.

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR				CHARACTERS DISPLAYED ON THE TYPOTRON CHARACTERS TO BE TYPED			
	CH 1	CH 2	CH 3	CH 4				
12	(55) 101101	(60) 110000	(57) 101111	(56) 101110	↚	(	←	end of line (no symbol)
13	(61) 110001	(62) 110010	(63) 110011	(64) 110100	A	B	C	D
14	(65) 110101	(66) 110110	(67) 110111	(70) 111000	E	F	G	H
15	(71) 111001	(72) 111010	(73) 111011	(74) 111100	I	↓	■	↑
16	(75) 111101	(76) 111110	(00) 000000	(77) 111111	✛	→	space bar (no symbol)	≡ (delete)
17	(01) 000001	(02) 000010	(77) 111111		1	2	≡ (delete)	
18	(03) 000011	(77) 111111			3	≡ (delete)		
19	(77) 111111				≡ (delete)			
20	(01) 000001	(02) 000010	(17) 001111		1	2	insert (no symbol)	
21	(61) 110001	(17) 001111			A	insert (no symbol)		
22	(17) 001111				insert (no symbol)			

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Figure 5-10. Keyboard Compose Mode

Table 5-11. Keyboard Edit Mode, Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Press KEYBOARD EDIT switch (6, figure 3-3)	KEYBOARD EDIT indicator (6) lights yellow, MODE REQUEST ADDRESS indicator (28, figure 5-1) lights, PRIORITY INTER (6) lights, and KBD REQUEST EDIT indicator (9) lights	Check mode selection circuits per figure 6-7
2	Set DISPLAY ADDRESS switch (21), CLEAR switch (23), TRIGGER SELECT switch (16) up, and momentarily press TRIGGER switch (15)	PRIORITY INTER indicator (6) goes out and display screen erases	Check addressing circuits per figure 6-2 and clear/erase and unblank circuits of figure 6-5
3	Set DISPLAY MODE 2^2 and 2^1 switches (17) up, RESET CTRS (27) up, and momentarily press TRIGGER switch (15); then set all operated switches down	MODE REQUEST ADDRESS indicators (28) go out, KBD REQUEST EDIT indicator (9) goes out, DISPLAYS BUSY indicator (6, figure 3-4) lights green, and KEYBOARD EDIT indicator (6, figure 3-3) changes from yellow to green	Check mode selection circuits per figure 6-7, transfer control circuits per figure 6-3
4	Type line one of figure 5-11	Character 1 appears at top left margin of display screen display area followed by an underscore and KEYBOARD INOPERABLE indicator (4) lights	Check data transfer circuits per figure 6-4, Underscore generation circuits per figure 6-12, character selection and positioning circuits per figures 6-8 and 6-10, and clear/erase and unblank circuit per figure 6-5
5	Momentarily press DATA TRANSFER READ switch (10, figure 5-1)	TAB/KBD CHAR 1, 2, 3, indicators (1, figure 5-1) light in accordance with binary codes of figure 5-11 and KEYBOARD INOPERABLE indicator (4, figure 3-3) goes out	Same as step 4

Table 5-11. Keyboard Edit Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
6	Repeat steps 4 and 5 for lines two through fifteen of figure 5-11	Associated characters appear on the display screen above the underscore placed by the preceding characters until line fifteen INSERT KEY is pressed then INSERT indicator (5, figure 5-1) lights	Same as step 4
7	Press ERASE switch (7, figure 3-4), set DISPLAY MODE 2^2 and 2^1 switches (17, figure 5-1) up, momentarily press TRIGGER switch (15); then set operated switches down	Display screen erases	Same as step 2
8	Set DATA TRANSFER switch (10) to READ	INSERT indicator (5) goes out	
9	Type line sixteen of figure 5-11	Associated character appears at top left margin of display screen display area followed by an underscore and TAB/ KBD CHAR 1, 2, 3 indicators (1) light in accordance with binary code of figure 5-11	Same as step 7
10	Repeat step 9 for lines seventeen through sixty-four of figure 5-11	Associated characters appear on display screen above underscore placed by the preceding character NOTE: DELETE key does not cause DELETE indicator (4) to light in keyboard edit mode	Same as step 4
11	Place DATA TRANSFER switch (13) to SINGLE WORD and momentarily press MODE RESET switch (19)	DISPLAYS BUSY indicator (6, figure 3-4) goes out and KEYBOARD EDIT indicator (6, figure 3-3) goes out	Same as step 1

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR			CHAR. TO BE TYPED
	CH 1	CH 2	CH 3	
1	(01) 000001	(01) 000001	(00) 000000	1
2	(02) 000010	(02) 000010	(00) 000000	2
3	(03) 000011	(03) 000011	(00) 000000	3
4	(04) 000100	(04) 000100	(00) 000000	4
5	(05) 000101	(05) 000101	(00) 000000	5
6	(06) 000110	(06) 000110	(00) 000000	6
7	(07) 000111	(07) 000111	(00) 000000	7
8	(10) 001000	(10) 001000	(00) 000000	8
9	(11) 001001	(11) 001001	(00) 000000	9
10	(12) 001010	(12) 001010	(00) 000000	+
11	(13) 001011	(13) 001011	(00) 000000	⧐

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR			CHAR. TO BE TYPED
	CH 1	CH 2	CH 3	
12	(14) 001100	(14) 001100	(00) 000000	⧏
13	(15) 001101	(15) 001101	(00) 000000	⫯
14	(16) 001110	(16) 001110	(00) 000000	=
15	(17) 001111	(17) 001111	(00) 000000	insert (no symbol)
16	(20) 010000	(01) 000001	(00) 000000	Ø
17	(21) 010001	(02) 000010	(00) 000000	/
18	(22) 010010	(03) 000011	(00) 000000	S
19	(23) 010011	(04) 000100	(00) 000000	T
20	(24) 010100	(05) 000101	(00) 000000	U
21	(25) 010101	(06) 000110	(00) 000000	V
22	(26) 010110	(07) 000111	(00) 000000	W

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR			CHAR. TO BE TYPED
	CH 1	CH 2	CH 3	
23	(27) 010111	(10) 010000	(00) 000000	X
24	(30) 011000	(11) 001001	(00) 000000	Y
25	(31) 011001	(12) 001010	(00) 000000	Z
26	(32) 011010	(13) 001011	(00) 000000	÷
27	(33) 011011	(14) 001100	(00) 000000	,
28	(34) 011100	(15) 001101	(00) 000000	>
29	(36) 011110	(16) 001110	(00) 000000	•••
30	(35) 011101	(17) 001111	(00) 000000	<
31	(37) 011111	(20) 010000	(00) 000000	⊣⊢
32	(40) 100000	(21) 010001	(00) 000000	–
33	(41) 100001	(22) 010010	(00) 000000	J

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Figure 5-11. Keyboard Edit Mode (Sheet 1 of 2)

LINE	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR			CHAR. TO BE TYPED
	CH 1	CH 2	CH 3	
34	(42) 100010	(23) 010011	(00) 000000	K
35	(43) 100011	(24) 010100	(00) 000000	L
36	(44) 100100	(25) 010101	(00) 000000	M
37	(45) 100101	(26) 010110	(00) 000000	N
38	(46) 100110	(27) 010111	(00) 000000	O
39	(47) 100111	(30) 011000	(00) 000000	P
40	(50) 101000	(31) 011001	(00) 000000	Q
41	(51) 101001	(32) 011010	(00) 000000	R
42	(52) 101010	(33) 011011	(00) 000000	*
43	(53) 101011	(34) 011100	(00) 000000	)
44	(54) 101100	(35) 011101	(00) 000000	.
45	(55) 101101	(36) 011110	(00) 000000	⧺
46	(56) 101110	(36) 011110	(00) 000000	end of line (no symbol)
47	(57) 101111	(01) 000001	(01) 000001	←
48	(60) 110000	(02) 000010	(01) 000001	(
49	(61) 110001	(03) 000011	(01) 000001	A
50	(62) 110010	(04) 000100	(01) 000001	B
51	(63) 110011	(05) 000101	(01) 000001	C
52	(64) 110100	(06) 000110	(01) 000001	D
53	(65) 110101	(07) 000111	(01) 000001	E
54	(66) 110110	(10) 001000	(01) 000001	F
55	(67) 110111	(11) 001001	(01) 000001	G
56	(70) 111000	(12) 001010	(01) 000001	H
57	(71) 111001	(13) 001011	(01) 000001	I
58	(72) 111010	(14) 001100	(01) 000001	↓
59	(73) 111011	(15) 001101	(01) 000001	■
60	(74) 111100	(16) 001110	(01) 000001	↑
61	(75) 111101	(17) 001111	(01) 000001	✣
62	(76) 111110	(20) 010000	(01) 000001	→
63	(76) 111110	(20) 010000	(01) 000001	space bar (no symbol)
64	(77) 111111	(22) 010010	(01) 000001	≡ (delete)

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Figure 5-11. Keyboard Edit Mode (Sheet 2 of 2)

Table 5-12. Tabular Mode Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Set DISPLAY ADDRESS switches (21, figure 5-1) up, CLEAR switch (23) up, TRIGGER SELECT switch (16) up, and momentarily press TRIGGER switch (15); then set operated switches down	Display screen erases	Check clear/erase and unblank circuits per figure 6-5
2	Set DISPLAY MODE 2^0 switch (17) up, RESET CTRS switch (27) up, and momentarily press TRIGGER switch (15); then set operated switches down and TAB switch (14) to SINGLE PAGE	DISPLAYS BUSY indicator (6, figure 3-4) lights green	Check mode selection circuits per figure 6-7 and transfer control circuits per figure 6-3
3	Set TAB/KBD CHAR 1, 2, 3, 4 switches (2) in accordance with line one binary codes of figure 5-12	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) light	
4	Momentarily press DATA TRANSFER RESET switch (12)	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) all go out	
5	Momentarily press DATA TRANSFER LOAD switch (11)	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) corresponding to operated switches light	
6	Momentarily press DATA TRANSFER READ switch (10)	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) go out NOTE: If first TAB/KBD CHAR switch is down, indicators go out; if first TAB/KBD CHAR switches up all indicators will light. Characters associated with binary codes of figure 5-12 appear on the display screen starting at top left margin of display area.	Check data transfer circuits per figure 6-4, character selection and positioning circuits per figures 6-8 and 6-10, and clear/erase and unblank circuit per figure 6-5

Table 5-12. Tabular Mode Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
7	Repeat steps 3 through 6 for lines two through four and after line four momentarily press ERASE switch (7, figure 3-4)	Characters associated with switch settings appear on display screen and display screen erases when ERASE switch is pressed	Same as step 6
8	Repeat step 3 through 6 for lines five through sixteen of figure 5-12	Characters associated with switch settings appear on display screen	Same as step 6
9	Set TAB/KBD CHAR 1, 2 3, 4 switches (2, figure 5-1) in accordance with line seventeen binary codes of figure 5-12 and momentarily press DATA TRANSFER READ switch (10)	Characters associated with switch settings appear on display screen	Same as step 6
10	Repeat step 9 for lines eighteen through twenty-one of figure 5-12	Same as step 9	Same as step 6
11	Repeat steps 1 and 2 and record time, set TAB/KBD 1, 2, 3, 4 switches (2) in accordance with line twenty-two binary codes of figure 5-12, momentarily press DATA TRANSFER RESET switch (12) then DATA TRANSFER switch (13) to AUTO then to SINGLE WORD	A full page of 50 characters by 32 lines of RCA are written on display screen; leave characters on screen until background starts to build toward white, record time; time difference between previous time record and present time record should be 4 minutes or more	Same as step 6
12	Repeat step 11 using line twenty-three of figure 5-12 and ignore time record	A vertical column of 32 lines of RCA is written on display screen	Same as step 6
13	Press KEYBOARD COMPOSE switch (7, figure 3-3)	KEYBOARD COMPOSE indicator (7) lights yellow, MODE REQUEST ADDRESS indicator (28, figure 5-1) lights, and KBD REQUEST COMPOSE indicator (7) lights	Same as step 2
14	Press MODE RESET switch (19)	PRIORITY INTER indicator (6) lights and DISPLAYS BUSY indicator (6, figure 3-4) goes out	Same as step 2

Table 5-12. Tabular Mode Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
15	Remove test card from card reader (2, figure 3-3) and reinsert card	KEYBOARD COMPOSE indicator (7) goes out, MODE REQUEST ADDRESS indicator (28, figure 5-1), and KBD REQUEST COMPOSE indicator (7) goes out	Check card reader circuits per figure 6-9

Table 5-13. Tabular Edit Mode Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Set DISPLAY ADDRESS switches (21, figure 5-1) up, CLEAR switch (23) up, TRIGGER SELECT switch (16) up, and momentarily press TRIGGER switch (15); then set operated switches down	PRIORITY INTER indicator (6) goes out and display tube erases	Check clear/erase and unblank circuits per figure 6-5
2	Set DISPLAY MODE 2^1 and 2^0 switches (17) and RESET CTRS switch (27) up and momentarily press TRIGGER switch (15); then set operated switches down	DISPLAYS BUSY indicator (6, figure 3-4) lights green	Check mode selection circuits per figure 6-7 and transfer control citcuits per figure 6-3
3	Set TAB/KBD CHAR 1, 2, 3, 4 switches (2, figure 5-1) in accordance with line one binary codes of figure 5-13 and momentarily press DATA TRANSFER RESET switch (12)	TAB/KBD CHAR indicators (1) all go out	
4	Momentarily press DATA TRANSFER LOAD switch (11)	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) corresponding to operated switches light	

Table 5-13. Tabular Edit Mode Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
5	Momentarily press DATA TRANSFER READ switch (10)	TAB/KBD CHAR 1, 2, 3, 4 indicator (1) go out (See note step 6, table 5-12) Character associated with binary codes of figure 5-13 appear on the display screen at top left margin of display area	Check data transfer circuits per figure 6-4, character positioning circuits per figure 6-8, and character selection circuits per figure 6-10, and clear/erase and unblank circuit per figure 6-5
6	Repeat steps 3 through 5 for lines two through twelve of figure 5-13	Same as steps 3 through 5	Same as step 5
7	Momentarily press MODE RESET switch (19) and record which TAB/KBD CHAR 1, 2, 3, 4 indicators are lighted	DISPLAYS BUSY indicator (6, figure 3-4) goes out	Same as step 2
8	Set DISPLAY MODE 2^2 and 2^1 switches (17, figure 5-1) up, momentarily press TRIGGER switch (15), and set DATA TRANSFER switch (13) to AUTO; then set DISPLAY MODE switches down	KEYBOARD EDIT indicator (6, figure 3-3) and DISPLAYS BUSY indicator (6, figure 3-4) lights green	Same as step 2
9	Actuate space bar of keyboard	Underscore appears three spaces to right of period of first line, and TAB/KBD CHAR 1, 2, 3, 4 indicators match record made in step 7	Check underscore generation circuits per figure 6-12
10	Actuate END OF LINE key of keyboard	Underscore appears at left margin one line below last underscore TAB/KBD CHAR 1, 2, 3, 4 indicators (1) remain unchanged	Same as step 9
11	Actuate END OF LINE key until underscore mark is beneath R of first line	Same as step 10	Same as step 9
12	Actuate SPACE BAR until underscore is beneath first tab underscore	Same as step 10	Same as step 9

Table 5-13. Tabular Edit Mode Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
13	Type in two digit number 14	First digit appears on display above the first tab underscore and second digit appears above second tab underscore TAB/KBD CHAR 1, 2, 3, 4 indicators (1) light in accordance with figure 5-14	Same as step 5
14	Actuate END OF LINE key	Underscore is displayed beneath first letter in second line TAB/KBD CHAR 1, 2, 3, 4 indicators (1) remain as in step 13	Same as step 9
15	Actuate space bar until underscore is beneath the first tab underscore	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) remain as in step 13	Same as step 9
16	Type date 10/31/63, digits appear over each tab underscore when space bar is used to jump past diagonal marks, type digits individually and check TAB/KBD CHAR 1, 2, 3, 4 indicators (1) for each digit typed	TAB/KBD CHAR 1, 2, 3, 4 indicators (1) light in accordance with figure 5-14	Same as step 5
17	Set DATA TRANSFER switch (13) to SINGLE WORD, momentarily press MODE RESET switch (19)	DISPLAYS BUSY Indicator (6, figure 3-4) and KEYBOARD EDIT indicator (6, figure 3-3) go out; KEYBOARD INOPERABLE indicator (4) lights	Same as step 2

LINE	TAB/KBD CHARACTER LAMPS AND SWITCHES ON THE SIMULATOR				CHARACTERS DISPLAYED ON THE TYPOTRON			
	CH 1	CH 2	CH 3	CH 4				
1	(01) 000001	(02) 000010	(03) 000011	(04) 000100	1	2	3	4
2	(05) 000101	(06) 000110	(07) 000111	(10) 001000	5	6	7	8
3	(11) 001001	(12) 001010	(13) 001011	(14) 001100	9	+	▶|	|◀
4	(15) 001101	(16) 001110	(20) 010000	(17) 001111	⧫	=	Ø	insert (no symbol)
5	(21) 010001	(22) 010010	(23) 010011	(24) 010100	/	S	T	U
6	(25) 010101	(26) 010110	(27) 010111	(30) 011000	V	W	X	Y
7	(31) 011001	(32) 011010	(33) 011011	(34) 011100	Z	÷	,	>
8	(36) 011110	(35) 011101	(37) 011111	(40) 100000	•••	<	⊣⊢	–
9	(41) 100001	(42) 100010	(43) 100011	(44) 100100	J	K	L	M
10	(45) 100101	(46) 100110	(47) 100111	(50) 101000	N	O	P	Q
11	(51) 101001	(52) 101010	(53) 101011	(54) 101100	R	*	)	•
12	(55) 101101	(56) 101110	(57) 101111	(60) 110000	✱̸	end of line (no symbol)	←	(
13	(61) 110001	(62) 110010	(63) 110011	(64) 110100	A	B	C	D
14	(65) 110101	(66) 110110	(67) 110111	(70) 111000	E	F	G	H
15	(71) 111001	(72) 111010	(73) 111011	(74) 111100	I	↓	■	↑
16	(75) 111101	(76) 111110	(00) 000000	(77) 111111	✛	→	space (no symbol)	≡ (delete)
17	(00) 000000	(51) 101001	(63) 110011	(61) 110001	space (no symbol)	R	C	A
18	(00) 000000	(22) 010010	(65) 110101	(43) 100011	space (no symbol)	S	E	L
19	(43) 100011	(46) 100110	(66) 110110	(66) 110110	L	O	F	F
20	(00) 000000	(23) 010011	(65) 110101	(22) 010010	space (no symbol)	T	E	S
21	(23) 010011	(73) 111011	(56) 101110	(00) 000000	T	■	end of line (no symbol)	space (no symbol)
22	(51) 101001	(63) 110011	(61) 110001	(54) 101100	R	C	A	•
23	(51) 101001	(63) 110011	(61) 110001	(56) 101110	R	C	A	end of line (no symbol)

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Figure 5-12. Tabular Mode

LINE	TAB/KBD CHARACTER LAMPS AND SWITCHES ON THE SIMULATOR				CHARACTERS DISPLAYED ON THE TYPOTRON				LINE	TAB/KBD CHARACTER LAMPS AND SWITCHES ON THE SIMULATOR				CHARACTERS DISPLAYED ON THE TYPOTRON			
	CH 1	CH 2	CH 3	CH4						CH 1	CH 2	CH 3	CH 4				
1	(51) 101001	(63) 110011	(61) 110001	(00) 000000	R	C	A	space (no symbol)	7	(66) 110110	(00) 000000	(23) 010011	(46) 100110	F	space (no symbol)	T	O
2	(22) 010010	(30) 011000	(22) 010010	(23) 010011	S	Y	S	T	8	(00) 000000	(45) 100101	(61) 110001	(22) 010010	space (no symbol)	N	A	S
3	(65) 110101	(44) 100100	(00) 000000	(45) 100101	E	M	space (no symbol)	N	9	(61) 110001	(00) 000000	(46) 100110	(45) 100101	A	space (no symbol)	O	N
4	(46) 100110	(73) 111011	(00) 000000	(36) 011110	O	■	space (no symbol)	•••	10	(00) 000000	(36) 011110	(36) 011110	(21) 010001	space (no symbol)	•••	•••	/
5	(36) 011110	(56) 101110	(22) 010010	(65) 110101	•••	end of line (no symbol)	S	E	11	(36) 011110	(36) 011110	(21) 010001	(36) 011110	•••	•••	/	•••
6	(43) 100011	(43) 100011	(46) 100110	(66) 110110	L	L	O	F	12	(36) 011110	(73) 111011	(00) 000000	(00) 000000	•••	■	space (no symbol)	space (no symbol)

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Figure 5-13. Tabular Edit Mode

DATA TRANSFER NUMBER	TAB/KBD CHARACTER LAMPS ON THE SIMULATOR			CHARACTER TYPED ON THE TYPOTRON	REMARKS
	CH 1	CH 2	CH 3		
First	(20) 010000	(20) 010000	(00) 000000	Ø	See Step 13
Second	(04) 000100	(21) 010001	(00) 000000	4	See Step 13
Third	(01) 000001	(24) 010100	(01) 000001	1	See Step 16
Fourth	(20) 010000	(25) 010101	(01) 000001	Ø	See Step 16
Fifth	(03) 000011	(27) 010111	(01) 000001	3	See Step 16
Sixth	(01) 000001	(30) 011000	(01) 000001	1	See Step 16
Seventh	(06) 000110	(32) 011010	(01) 000001	6	See Step 16
Eighth	(03) 000011	(33) 011011	(01) 000001	3	See Step 16

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Figure 5-14. Keyboard Edit Fill In for Tabular Edit Data

Table 5-14. Graph Mode, Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Set appropriate DISPLAY ADDRESS switches (21, figure 5-1), CLEAR switch (23), and TRIGGER SELECT switch (16) up and momentarily press TRIGGER switch (15)	Display screen erases	Check clear/erase and unblanking circuits per figure 6-5
2	Set DISPLAY MODE 2^1 switch (17) and RESET CTRS switch (27) up and momentarily press TRIGGER switch (15); then set operated switches down	DISPLAY BUSY indicator (6, figure 3-4)	Check mode selection circuits per figure 6-7
3	Set GRAPH CHAR 1, 2 switches (2, figure 5-1) in accordance with line one binary codes of figure 5-15 and momentarily press DATA TRANSFER READ switch (10)	Coordinate line 1 figure 5-17 traced on display screen	Check data transfer circuits per figure 6-4, character selection and positioning circuits per figures 6-8 and 6-10, and clear/erase and unblank circuit per figure 6-5
4	Repeat step 3 for each line of figure 5-15	Coordinate lines 2 through 12 figure 5-17 are traced on display screen	Same as step 3
5	Set GRAPH CHAR 1, 2, 3 switches (2) in accordance with binary codes of lines one and two of figure 5-16 and momentarily press DATA TRANSFER read switch (10)	Graph symbol/spot 1 and 2 figure 5-17 appears in center of squares	Same as step 3
6	Set DISPLAY MODE 2^1 switch (17) and GRAPH SYMBOL 2^0 switch (20) up and momentarily press TRIGGER switch (15); then set operated switches down	Graph symbol spot changes to discreet on symbol	Same as step 3 and graph submode circuits per figure 6-6

Table 5-14. Graph Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
7	Repeat step 5 for lines three and four of figure 5-16	Graph symbol discreet on 3 and 4 figure 5-17 appears on display screen	Same as step 6
8	Set DISPLAY MODE 2^1 switch (17) and GRAPH SYMBOL 2^1 switch (20) up and momentarily press TRIGGER switch (15); then set operated switches down	Graph symbol discreet on changes to discreet off symbol	Same as step 6
9	Repeat step 5 for lines five and six of figure 5-16	Graph symbol discreet off 5 and 6 figure 5-17 appear on display screen	Same as step 6
10	Set DISPLAY MODE 2^1 switch (17) and GRAPH SYMBOL 2^1 and 2^0 switches (20) up and momentarily press TRIGGER switch (15); then set operated switches down	Graph symbol changes from discreet off to limit symbol	Same as step 6
11	Repeat step 5 for lines seven, eight, and nine of figure 5-16	Graph symbol limit 7, 8, and 9 figure 5-17 appear on display screen	Same as step 6
12	Press ERASE switch (7, figure 3-4)	Display screen erases	Same as step 1
13	Set DISPLAY MODE 2^1 switch (17, figure 5-1), RESET CTRS switch (27), and GRAPH SYMBOL 2^1 and 2^0 switches (20) up; momentarily press TRIGGER switch (15), then set all operated switches down		
14	Set GRAPH CHAR 1, 2, 3 switches (2) in accordance with line one binary codes of figure 5-18 and momentarily press DATA TRANSFER READ switch (10)	Three limit symbols appear on display screen as indicated in figure 5-19 (.8)	Same as step 6

Table 5-14. Graph Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
15	Set DISPLAY MODE 2^1 switch (17) up, GRAPH SYMBOL 2^1 switch (20) up, and momentarily press TRIGGER switch (15); then set operated switches down		
16	Repeat step 14 for line two of figure 5-18	Three discreet off symbols appear on display screen as indicated in figure 5-19 (.6)	Same as step 6
17	Set DISPLAY MODE 2^1 switch (17) up, GRAPH SYMBOL 2^0 switch (20) up, and momentarily press TRIGGER switch (15); then set operated switches down		
18	Repeat, step 14 for line three of figure 5-18	Three discreet on symbols appear on display screen as indicated in figure 5-19 (.4)	Same as step 6
19	Set DISPLAY MODE 2^1 switch (17) up and momentarily press TRIGGER switch (15); then return operated switch down		
20	Repeat step 14 for line four of figure 5-18	Three spot symbols appear on display screen as indicated in figure 5-19 (.2)	Same as step 6
21	Set DISPLAY MODE 2^1 switch (17) up, GRAPH SYMBOL 2^1 and 2^0 switches (20), up, and momentarily press TRIGGER switch (15); then set operated switches down		
22	Repeat step 14 for lines five and six of figure 5-18	Three limit symbols are plotted on display screen as indicated in figure 5-19 (.2)	Same as step 6
23	Repeat step 19		

Table 5-14. Graph Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
24	Repeat step 14 for lines one and seven of figure 5-15	Vertical line at left and horizontal line at top of graph area appear on display screen as indicated in figure 5-19	Same as step 3
25	Press KEYBOARD EDIT switch (6, figure 3-3)	KEYBOARD EDIT indicator (6, figure 3-3), lights yellow, MODE REQUEST ADDRESS indicator (28, figure 5-1) and KBD REQUEST EDIT indicators (9) light	
26	Press MODE RESET switch (19, figure 5-1)	PRIORITY INTER indicator (6) lights and DISPLAYS BUSY indicator (6, figure 3-4) goes out	
27	Remove test card from card reader (2, figure 3-3) and the insert card	KEYBOARD EDIT indicator (6, figure 3-3) goes out, MODE REQUEST ADDRESS indicator (28, figure 5-1) goes out, and KBD REQUEST EDIT indicator (9) goes out	

Table 5-15. Keyboard Self-Check Mode, Performance Test

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
	NOTE Before proceeding with this test the equipment must be energized. Turn on power and assure proper power supply operation by performing the power sequencer performance test procedure outlined in table 5-8.		
1	Press KEYBOARD SELF-CHECK switch (8, figure 3-3)	KEYBOARD SELF-CHECK indicator (8) lights yellow, MODE REQUEST ADDRESS indicator (28, figure 5-1) lights, and KBD REQUEST SELF-CHECK indicator (7) lights	

Table 5-15. Keyboard Self-Check Mode, Performance Test (Cont)

STEP	PROCEDURE	PERFORMANCE STANDARD	CORRECTIVE ACTION
2	Momentarily press MODE RESET switch (19)	PRIORITY INTER indicator (6) lights, DISPLAYS BUSY indicator (6, figure 3-4) lights, and KEYBOARD INOPERABLE indicator (4, figure 3-3) lights	
3	Set DISPLAY MODE 2^2 switch (17, figure 5-1) up, RESET CTRS switch (27) up, and momentarily press TRIGGER switch (15); then set operated switches down	MODE REQUEST ADDRESS indicator (28) goes out, KBD REQUEST SELF-CHECK indicator (7) goes out, DISPLAYS BUSY indicator (6, figure 3-4) lights green, KEYBOARD SELF-CHECK indicator (8, figure 3-3) changes from yellow to green	
4	Set DISPLAY ADDRESS switches (21, figure 5-1) up, TRIGGER SELECT switch (16) up, and momentarily press TRIGGER switch (15); then set operated switches down	PRIORITY INTER indicator (6) goes out	
5	Press MODE RESET switch (19)	DISPLAYS BUSY indicator (6, figure 3-4) goes out, KEYBOARD SELF-CHECK indicator (8, figure 3-3) goes out, and KEYBOARD INOPERABLE indicator (4) lights	
6	Momentarily press DISPLAY MODE KBD SELF-CHECK switch (18, figure 5-1)	DISPLAYS BUSY indicator (6, figure 3-4) lights green, KEYBOARD SELF-CHECK indicator (8, figure 3-3) lights green, and KEYBOARD INOPERABLE indicator (4) goes out	
7	System is available for typing information for immediate display of typed data without computer interference		

LINE	GRAPH CHARACTER LAMPS AND SWITCHES		REMARKS
	CH 1	CH 2	
1	(376) 11111110	(040) 00100000	Vertical line Left border of graph
2	(376) 11111110	(066) 00110110	Vertical line 1/8 way across graph area
3	(376) 11111110	(113) 01001011	Vertical line 1/4 way across graph area
4	(376) 11111110	(166) 01110110	Vertical line 1/2 way across graph area
5	(376) 11111110	(241) 10100001	Vertical line 3/4 way across graph area
6	(376) 11111110	(313) 11001011	Vertical line Right border of graph

LINE	GRAPH CHARACTER LAMPS AND SWITCHES		REMARKS
	CH 1	CH 2	
7	(377) 11111111	(040) 00100000	Horizontal line Top border of graph
8	(377) 11111111	(073) 00111011	Horizontal line 1/8 way across graph area
9	(377) 11111111	(126) 01010110	Horizontal line 1/4 way across graph area
10	(377) 11111111	(214) 10001100	Horizontal line 1/2 way across graph area
11	(377) 11111111	(302) 11000010	Horizontal line 3/4 way across graph area
12	(377) 11111111	(370) 11111000	Horizontal line Bottom border of graph

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Figure 5-15. Vertical and Horizontal Coordinates

LINE	GRAPH CHARACTER LAMPS AND SWITCHES			GRAPH SYMBOLS DISPLAYED	
	CH 1	CH 2 (X)	CH 3 (Y)		
1	(373) 11111011	(266) 10110110	(335) 11011101	Spot Graph Symbol	• 0
2	(373) 11111011	(214) 10001100	(247) 10100111	Spot Graph Symbol	• 0
3	(373) 11111011	(214) 10001100	(110) 01001000	Discreet on Graph Symbol	⊣/⊢ 1
4	(373) 11111011	(266) 10110110	(056) 00101110	Discreet on Graph Symbol	⊣/⊢ 1
5	(373) 11111011	(054) 00101100	(335) 11011101	Discreet off Graph Symbol	⊣⊢ 2
6	(373) 11111011	(101) 01000001	(247) 10100111	Discreet off Graph Symbol	⊣⊢ 2
7	(373) 11111011	(101) 01000001	(110) 01001000	Limit Graph Symbol	✛ 3
8	(373) 11111011	(054) 00101100	(056) 00101110	Limit Graph Symbol	✛ 3
9	(373) 11111011	(141) 01100001	(161) 01110001	Limit Graph Symbol	✛ 3

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Figure 5-16. Jump Scan Symbol Locations

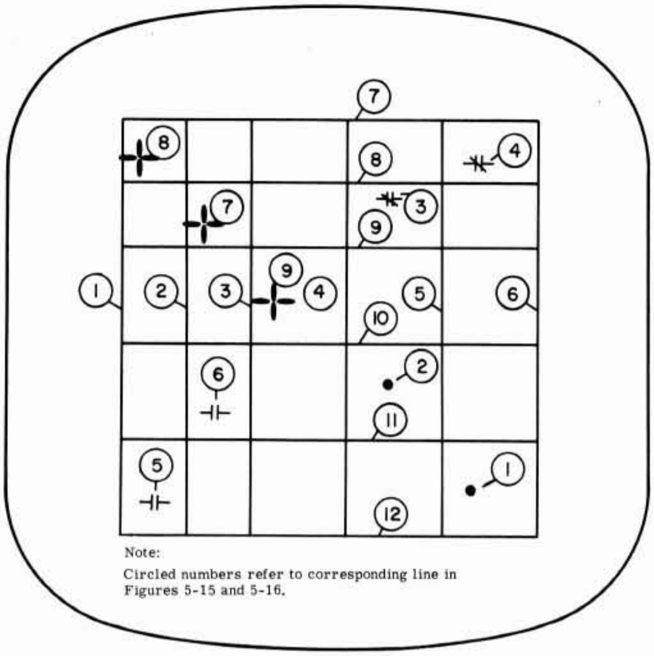

Figure 5-17. Typotron Horizontal and Vertical Coordinates and Jump Scan Display

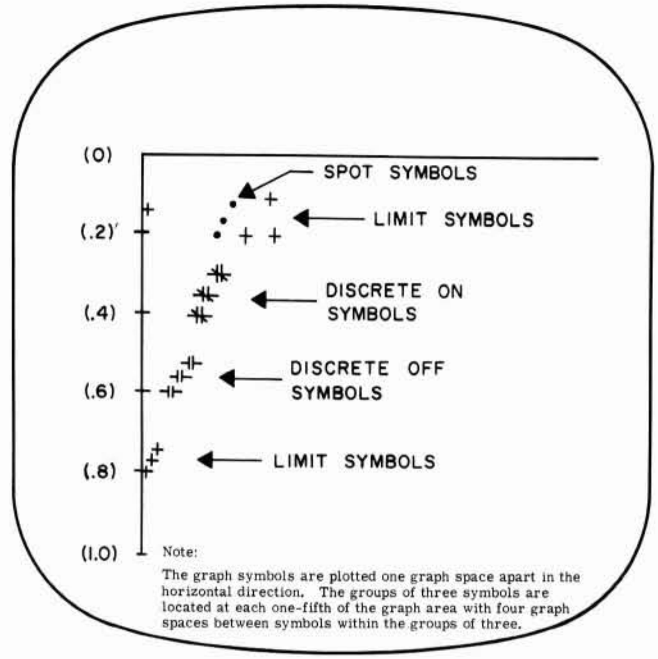

Figure 5-19. Graph Plotting Display

LINE	GRAPH CHARACTER LAMPS AND SWITCHES ON THE SIMULATOR			GRAPH SYMBOL DISPLAYED
	CH 1	CH 2	CH 3	
1	(314) 11000110	(310) 11001000	(304) 11000100	Limit ╋ Graph symbol 3
2	(241) 10100001	(235) 10011101	(231) 10011001	Discreet off ⊣⊢ Graph symbol 2
3	(166) 01110110	(162) 01110010	(156) 01101110	Discreet on ⫲ Graph symbol 1
4	(113) 01001011	(107) 01000111	(103) 01000011	Spot ● Graph symbol 0
5	(113) 01001011	(375) 11111101	(103) 01000011	Limit ╋ Character 2 is a graph blank
6	(113) 01001011	(374) 11111100	(103) 01000011	Limit ╋ Character 2 is an end of graph

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Figure 5-18. Graph Plotting Mode

SECTION III

CORRECTIVE MAINTENANCE

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SECTION III
CORRECTIVE MAINTENANCE

1. GENERAL

This section contains maintenance troubleshooting, adjustment, alignment, removal, and replacement instructions. The troubleshooting techniques are prepared in the form of flow chart procedures using the simulator to generate necessary signal and logic requirements. The adjustment and alignment procedures pertain to mechanical and electrical components. The removal and replacement procedures pertain to major assemblies and special components.

2. ADJUSTMENT AND ALIGNMENT PROCEDURES

The adjustment and alignment procedures described in the subsequent paragraphs are to be performed on assemblies still connected as an integral part of the operating equipment and should be performed by a two-man maintenance team whenever possible. Before beginning the procedure of paragraph 2. 3, the Electrostatic Deflection Assembly must be loosened and slid down the guide ways to provide required access to control switches.

2.1 Typotron Tube

Whenever the typotron tube has been replaced and adjustment and alignment procedures are performed, complete performance testing of the display set should follow.

a. Turn off CRT power and dc power.

b. Remove plugs from the high voltage power supplies (PS323201 and PS323101).

c. Remove rear plate from typotron tube assembly and disconnect flood gun connector P2302 and write gun connector P2301.

d. Temporarily jumper pin 5 of the typotron tube flood gun (A2301J2-5) to dc return E0001 at rear of console.

e. Turn on dc power and CRT power. Allow approximately 3 minutes for the CRT POWER indicator (2, figure 3-4) to light green. Refer to Power Control Assembly ac sense adjustment if CRT POWER indicator does not light green, paragraph 2. 2 of this section.

f. Remove card from card reader (2, figure 3-3).

g. With a vacuum tube voltmeter, measure the voltages at test points listed in table 5-16. If voltage indication obtained are not within tolerances indicated, adjust the associated control indicated in the ADJUSTMENT column of table 5-16.

h. With meter set for measuring ac volts, measure voltage at flood gun connector pins P2302-2 and P2302-3; and write gun connector pins P2301-16 and P2301-17. Meter indication at both connector test points should be 6. 3 ± 0. 6 volts.

i. Insert good card in card reader.

j. Turn off CRT power. Replace plugs removed for step b.

k. Turn CRT power on. Allow CRT POWER indicator to light green.

l. With an electrostatic voltmeter, measure the voltages at test points listed in table 5-17. If voltage indications obtained are not within tolerances indicated, adjust the associated control indicated in the ADJUSTMENT column of table 5-17. Test point PS3101-1 is located on high voltage power supply PS323101.

Table 5-16. Typotron Tube Low Voltage Adjustments

CONSOLE TEST POINTS		VOLTAGE (vdc)	TOLERANCES (vdc)	ADJUSTMENT
A1101J5 (7, figure 5-20	A1101J7, DC RET (4, figure 5-20)	+5[1]	± 0. 1	R12, BACKING ELECT DC LEVEL (9, figure 5-20)
A2301TB2-18	P2302-5, DC RETURN	+150	± 15	***
A2301TB2-16	P2302-5, DC RETURN	*	±0. 5	FLOOD COLL (5, figure 5-21)
P2302-4	P2302-5, DC RETURN	+100	± 10	***
P2302-6	P2302-5, DC RETURN	+50	± 5	***
P2301-22	P2302-5, DC RETURN	+50	± 5	***
P2302-7	P2302-5, DC RETURN	**	± 0. 5	VIEW BIAS (6, figure 5-21)

*COLLIMATING ELECTRODE (fg4) voltage. Set according to label on rear of typotron tube (Nominal Range +30 to +60 v)

**FLOOD GUN CONTROL GRID (fg1) voltage. Set according to label on rear of typotron tube (Nominal Range -10 to -50 v)

***No Adjustment — Zener Diodes

[1] Voltage present with no card in Card Reader.

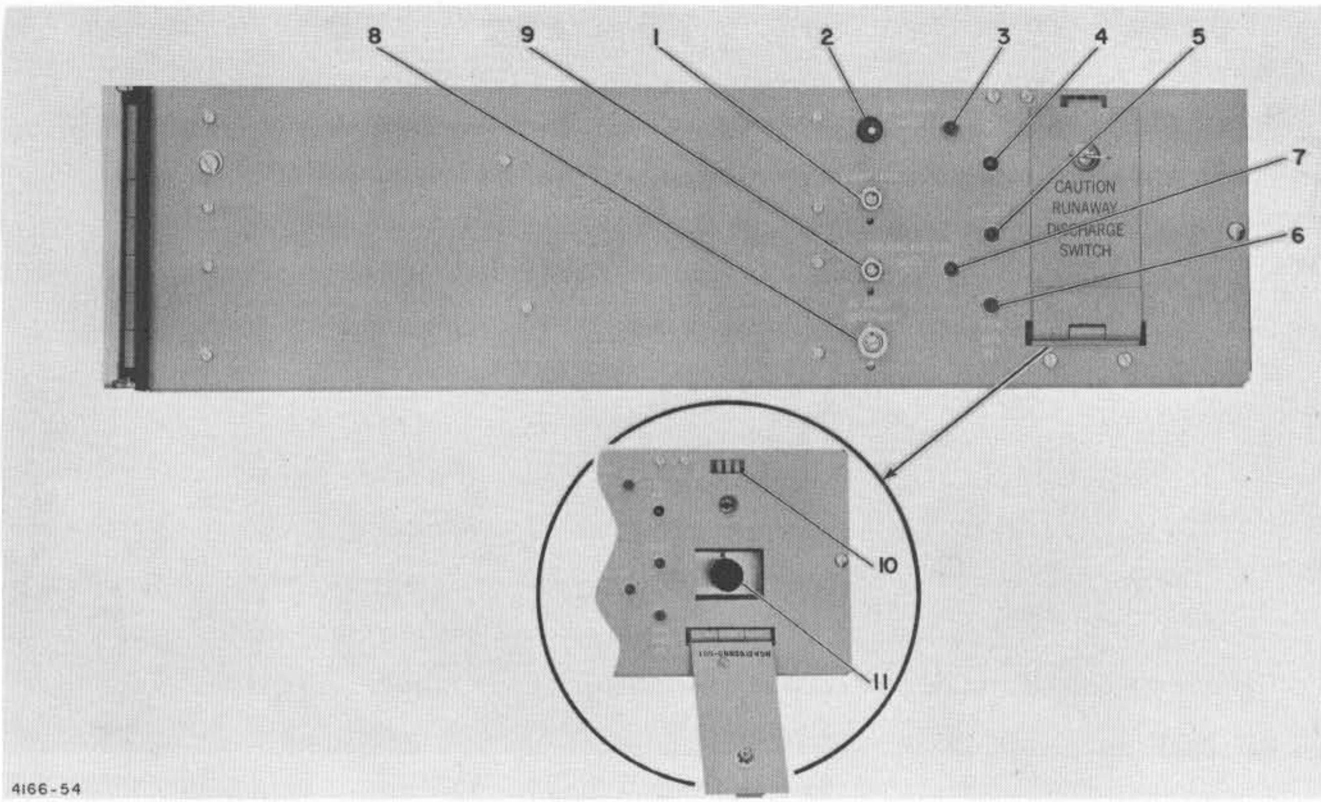
WARNING

High voltages are involved. For safety, turn off CRT power after each measurement in table 5-17 has been made and turn ON after electrostatic voltmeter has been connected to the succeeding test points.

Table 5-17. Typotron Tube High Voltage Adjustments

CONSOLE TEST POINTS		NOMINAL VOLTAGE (vdc)	ADJUSTMENT
P2301-15	J17, DC RETURN (2, figure 5-22)	-3, 250*	WRITE CATHODE (7, figure 5-21)
P2301-1	J17, DC RETURN (2)	-2, 950*	FOCUS (2)
P2301-3	J17, DC RETURN (2)	-2, 675*	IMAGE (3)
P2301-6	J17, DC RETURN (2)	+2, 700*	MATRIX (10)
P2301-23	J17, DC RETURN (2)	-3, 500*	WRITE BIAS (8)
P3101-1	J17, DC RETURN (2)	+8, 000 -9, 000*	VIEW SCREEN (9)

*Polarity of dc voltage is shown for reference only. The electrostatic voltmeter used for these measurements is not polarity sensitive, but for safe operation must always have its dc return or common connection tied to dc return.



1	CLAMP LEVEL control, R5	7	BACK ELECT DC LEVEL test jack, J5
2	DECAY RATE INPUT control, R2	8	AC SENSE SENSITIVITY control, R14
3	DECAY RATE INPUT test jack, J8	9	BACKING ELECT DC LEVEL control, R12
4	DC RET test jack, J7	10	Interlock switches, S2, S3 and S4
5	COLLECT test jack, J4	11	RUNAWAY DISCHARGE switch, S1
6	VIEW BIAS RET test jack, J6		

Figure 5-20. Power Control Assembly Maintenance Controls

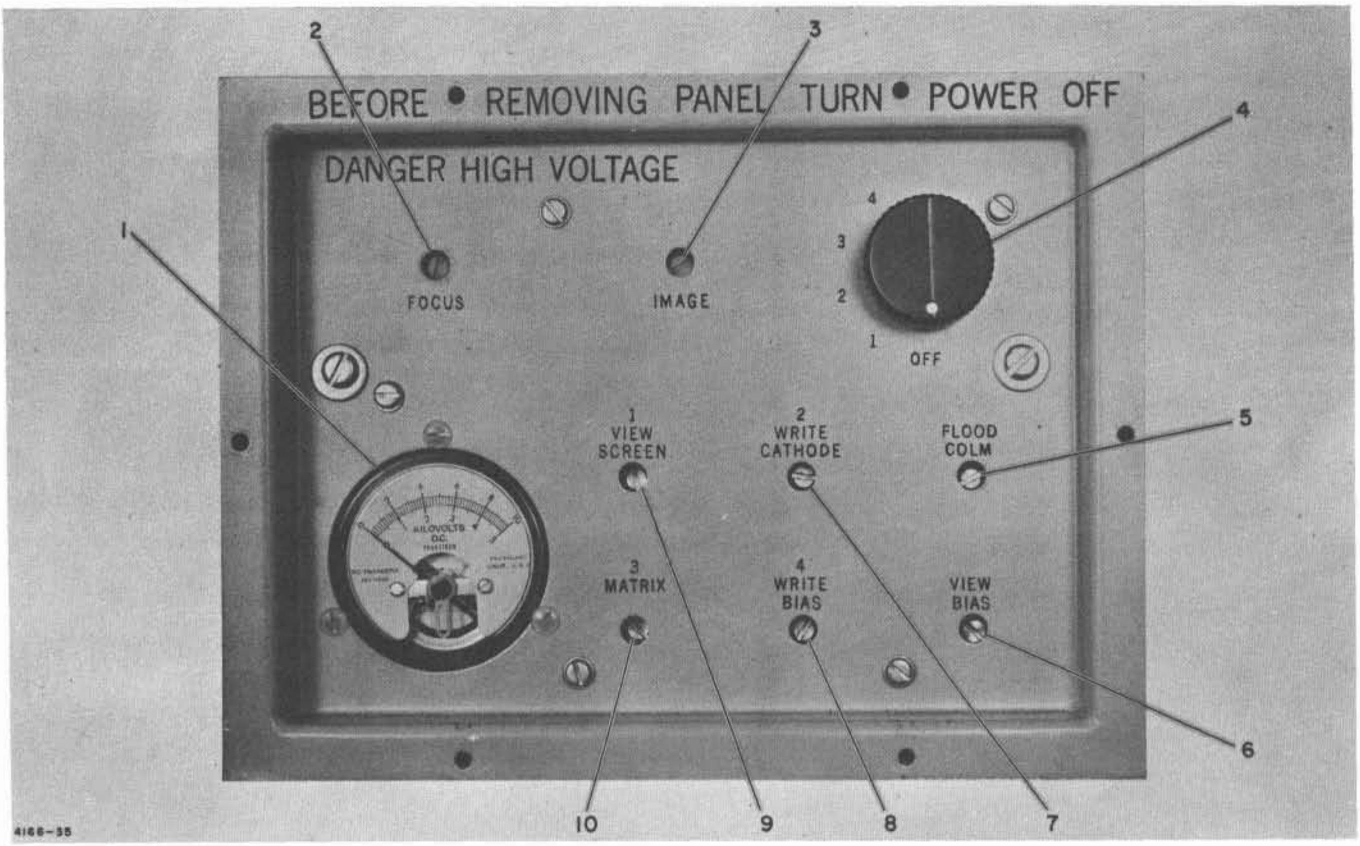
m. Turn CRT power off. Remove temporary jumper from A2301J2-5; reconnect P2302 to typotron tube flood gun, and replace rear plate removed for step c.

n. Turn CRT power on. Allow display background to build up.

NOTE

Adjustments of steps o and p should not be necessary if set to voltage given on tube during measurement.

o. Adjust FLOOD COLL control (5, figure 5-21) for full collimation. (Complete coverage of display surface by flood electrons.)



1	High voltage meter	6	VIEW BIAS control
2	FOCUS control	7	WRITE CATHODE control
3	IMAGE control	8	WRITE BIAS control
4	Meter selector switch	9	VIEW SCREEN control
5	FLOOD COLL control	10	MATRIX control

Figure 5-21. Tube Bias Maintenance Controls

p. Set VIEW BIAS control (6) fully clockwise. Turn VIEW BIAS control clockwise until visual brightness "pop" occurs on display surface (this is the point at which flood electrons are attracted to the collimation electrodes instead of the view screen). The VIEW BIAS control should be left in the position which results in the brightest display before or after the "pop."

q. Repeat steps o and p until the desired optimum collimation and view bias is obtained.

r. Turn off CRT power and dc power; reconnect P2301 to the Typotron write gun.

NOTE

VIEW SCREEN, WRITE CATHODE, MATRIX, and WRITE BIAS voltages can be monitored at the Tube Bias Adjustment Control Panel meter (1, figure 5-21) using the meter selector switch (4). This meter should be used for minor adjustments or checks, all final adjustments should be made visually by observing tube display.

2.2 Power Control Assembly

Alignment of the ac sense circuit sensitivity is required before the electrostatic deflection circuit alignment is started. Adjustment of the extended storage circuits is accomplished after the electrostatic and magnetic deflection circuit adjustments are completed. The ac sense sensitivity circuit is adjusted as follows:

a. Turn off CRT power and dc power.

b. Set DELAY RATE INPUT control R2 (2, figure 5-20) and CLAMP LEVEL control R5 (1) maximum counterclockwise.

c. Set AC SENSE SENSITIVITY control R14 (8) maximum clockwise.

d. Remove plugs from high voltage power supplies (PS323201 and PS323202).

e. Turn on dc power and CRT power.

f. Allow approximately 3-1/2 minutes for the CRT power indicator (2, figure 3-4) to light green.

g. Connect a dc voltmeter between VIEW BIAS RET test jack J6 (6, figure 5-20) and DC RET test jack J7 (4). Meter should indicate 0 vdc.

h. Adjust AC SENSE SENSITIVITY control (8) full counterclockwise to measure -300 vdc and return in clockwise direction to the point where 0 vdc is indicated, and continue rotation clockwise 1/2 turn.

2.3 Electrostatic Deflection Assembly

Adjust the electrostatic deflection assembly by performing the following procedure:

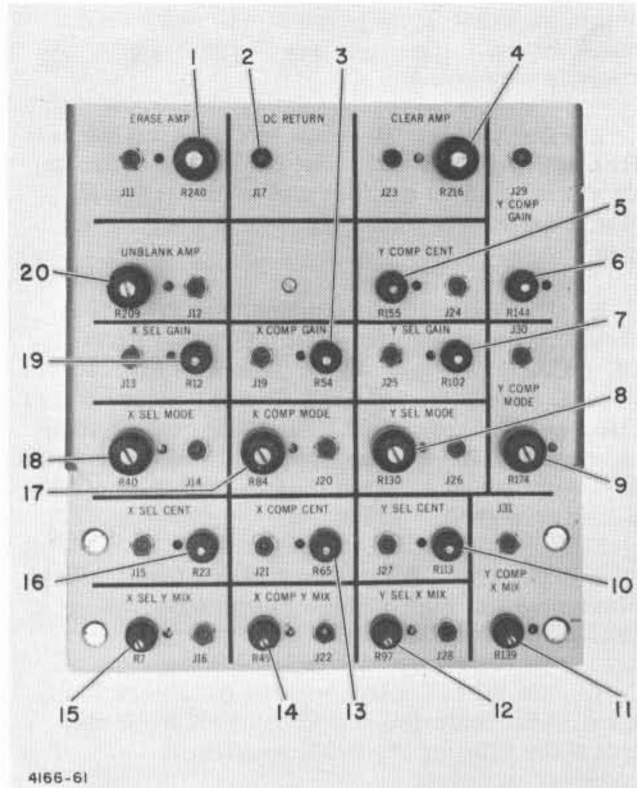
a. Turn off CRT power and dc power.

b. Set ERASE AMP control R240 (1, figure 5-22), CLEAR AMP control R216 (4), and UNBLANK AMP control R209 (20) maximum counterclockwise.

c. Remove plugs from high voltage power supplies (PS323201 and PS323202).

d. Turn on dc power and CRT power.

e. Connect an oscilloscope between BACKING ELECT DC LEVEL test jack J5 (7, figure 5-20) and DC RET test jack J7 (4) and remove card from card reader. Connect a vacuum tube voltmeter across oscilloscope leads; meter should indicate +5 ±0. 05 volts dc. If necessary, adjust BACKING ELECT DC LEVEL control R12 (9) to obtain correct indication.



1. ERASE AMP control R240
2. DC RETURN test jack J17
3. X COMP GAIN control R54
4. CLEAR AMP control R216
5. Y COMP CENT control R155
6. Y COMP GAIN control R144
7. Y SEL GAIN control R102
8. Y SEL MODE control R130
9. Y COMP MODE control R174
10. Y SEL CENT control R113
11. Y COMP X MIX control R139
12. Y SEL X MIX control R97
13. X COMP CENT control R65
14. X COMP Y MIX control R49
15. X SEL Y MIX control R7
16. X SEL CENT control R23
17. X COMP MODE control R84
18. X SEL MODE control R40
19. X SEL GAIN control R12
20. UNBLANK AMP control R209

Figure 5-22. Electrostatic Deflection Assembly, Maintenance Controls

f. Insert card in card reader. Press ERASE switch (7, figure 3-4) and adjust ERASE AMP control R240 (1, figure 5-22) to obtain an erase level pulse of +10 volts on the oscilloscope. (See figure 4-27, composite clear/erase pulse.)

g. Connect oscilloscope to CLEAR AMP test jack J23 (figure 5-22). Set oscilloscope for dc, 20 v/cm, and 10 ms/cm and adjust trace so that it coincides with a horizontal centimeter line.

h. Disconnect oscilloscope lead from test jack J23 and reconnect it to BACKING ELECT DC LEVEL test jack J5 (7, figure 5-20). Press ERASE switch (7, figure 3-4) and observe top of clear pulse. Adjust CLEAR AMP control R216 (4, figure 5-22) so that the top of the clear pulse is 7 volts more positive than the reference line set up in step g.

i. Turn off CRT power and dc power. Replace plugs at high voltage power supplies (PS323201 and PS323202).

j. Set WRITE BIAS control (8, figure 5-21) maximum clockwise and UNBLANK AMP control R209 (20, figure 5-22) maximum counterclockwise.

k. Turn on dc power and CRT power. Place console in KEYBOARD SELF-CHECK mode.

l. Press ERASE switch (7, figure 3-4) and measure tube storage time (elapsed time between completion of erase operation and buildup of significant background deterioration). Alternately press ERASE switch and adjust ERASE AMP control R178 (1, figure 5-22) until storage time is approximately 1 1/2 to 2 1/2 minutes.

CAUTION

Until DELAY RATE INPUT control R2 (2, figure 5-20) and CLAMP LEVEL control R5 (1) have been adjusted, storage times greater than 2 1/2 minutes may adversely affect the writing capability of the display equipment.

m. Set the Y COMP CENT control R155 (5, figure 5-22), Y SEL CENT control R113 (10), X COMP CENT control R65 (13), and X SEL CENT control R23 (16) to obtain -5.6 volt output at their respective test jacks J24, J27, J21, and J15.

n. Set Y COMP X MIX control R139 (11, figure 5-22), Y SEL X MIX control R97 (12), X COMP Y MIX control R49 (14), and X SEL Y MIX control R7 (15) to midrange. Set X COMP GAIN control R54 (3), Y COMP GAIN control R144 (6), Y SEL GAIN control R102 (7), and X SEL GAIN control R12 (19) to maximum counterclockwise.

o. Using an oscilloscope with dual trace preamplifier; repeatedly press the "X" key of keyboard and observe the simultaneous outputs of the X selection amplifier at connectors J9 and J10 at the rear of the Electrostatic Deflection Assembly A322101. Adjust X SEL MODE control R40 (18) for an algebraic sum (both preamp input polarities positive) of 100 ± 10 volts between the two output voltage amplitudes.

p. Repeat step o for the X compensation amplifier using connectors J7 and J8 and adjust X COMP MODE control R84 (17).

q. Repeat step o for the Y selection amplifier using connectors J5 and J6 and adjust Y SEL MODE control R130 (8).

r. Repeat step o for the Y compensation amplifier using connectors J3 and J4 and adjust Y COMP MODE control R174 (9).

s. Repeatedly press the "X" key and slowly adjust UNBLANK AMP control R209 (20) until any character or any portion of a character is just visible on the display face.

NOTE

If R209 has been adjusted to maximum clockwise position without visible display, repeat step s using WRITE BIAS control (8, figure 5-21). For final setting of WRITE BIAS control and R209, it is desirable that the WRITE BIAS control not be completely full clockwise but approximately 1/8 turn less. For the write bias adjustment to be set to this position, the amplitude of the unblank pulse may have to be reduced by adjusting R209 counterclockwise.

t. Repeatedly press the "X" key and adjust X SEL CENT control R23 (16, figure 5-22) and Y SEL CENT control R113 (10) until character is completely displayed.

u. Repeatedly press the "X" key and adjust the FOCUS control (2, figure 5-21) until portions of characters "P" and "7" appear above and below the "X" character.

v. Repeatedly press the "X" key and adjust the IMAGE control (3) until the height of the "X" character is 0. 19 (approximately 3/16) inches ± 10%.

w. Repeatedly press the "X" key and adjust X SEL CENT control R23 (16, figure 5-22) and Y SEL CENT control R113 (10) until the "X" character is centered.

x. Repeatedly press the "X" key and adjust the FOCUS control (2, figure 5-21) until the "P" and "7" characters disappear and the "X" character only is displayed.

y. Repeatedly press the "X" key and adjust the MATRIX control (10) for minimum distortion of the "X" character. (Readjust IMAGE control (3) and FOCUS control (2), if necessary.)

z. Using the matrix in figure 1-6 repeatedly press the keys shown in vertical column 7 (≡, ←, G, P, etc.) and carefully adjust Y SEL GAIN control R102 (7, figure 5-22) and Y SEL CENT control R113 (10) until all characters in vertical column 7 are correctly selected. This is accomplished by alternately pressing keys "X" and "P" and increasing the gain (CW increase) until the characters are selected. While this is being done the selection of "X" must be maintained by also adjusting centering. After "X" and "P" have been correctly selected, move to the next two characters "G" and "7." Adjust gain and centering until these two characters are correctly selected when struck. Repeat this procedure and continue to adjust the gain and centering controls until the entire vertical column of eight characters are correctly selected. Disregard the fact that the selected characters are not written equally spaced on the same horizontal line. (If character displacement is objectionable R144 and R54 may be adjusted, steps ah and ai, before this step to reduce displacement.)

aa. Repeat step z using the characters in horizontal row 2 (T, S, /, Ø, etc.). Starting with "Ø" and "X" adjust X SEL GAIN control R12 (19, figure 5-22) and X SEL CENT control R23 (16).

ab. Repeat step z using the characters in vertical column 3 and Y SEL GAIN control R102 (7) and Y SEL CENT control R113 (10).

ac. Repeat step z using the characters in horizontal row 7 and X SEL GAIN control R40 (18) and X SEL CENT control R23 (16).

ad. Using the characters in vertical column 4, particularly characters 4, >, and ⏮, adjust X SEL Y MIX control R7 (15) to produce good selection of these characters in the X-(horizontal) direction. Repeat steps ac and ad if necessary until characters of both, horizontal row 7 and vertical column 4, are selected in the X-direction.

ae. Using the characters in horizontal row 1, particularly characters =, +, and ⏮, adjust Y SEL X MIX control R97 (12) to produce good selection of these characters in the Y-(vertical) direction. Repeat steps ab and ae if necessary until characters of both, vertical column 3 and horizontal row 1, are selected in the Y-direction.

af. At this point the characters should be selected correctly. If not, only minor touch up of the appropriate gain, centering, and mixing controls should be required.

ag. Adjust MATRIX (10, figure 5-21) voltage for minimum "pin cushioning" or "barrelling" distortion of the displayed character, indicated by distortion of any character. Touch up selection adjustments if necessary.

ah. Set all corner correction controls (1 through 8, figure 5-23) to maximum counterclockwise before starting the following compensation alignment procedure.

aj. Alternately press keys corresponding to characters of vertical column 1 of matrix starting with the "I" and "9" keys and adjust Y COMP GAIN control R144 (6, figure 5-22) until all characters are displayed without vertical displacement.

ak. Repeat step ah using the keys corresponding to characters of horizontal row 0, starting with the 3 and 4 while adjusting Y COMP X MIX control R139 (11).

al. Repeat steps ah and aj until all the characters in vertical column 1 and horizontal row 0 are written with minimum vertical displacement.

am. Alternately press keys corresponding to characters of horizontal row 6 starting with the "C" and "D" keys and adjust X COMP GAIN control R54 (3) until all characters of horizontal row 6 are displayed with equal horizontal spacing.

an. Repeat step al using characters of vertical column 6 starting with the → and = keys, adjust X COMP Y MIX control R49 (14).

ao. Repeat steps al and am until all the characters of horizontal row 6 and vertical column 6 are written with minimum horizontal displacement from their equal spaced reference.

ap. At this point all characters except the corner characters should be compensated properly. If not, only minor adjustment of the appropriate gain and mixing controls should be required.

NOTE

The X COMP CENT and Y COMP CENT controls should be set so that the output signals from the respective amplifiers is approximately centered in their linear range of operation. (Approximately -5.6 vdc at test jacks J21 and J24, figure 5-22.) If these conditions are not met, complete compensation will not be possible.

aq. Normally the corner characters are adequately compensated and additional adjustments are not required. However; if some adjustment is desired, any one or all of the following corner correction adjustments may be made.

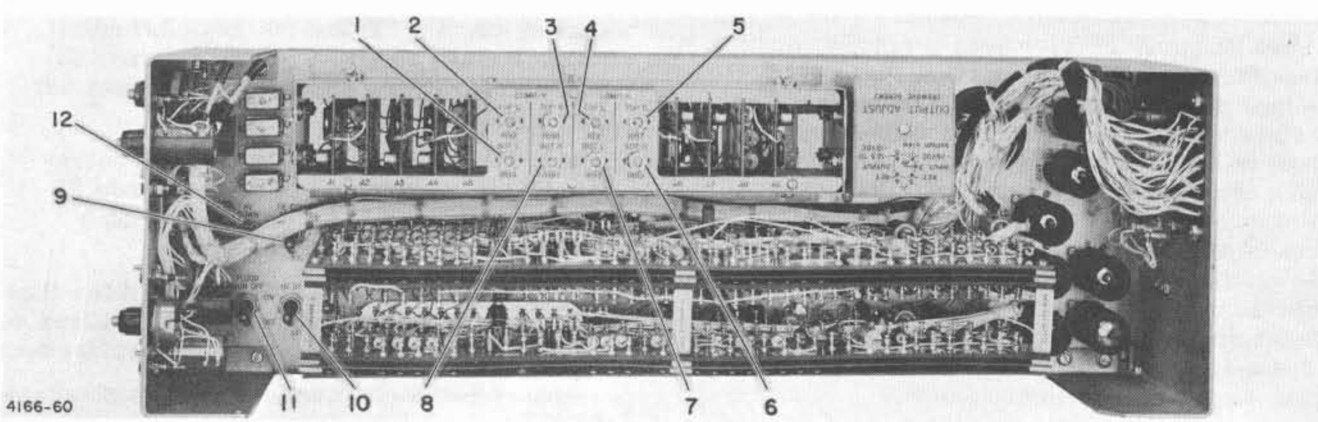
(1) Vertical compensation of top left corner characters [■) ↓] is accomplished by adjusting the COMP-Y TOP L control R192 (2, figure 5-23). Alternately press [ )] and [( ] keys and adjust R192 for minimum vertical displacement.

(2) Horizontal compensation of top left corner characters [≡) ↓] is accomplished by adjusting the COMP-X TOP L control R191 (4). Alternately press [↓] and "E" keys and adjust R191 for minimum horizontal displacement.

(3) Vertical compensation of bottom left characters [, ▶| +] is accomplished by adjusting the COMP-Y BOT L control R194 (1). Alternately press [+] and [*] keys and adjust R194 for minimum displacement.

(4) Horizontal compensation of bottom left characters [, ▶| +] is accomplished by adjusting the COMP-X BOT L control R193 (7). Alternately press [+] and [5] keys and adjust R193 for minimum horizontal displacement.

(5) Vertical compensation of top right characters [-¦- ↑ •] is accomplished by adjusting the COMP-Y TOP R control R188 (3). Alternately press [↓] and [↑] keys and adjust R188 for minimum vertical displacement.



1. BOT L control R194
2. TOP L control R192
3. TOP R control R188
4. TOP L control R191
5. TOP R control R187
6. BOT R control R189
7. BOT L control R193
8. BOT R control R190
9. TIE COLL TO B. E. switch S3
10. HV UP switch S4
11. FLOOD GUN OFF switch S2
12. HV DOWN switch S1

Figure 5-23. Electrostatic Deflection Assembly, Non-Storage and Corner Correction Maintenance Controls

(6) Horizontal compensation of top right characters (-¦-↑ •) is accomplished by adjusting the COMP-X TOP R control R187 (5). Alternately press "*" and " " keys and adjust R187 for minimum vertical displacement.

(7) Vertical compensation of bottom right characters (> ♦ |◀) is accomplished by adjusting the COMP-Y BOT R control R190 (8). Alternately press "▶| " and " |◀" keys and adjust R190 for minimum vertical displacement.

(8) Horizontal compensation of bottom right characters (> ♦ |◀) is accomplished by adjusting the COMP-X BOT R control R189 (6). Alternately press "+" and "÷" keys and adjust R189 for minimum horizontal displacement.

2.4 Magnetic Deflection Assembly

a. Turn off CRT power and dc power.

b. Set potentiometers R3, R11 and R14 (figure 6-8) of magnetic deflection preamp modules A1318 and A1319 to the center positions (approximately 10 turns from full counterclockwise).

c. Turn on dc power and CRT power. Place console in KEYBOARD SELF-CHECK mode.

d. Connect the positive side of a dc voltmeter to FEEDBACK test jack J7 (13, figure 5-24), and the negative side to DC RETURN test jack J17 (2, figure 5-22).

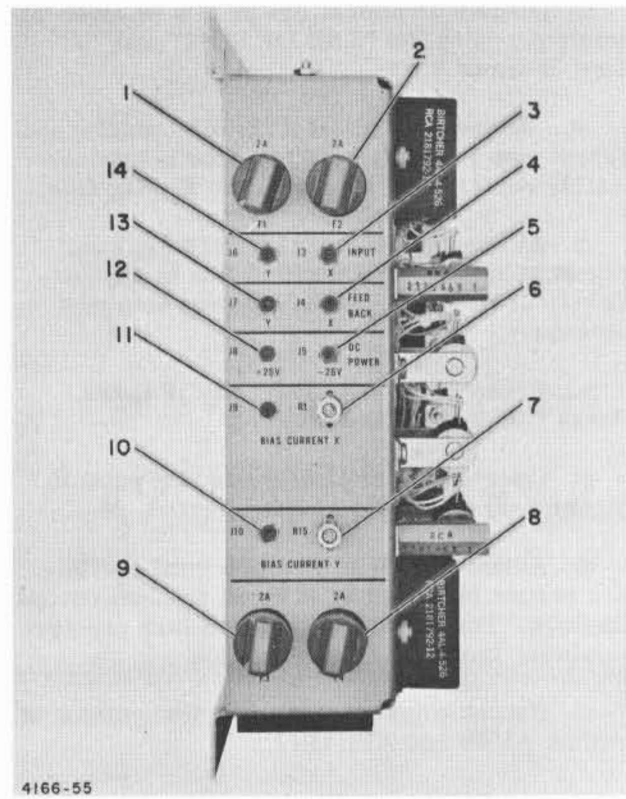
e. Alternately press "END OF LINE" and "M" keys on keyboard until a reading of approximately 0 volts dc is observed on the voltmeter.

f. Connect the positive side of a dc voltmeter to FEEDBACK X test jack J4 (4, figure 5-24) and the negative side to DC RETURN test jack J17 (2, figure 5-22). Repeatedly press the "M" key until a reading of approximately 0 volts is observed on the voltmeter.

g. Connect the positive side of a dc voltmeter to BIAS CURRENT X test jack J9 (11, figure 5-24) and the negative side to -26V DC POWER test jack J5 (5). Adjust BIAS CURRENT X control R1 (6) for a voltmeter reading of +1 vdc.

h. Repeat step g using BIAS CURRENT Y test jack J10 (10) and BIAS CURRENT Y control R15 (7).

i. Display a horizontal line of "M" characters by pressing the "END OF LINE" key once and the "M" key 50 times.



1. 2 Amp fuse F1
2. 2 Amp fuse F2
3. INPUT X test jack J3
4. FEED BACK X test jack J4
5. -26V DC POWER test jack J5
6. BIAS CURRENT X control R1
7. BIAS CURRENT Y control R15
8. 2 Amp fuse F4
9. 2 Amp fuse F3
10. BIAS CURRENT Y test jack J10
11. BIAS CURRENT X test jack J9
12. +26V DC POWER test jack J8
13. FEED BACK Y test jack J7
14. INPUT Y test jack J6

Figure 5-24. Magnetic Deflection Assembly Maintenance Controls

j. Alternately adjust A1318R3 [R3 (middle) of module A1318] and repeat step i until the horizontal line is approximately centered horizontally on the display face.

k. Alternately adjust A1318R14 (top) and repeat step i until the horizontal line is approximately 11 inches in length. Repeat step j if necessary.

l. Display a vertical line of M's by alternately pressing the "END OF LINE" and "M" keys 32 times each.

m. Alternately adjust A1319R3 (middle) and repeat step l until the vertical line is approximately centered vertically on the display face.

n. Alternately adjust A1319R14 (top) and repeat step l until the vertical line is approximately 11 inches in length. Repeat step m if necessary.

o. Press "END OF LINE" key 16 times. Press "M" key 25 times.

p. Connect an oscilloscope to test point E (figure 6-8) of module A1318.

q. Adjust A1318R11 (bottom) until oscillation occurs (as noted by rf burst on oscilloscope display). Turn A1318R11 one full turn counterclockwise from point of oscillation.

r. Repeat steps p and q using test point E of module A1319 and A1319R11.

2.5 Extended Storage Adjustment Procedures

Adjust the direct view storage tube (DVST) for greater than 4 minutes storage time by performing the following adjustments:

a. Turn on dc power and CRT power. Allow 15-30 minutes warmup.

b. Ensure that CLAMP LEVEL control R5 (1, figure 5-20) and DECAY RATE INPUT control R2 (2) are turned maximum counterclockwise. After decay time has elapsed set CLAMP LEVEL control R5 to obtain 30 volts on VTVM. Adjust Decay Rate.

c. Press the ERASE switch (7, figure 3-4) and note the time.

d. Write a page on the DVST using the simulator.

e. Wait until it is evident that the background is starting to build-up and note the time. If time is not greater than 4 minutes, do step f.

f. Turn DECAY RATE INPUT control R2 (2, figure 5-20) one full turn clockwise.

g. Repeat steps c, d, e, and f until the desired storage time is reached.

NOTE

> DECAY RATE INPUT control R2 (2) should be adjusted gradually so that the written page does not disappear before the background builds-up. Final adjustments of R2 in step f will be in increments smaller than one full turn.

2.6 Power Supply Assemblies

Adjustment of the power supply assemblies is accomplished through proper setting of the individual power supply output voltage switches and vernier control. Figures 5-25 and 5-26 illustrate the location of power supply maintenance controls and protective devices, and tables 5-18 and 5-19 list the maintenance item and function of each. Adjust the power supplies as follows:

CONDITIONS:

a. The multi-console system must be operational and under "full load" conditions (all cables, modules, chassis, etc. plugged in) and CRT power on.

b. All system cables must be in their proper positions. The purpose of these adjustments is to compensate for the long cable voltage drops.

c. The system should be in a "rest" condition, i. e., in "No Mode" and all simulator switches down.

d. Measurements must be made with Fluke meters or Digital voltmeters and recordings made to 4 significant digits, if possible. Up to 6 meters will be required for fastest setup.

e. A warmup period of a half hour is required.

MEASUREMENTS:

f. Record the serial numbers of the power supplies in the space provided in table 5-20.

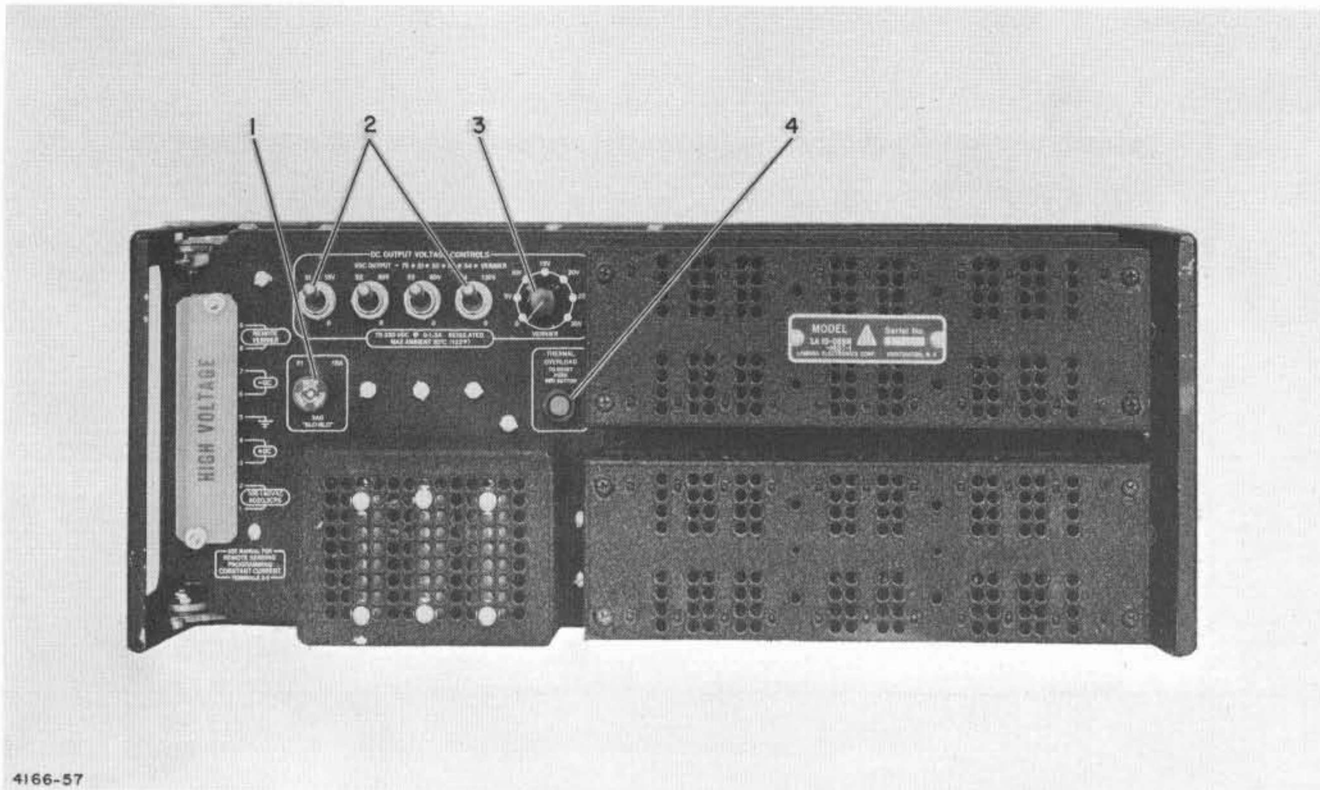


Figure 5-25. +300 and -300 VDC Power Supply Maintenance Controls

Table 5-18. +300 and -300 VDC Power Supply Maintenance Controls

FIGURE 5-25 INDEX NO.	CONTROL	REFERENCE DESIGNATION	FUNCTION
1	FUSE 15A	F1	Protects supply against overload
2	VDC OUTPUT switches	S1, S2, S3, and S4	Select the dc voltage operating range
3	VERNIER control	R7	Provides fine adjustment of the selected voltage range
4	THERMAL OVERLOAD reset push-button	TS1	Provides restoration of power supply operation after safe operating temperature is reached

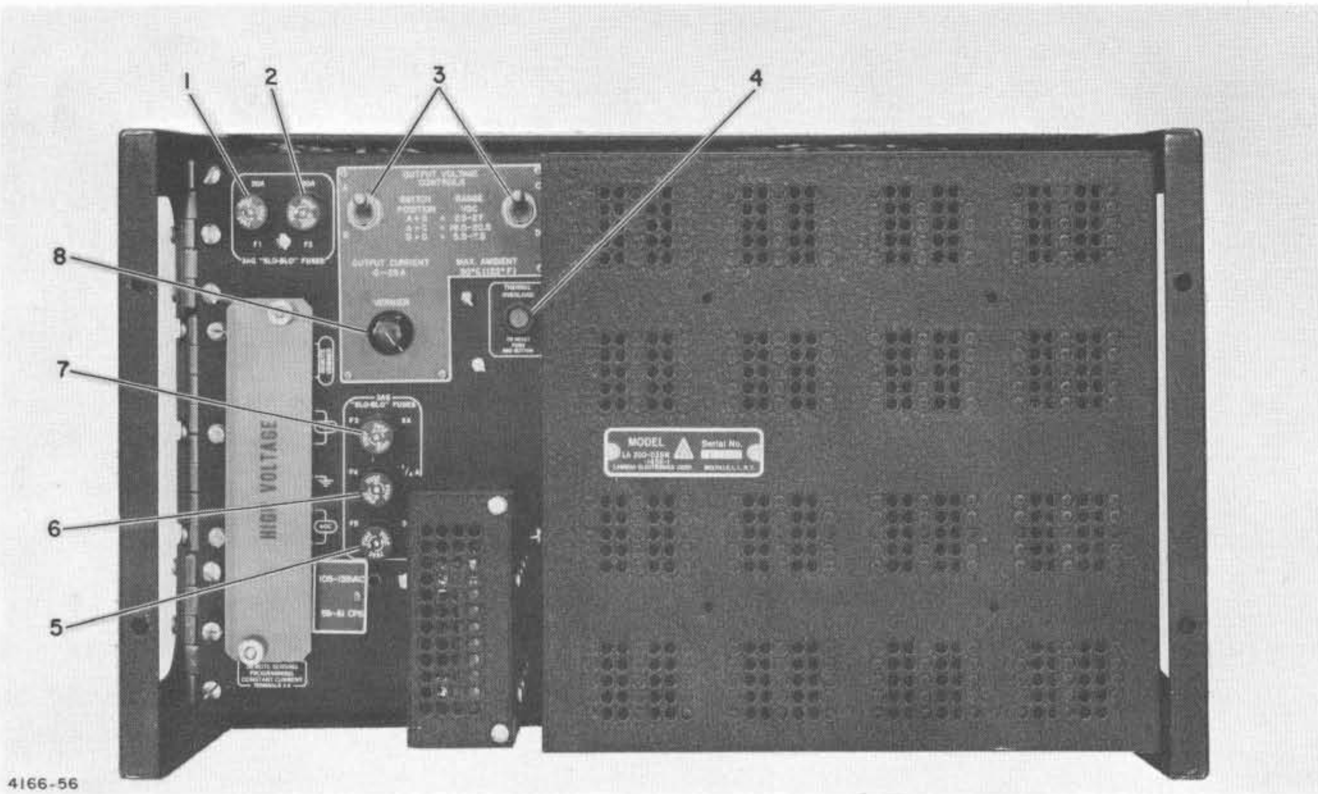


Figure 5-26. (-6. 5 V, -26 V, and +26 V) Power Supply, Maintenance Controls

Table 5-19. (-6. 5 v, -26 v, and +26 v) Power Supply, Maintenance Controls

FIGURE 5-26 INDEX NO.	CONTROL OR INDICATOR	REFERENCE DESIGNATION	FUNCTION
1	FUSE 30 amp	F1	Protects dc internal power circuits
2	FUSE 30 amp	F2	Protects dc internal power circuits
3	DC OUTPUT VOLTAGE CONTROL switches	S1, S2, S3, and S4	Selects the dc voltage operating range
8	VERNIER control	R39	Provides fine adjustment of the selected voltage range
4	THERMAL OVERLOAD reset push-button	TS1	Press to restore power supply operation when proper temperature is reached
5	FUSE 30 A	F5	Protects ac input circuits
6	FUSE 1/4 A	F4	Protects dc internal auxiliary circuits
7	FUSE 2 A	F3	Protects dc internal auxiliary circuits

Table 5-20. Saturn Display Pre-Acceptance Power Supply Adjustment-System No.

POWER SUPPLY LOCATION	BUS NAME	POWER SUPPLY SERIAL NUMBER	MEASURE AND ADJUST FOR MINIMUM AVERAGE OF EXTREMES, THEN RECORD VOLTAGE BETWEEN POINTS INDICATED IN THE FOLLOWING UNITS:								RECORD AS APPLICABLE	
			CAB 30	CAB 31	CSL 1	CSL 2	CSL 3	CSL 4	CSL 5	CSL 6	VOLTAGE ACROSS P. S. TERMINALS	FRONT PANEL METERS
PS301901	-6.5 V No. 1		E301002C E301003C V	SIM E2C SIM E3C V							V	V A
PS302301	-26 V No. 1 (19.5 V)		E301002C E301004C V	SIM E2C SIM E4C V							V	V A
PS301701	-6.5 V No. 2				E0001 TB1-2 V	E0001 TB1-2 V					V	V A
PS302101	-26 V No. 2 (19.5 V)				E0001 TB1-9 V	E0001 TB1-9 V					V	V A
PS301501	+26 V No. 1		E301002C E301001C V	SIM E2C SIM E1C V	E0001 TB1-6 V	E0001 TB1-6 V					V	V A
PS300101	-300 V				E0001 TB1-14 V	E0001 TB1-14 V	E0001 TB1-14 V	E0001 TB1-14 V	E0001 TB1-14 V	E0001 TB1-14 V	V	V A
PS301301	+300 V				E0001 TB1-13 V	E0001 TB1-13 V	E0001 TB1-13 V	E0001 TB1-13 V	E0001 TB1-13 V	E0001 TB1-13 V	V	V A
PS311901	-6.5 V No. 3						E0001 TB1-2 V	E0001 TB1-2 V			V	V A
PS312301	-26 V No. 3 (19.5 V)						E0001 TB1-9 V	E0001 TB1-9 V			V	V A
PS311701	-6.5 V No. 4								E0001 TB1-2 V	E0001 TB1-2 V	V	V A
PS312101	-26 V No. 4 (19.5 V)								E0001 TB1-9 V	E0001 TB1-9 V	V	V A
PS311501	+26 V No. 2						E0001 TB1-6 V	E0001 TB1-6 V	E0001 TB1-6 V	E0001 TB1-6 V	V	V A

g. Adjust the power supplies in the sequence given in the table, as in the following example:

(1) Place voltmeter leads of one meter across E301002C and E301003C (C = center of nest bus bars) and another meter at Simulator nest bus bars E2-C and E3-C.

(2) Read the voltages and slowly adjust the vernier of PS 301901 until these voltages are 6. 500 volts, or until a minimum average deviation (difference) is obtained (lowest average of the two extreme readings).

(3) Record the final readings in the spaces provided in table 5-20.

(4) Repeat procedure for the next power supply, and all others using measuring points given.

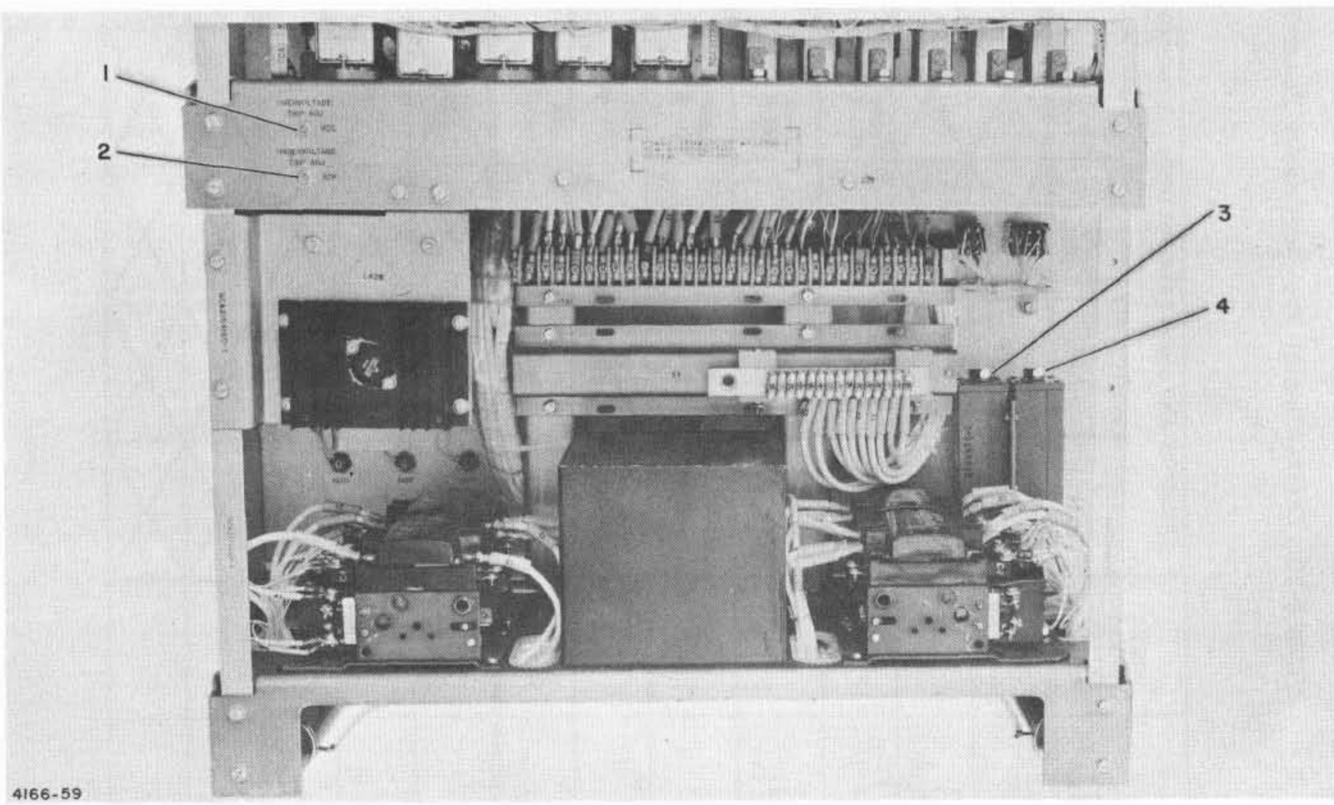
h. Measure and record the voltage across terminals 4 and 7 of each supply. (This allows replacement of a power supply without repeating this whole procedure.)

i. Record the front panel voltmeter and ammeter readings in table 5-20.

j. Make any necessary tube alignment touch-up adjustments required to optimize the displays.

2.7 Overvoltage and Undervoltage Protection Circuit

Adjustment of the overvoltage and undervoltage protection circuits are not generally necessary. These controls are set at time of manufacture and should not require readjustment unless circuit components have been replaced or changed. Adjustment of these controls, figure 5-27, is accomplished as follows:



1. OVERVOLTAGE TRIP ADJ control R25
2. UNDERVOLTAGE TRIP ADJ control R26
3. 6 second Time Delay Relay K26 adjustment
4. 30 second Time Delay Relay K28 adjustment

Figure 5-27. Power Sequencer Assembly Maintenance Controls

CAUTION

Remove cabinet modules and disconnect dc power to consoles to prevent equipment damage.

a. Remove connector P300301 at Power Sequencer Assembly.

b. Set R25(1) to approximately center of rotation, and R26(2) to extreme counterclockwise position.

c. Connect -26 volt external power source to TB4-85 of Power Sequencer Assembly.

d. Connect digital voltmeter across output of a 0-34 volt variable power supply and set output to -6. 5 volts; turn power off and connect to TB4-33.

e. Apply power as follows: -26 volts first and -6. 5 volts next; relays K19 and K20 will energize.

f. Decrease output voltage of variable supply until relay K20 deenergizes and note the voltage level indicated on the voltmeter. Voltage level should agree with undervoltage limits listed in table 5-21.

g. If voltage indication does not agree with limit of table turn R26 clockwise a few degrees and set variable supply back to -6. 5 volts or to point where relay K20 energizes. Set for -5. 5 volts trip.

h. Repeat steps f and g until limits of table 5-21 are obtained.

i. Test in accordance with paragraph 4. 8 of Section II.

j. Set R25(1) to maximum clockwise position.

k. Increase output voltage of variable supply until relay K19 deenergizes and note the voltage level indicated on the voltmeter. Voltage level should agree with overvoltage limits listed in table 5-21.

l. If voltage indication does not agree with limit of table turn R25 counterclockwise a few degrees and set variable supply back to -6. 5 volts or to point where relay K19 energizes. Set for 7. 3 volt trip.

m. Repeat steps j and k until limits of table 5-21 are obtained.

n. Replace modules and console connectors.

Table 5-21. Overvoltage and Undervoltage Trip Ranges

NOMINAL VOLTAGE	TRIP RANGE UNDER-VOLTAGE	TRIP RANGE OVER-VOLTAGE
-6. 5 v	-7. 0 to -8. 0 v	-4. 5 to -6. 0 v
-26. 0 v	-29. 0 to -35. 0 v	-17. 0 to -23. 0 v
+26. 0 v	+29. 0 to +35. 0 v	+17. 0 to -23. 0 v

2.8 Power Sequencer Assembly Time Delay Relay Adjustment

These time delay relays K26 and K28 (3 and 4, figure 5-27) do not generally require adjustment and should not be adjusted unless absolutely necessary. The adjustment of both relays is similar only the method of determining timing cycle is different, since relay K26 is a delayed operate and relay K28 is a delayed release. The adjustment procedure is accomplished as follows:

CAUTION

Remove cabinet modules and disconnect dc power to consoles to prevent equipment damage.

2. 8. 1 SIX SECOND TIME DELAY RELAY

a. Set circuit breaker of -300 VDC Power Supply (PS300101) to OFF.

b. Press DC POWER ON switch (1, figure 3-1) and start stop watch. After approximately six seconds time elapse, the equipment should start to sequence off and return to standby status; DC POWER ON indicator lighted yellow.

c. If equipment does not start to sequence off within 5 - 7 seconds remove hexagonal dust cover on top of relay K26 (3, figure 5-27) and turn adjusting screw counterclockwise to decrease time and clockwise to increase time.

d. Repeat step b. If time cycle is correct replace hexagonal dust cover, turn -300 VDC ON, modules, and console connectors.

2.8.2 THIRTY SECOND TIME DELAY RELAY

a. Turn BLOWERS and 28V P. S. circuit breaker (9, figure 3-1) to OFF.

b. Turn BLOWERS and 28V P. S. circuit breaker (9) to ON, and observe time that DC POWER ON indicator (1) lights red. After 30 seconds time elapse DC POWER ON indicator changes from red to yellow.

c. If time elapse is not within 27-33 seconds remove hexagonal dust cover from relay K28 and adjust screw counterclockwise to increase time. Repeat until correct time elapse is obtained.

d. If time cycle is correct replace hexagonal dust cover, modules, and console connectors.

2.9 Computer Simulator Adjustment

Adjustment of the computer simulator is accomplished as follows:

a. Turn CRT power and dc power off.

b. Interchange the simulator connectors and computer connectors at receptacles J300013 and J300014.

c. Turn dc power on.

d. Connect oscilloscope to test point K of simulator module assembly A12.

e. Adjust control R3 (1, figure 5-28) of simulator module assembly A7 to provide 1 cycle time of 3.2 μsec.

f. Connect oscilloscope to test point K of simulator module assembly A14.

g. Momentarily press READ switch (10, figure 5-1) and observe pulse. Pulse should be positive going and 50 μsec in duration.

h. Adjust control R21 (2, figure 5-28) of simulator module assembly A7 to obtain correct pulse time duration of 50 ±10% μsec.

i. Connect oscilloscope to test point K of simulator module assembly A13.

j. Momentarily press TRIGGER switch (15, figure 5-1) and observe pulse. Each time the TRIGGER switch is pressed a pulse of 16 μsec duration should appear.

k. Adjust control R10 (3, figure 5-28) of simulator module A7 to obtain correct pulse time duration of 16 ±10% μsec.

2.10 Keyboard Assembly

When corrective maintenance requires the replacement of a lamp or photocell in the keyboard assembly or keyboard bit generation trouble is traced to the keyboard assembly, adjustment of the light beam may be necessary. Adjustment of the keyboard assembly light beam is accomplished as follows:

a. Unlatch Dzus fasteners at rear ledge of Manual Input Assembly and tilt cover forward on hinge.

b. Remove keyboard assembly mounting screws, accessible at under side of Manual Input Assembly.

c. Remove back plate from keyboard assembly to gain accessibility to terminal board TB1.

d. Turn keyboard assembly over or stand on side if possible to provide accessibility to keyboard lamp assembly locking screws.

e. Connect negative lead of voltmeter to TB1-11 and connect positive lead to the terminal associated with the lamp under adjustment.

Terminal Board Connection	Lamp
TB1-6	DS1
TB1-5	DS2
TB1-4	DS3
TB1-3	DS4
TB1-2	DS5
TB1-1	DS6
TB1-10	DS10

f. Loosen lamp assembly locking screw with Allen wrench.

g. Raise, lower, and rotate lamp in housing to obtain minimum voltage while holding the DEL (delete) key depressed. Should be less than 8.0 volts or replace lamp or photocell.

h. Tighten lamp assembly locking screw after lamp has been properly aligned.

i. Replace keyboard into mounting position, secure in place and fasten Manual Input Assembly cover.

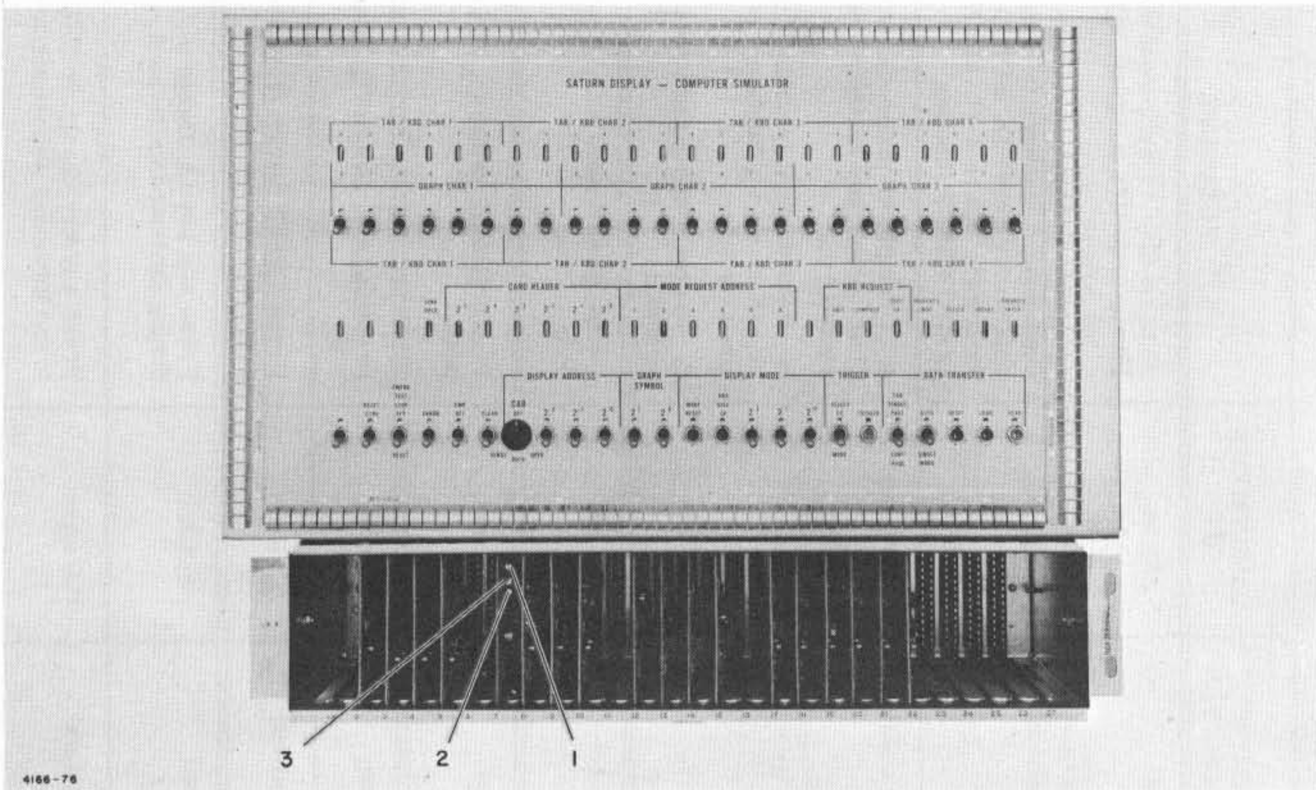


Figure 5-28. Computer Simulator Maintenance Controls

2.11 Multivibrator Adjustments

The adjustment of the display multivibrators are tabulated in table 5-22.

3. REMOVAL AND REPLACEMENT

The following paragraphs provide information to aid in the removal and replacement of components in the display console and display cabinet. The procedures outlined in these paragraphs should be performed by a two-man maintenance team.

WARNING

Remove primary input power before attempting to remove or replace any component, by setting MAIN POWER circuit breaker (12, figure 3-1) to OFF.

3.1 High Voltage Power Supplies

The high voltage power supplies are removed and replaced through the front door of the display console. The power supplies weigh approximately 150 pounds; therefore, a dolly should be used to transport the power supply to and from the work area.

3.1.1 REMOVAL

a. Remove plug from connector at top of respective power supply.

b. Remove plastic high voltage shield and wires from insulated terminals at rear of power supply.

c. Remove screws securing power supply to base of display console, and slide forward on to dolly.

Table 5-22. Display Set Multivibrator Adjustments

MODULE LOCATION & TYPE	MODULE CIRCUIT TEST POINT	FUNCTION	ADJUSTMENT POTENTIOMETER	ADJUSTMENT (+10%, -o)	FUNCTION
A0806 V-115	F	Clock pulse generator	R3 (Top)	250 kc	Turn on display equipment power. Power sequence complete starts clock pulses
(Cabinet)	E	MAIN CLEAR A pulse	R10 (Bottom)	10 μsec	Once power sequence is complete, continually press DC POWER ON switch (1, figure 3-1), MAIN LOGIC RESET function
	J	Priority interrupt pulse (PIP)	R21 (Middle)	100 μsec	a. Once power sequence is complete, press any keyboard request switch b. Remove card from card reader and press any keyboard request switch c. Repeat steps a and b until adjusted.
A1227 V-106 (Console)	H	Clear and erase timing	R6 (Top)	475 ms	Press ERASE switch (7, figure 3-4)
A1327 V-106 (Console)	H	Clear and erase timing	R6 (Top)	475 ms	Press ERASE switch (7, figure 304)
A1226	C	Clear timing	R16 (Top)	30 ms	Press ERASE switch (7, figure 3-4)
V-108 (Console)	M	Clear timing	R22 (Bottom)	75 μsec	Press ERASE switch (7, figure 3-4)
A1209	C	Keyboard strobe delay timing	R16 (Top)	30 ms	Press any key (3, figure 3-3) during keyboard self-check mode
V-108 (Console)	M	Keyboard strobe pulse width timing	R22 (Bottom)	150 μsec	Press any key (3, figure 3-3) in the keyboard self-check mode

3.1.2 REPLACEMENT

a. Slide power supply from dolly into respective position, and secure to display console with mounting screws.

b. Connect plug to receptacle at top of power supply.

c. Connect wires to insulated terminals at rear of power supply as follows:

(1) Thread a strain relief nut on terminal stud (figure 5-29) and leave approximately one thread spacing above insulator fastening nut.

(2) Place internal tooth lockwasher above strain relief nut.

(3) Place terminal lug(s) above lockwasher.

(4) Thread on fastening nut and tighten to three inch pounds of pressure with a torque wrench, while holding strain relief nut with another wrench to avoid damaging ceramic insulator.

d. Attach plastic high voltage shield.

3.2 Electrostatic Deflection Assembly

3.2.1 REMOVAL

a. Remove all plugs from receptacles at rear of assembly and position cables free from work area.

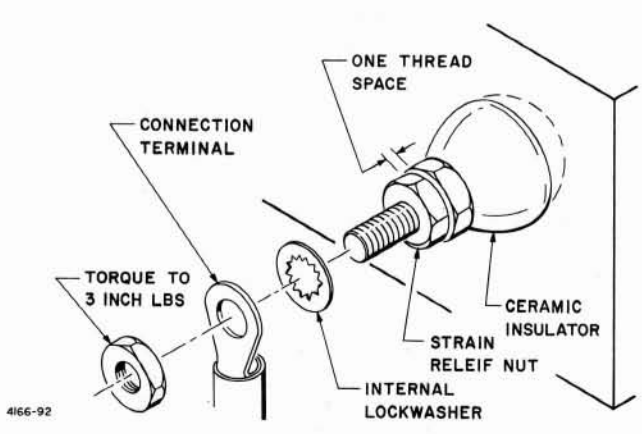


Figure 5-29. High Voltage Power Supply Terminal Connection

b. Release chassis mounting clamp and allow assembly to slide down mounting tracks far enough to permit removal.

3.2.2 REPLACEMENT

a. Place assembly on mounting tracks, slide forward against front panel, and restore mounting clamp pressure.

b. Replace all plug and receptacle connections at rear of assembly.

c. Adjust as required in accordance with procedures of paragraph 2.3 of this section.

3.3 Magnetic Deflection Assembly

3.3.1 REMOVAL

a. Remove plugs from receptacles at bottom of assembly.

b. Turn quarter turn fasteners from top and bottom of chassis, securing assembly to mounting frame; and lift free from console.

3.3.2 REPLACEMENT

a. Position assembly on mounting frame and secure.

b. Replace plug and receptacle connections at bottom of assembly.

c. Adjust as necessary in accordance with procedures of paragraph 2.4 of this section.

3.4 Keyboard Assembly

3.4.1 REMOVAL

a. Unlatch Dzus fasteners at rear ledge of Manual Input Assembly, and tilt cover forward on hinge.

b. Remove plug from receptacle at rear of Keyboard Assembly.

c. Remove Keyboard Assembly mounting screws, accessible at under side of Manual Input Assembly, and lift Keyboard Assembly out of position.

3.4.2 REPLACEMENT

a. Place Keyboard Assembly into position and secure to Manual Input Assembly.

b. Replace plug and receptacle connection at rear of Keyboard Assembly.

c. Lower Manual Input Assembly cover and tighten Dzus fasteners to secure cover.

3.5 Console Blower Assembly

3.5.1 REMOVAL

a. Remove air filter by pulling forward at top corners of filter frame.

b. Remove wire connections at terminal board, and remove cable by extracting it at grommet.

c. Remove screws securing assembly to console swinging frame and lift out of mounting position.

3.5.2 REPLACEMENT

a. Place blower assembly into position and secure to swinging frame.

b. Insert cable through grommet and connect wires at terminal board.

c. Replace air filter.

3.6 Typotron Tube Assembly

The Typotron Tube Assembly is quite heavy; therefore, if a variable height mobile platform is available it would be very advantageous. Also the typotron tube contained within the shield assembly is very fragile and all precaution should be taken to avoid dropping. Special attention should be exercised when handling this assembly and all warning pertaining to lifting, tools, and handling should be regarded.

3.6.1 REMOVAL

a. Remove plug from write gun connector.

b. Remove nut and washer securing write gun shield cylinder to assembly frame (do not allow cylinder to rest on write gun envelope).

c. Remove shield support bracket from assembly by loosening screws at each side where it is attached to main frame.

d. Loosen nuts holding shield cylinder to shield assembly rear plate and cautiously slide cylinder backward along gun envelope until it is free of tube connector (do not allow cylinder to rest on or jar gun envelope).

e. While shield assembly rear plate is being supported remove screws holding plate to shield assembly housing, and carry rear plate backward along gun envelope until free of connector (do not allow plate to rest on gun envelope).

f. Remove plug from flood gun connector.

g. Remove plastic high voltage shield from high voltage power supply PS323101, and remove cable from power supply terminal, OUTPUT NO. 1.

h. Release assembly mounting clamp and slide assembly backward along mounting track onto mobile platform free from console, using handles provided on assembly.

3.6.2 REPLACEMENT

a. Slide Typotron Tube Assembly from mobile platform onto mounting track and forward to mate properly with console bezel.

b. Restore assembly mounting clamp pressure.

c. Attach shielded high voltage cable to high voltage power supply (PS323101) terminal No. 1 in accordance with procedure of paragraph 3.2.2.c. of this section.

d. Replace plastic high voltage shield on high voltage power supply.

e. Attach plug to flood gun connector.

f. Cautiously carry shield assembly rear plate forward along write gun envelope to secure to shield assembly housing (do not allow plate to rest on gun envelope).

g. Cautiously replace shield cylinder over write gun envelope and fasten to shield assembly rear plate. (Do not allow cylinder to rest on write gun envelope.)

h. While supporting shield cylinder replace shield support bracket and fasten shield cylinder to support bracket.

i. Reconnect plug to write gun connector.

3.7 Typotron Tube

After the Typotron Tube Assembly has been removed from the console the typotron tube may be removed from the shield housing as follows:

WARNING

All persons involved with handling of tube during removal and replacement should wear safety goggles and rubber apron. Persons not required to accomplish the tube changing should not be within the immediate work area for damage to tube during handling can cause severe injury.

3.7.1 REMOVAL

a. Remove screws securing front retainer ring to shield housing.

b. Remove wires from terminal board TB2.

c. Disconnect and remove magnetic deflection yoke and remove yoke mounting bracket.

d. While one person supports the typotron tube at the rear of assembly and another holds the typotron tube from sliding forward, a third person can release the pressure from the 7 pressure pads around the typotron tube.

e. Remove typotron tube from housing by having one person cautiously pushing from the rear and two persons supporting the tube at the front. (Do not lift or place pressure on the two gun envelopes or necks.)

f. Remove safety shield from face of tube for placement on new tube.

3.7.2 REPLACEMENT

a. After removing tube from shipping container place in a fixture to facilitate attachment of wire terminations.

b. Using the removed tube as a sample install wire terminations as required. Materials required are indicated on wire connection list documents supplied as engineering documentation.

c. Clean face of tube with soap and water and dry with lint free cloth. Remove old tape from safety shield and clean with soap and water and dry with lint free cloth.

d. Tape safety shield to face of tube with two layers of mylar tape. Pull mylar around edge leaving at least 1/2 inch of tape folded over shield edge. Rub tape vigorously to insure maximum adhesive contact to shield and tube bell surface.

e. Apply two layers of mylar tape strips 2 inches long at junction of write gun envelope and tube bell. Allow for 1 inch of tape on each side of junction. Use old tube as sample.

f. Apply light coating of Dow Corning DC-4 silicone grease to adjustment pads inside housing.

g. Install tube into housing. This will require four men as follows:

(1) 2 men to hold tube in front of housing and gradually slide it into position.

(2) 1 man to feed the connection leads through grommets provided in housing.

(3) 1 man to support tube at back of housing to insure that gun envelopes do not bump any objects.

h. Check that center marking on face of tube aligns with 12 o'clock mark on housing. Flood gun envelope should be located at approximately 12 o'clock.

i. Install retainer ring to front of housing.

j. Slowly and alternately adjust the three adjusting pads on bell of housing until tube is centered and securely against retainer ring.

k. Slowly and alternately adjust the four adjusting pads near front of housing to center tube horizontally and vertically in position.

l. Install yoke collar assembly to inside of housing.

m. Carefully install yoke with pin 4 positioned at 12 o'clock. While maintaining the same clearance between yoke and gun envelope very carefully tighten thumb screws until yoke is held firmly in place. Tighten hexagonal nuts on thumb screws finger tight.

n. Install typotron tube assembly into console in accordance with replacement procedures of paragraph 3. 6. 2.

3.8 Power Control Assembly

3. 8. 1 REMOVAL

a. Remove plugs from connectors of Power Control Assembly.

b. Remove screws securing assembly to swinging frame and lift out of mounting position.

3. 8. 2 REPLACEMENT

a. Place Power Control Assembly into position and secure to swinging frame.

b. Replace plug and receptacle connections.

3.9 Low Voltage Power Supplies

The following procedure is applicable to all low voltage power supplies. The power supplies weigh between 100 and 150 pounds. It is recommended that a variable height mobile platform be used if available.

3. 9. 1 REMOVAL

a. Remove wires from terminal board at rear of power supply and position the wires free from cable entrance opening.

b. Remove screws securing power supply to cabinet mounting frame and slide the supply forward out of the cabinet.

3. 9. 2 REPLACEMENT

a. Install power supply into respective location and secure with mounting screws.

b. Adjust output voltage in accordance with adjustment procedure of paragraph 2. 6 of this section.

c. Reconnect wires to power supply terminal board.

3.10 Rear Cabinet Blower

The rear cabinet blower is the blower assembly mounted below the Low Voltage Power Supplies.

3. 10. 1 REMOVAL

a. Remove screws securing blower to frame and lift out of mounting position. Remove top cover plate.

b. Remove connections from terminal block and remove cable from assembly.

3. 10. 2 REPLACEMENT

a. Insert cable into assembly and fasten connections at terminal block.

b. Place blower assembly into mounting position and secure to frame.

c. Replace top cover plate.

3.11 Power Sequencer Assembly

The Power Sequencer Assembly is quite heavy; therefore, if a variable height mobile platform is available it would be advantageous.

WARNING

Be sure primary power wall disconnect is OFF and LOCKED and all circuit breakers of the Power Sequence Assembly and Auxiliary Sequence Assembly are in ON position before attempting to remove or install the Power Sequence Assembly. The RFI filters retain a change which must be discharged to ground, to avoid shock.

3. 11. 1 REMOVAL

a. Connect a clip lead between ground and each input line terminal of CB9 and E1 (neutral) for a minimum of 10 seconds at each point.

b. Remove plugs from receptacles J1 and J2 of Power Sequencer Assembly.

c. Remove 6 primary power cables from MAIN POWER circuit breaker CB9.

d. Remove external connections from terminal board TB1 and 2 ac neutral cables from ground bar E1 of Power Sequencer Assembly.

e. Remove cable retaining bolts from cable retaining bracket, and remove cables from cable retainer to position cables free from assembly.

f. Remove screws securing assembly to swinging frame and slide forward onto mobile platform if available.

3.11.2 REPLACEMENT

a. Slide assembly from mobile platform into position and secure to swinging frame.

b. Route cables going to TB1 and E1 through cable retaining bracket and attach cable retaining bolts to bracket.

c. Connect ac neutral cable to ground bar E1, and external connections to terminal board TB1 in accordance with identifying tags.

d. Connect primary power cables to MAIN POWER circuit breaker CB9.

e. Attach plugs to respective receptacles J1 and J2 of assembly.

3.12 Auxiliary Sequencer Assembly

WARNING

Be sure primary power wall disconnect is OFF and LOCKED and all circuit breakers of the Power Sequence Assembly and Auxiliary Sequence Assembly are in ON position before attempting to remove or install the Power Sequence Assembly. The RFI filters retain a charge which must be discharged to ground, to avoid shock.

3.12.1 REMOVAL

a. Connect a clip lead between ground and each input line terminal of CB9 and E1 (neutral) for a minimum of 10 seconds at each point.

b. Remove external connections at terminal board TB1, and ac neutral cable at ground bar E1.

c. Remove plug from connector J1.

d. Remove screws at front right hand side of auxiliary sequencer panel and swing open to remove external power connections at POWER SUPPLIES circuit breakers CB1, CB2, and CB3. Loosen cable clamps and remove external wiring.

e. Close and secure auxiliary sequencer panel.

f. Remove mounting screws securing assembly to swinging frame and lift out of position.

3.12.2 REPLACEMENT

a. Place Auxiliary Sequencer Assembly into position and secure to swinging frame.

b. Remove screws at front right hand side of auxiliary sequencer panel and swing open to connect external power cables to POWER SUPPLIES circuit breakers CB1, CB2, and CB3.

c. Secure panel to assembly.

d. Replace plug and receptacle connection at J1.

e. Reconnect ac neutral cable to ground bar E1 and external connections at terminal board TB1.

3.13 Computer Simulator

3.13.1 REMOVAL

a. Remove plug from connector J1.

b. Remove Computer Simulator connections from cabinet wall receptacles J300013 and J300014 or DUMMY receptacles.

c. Cut cable straps holding simulator cable to lacing bar.

d. Remove bolts securing simulator panel and module nest assembly to swinging frame, and lift complete assembly out of position.

3.13.2 REPLACEMENT

a. Place complete simulator and module nest assembly into position and secure to swinging frame.

b. Reconnect computer simulator plugs to cabinet wall receptacles J300013 and J30014 or DUMMY receptacles.

c. Tie cable to lacing bar.

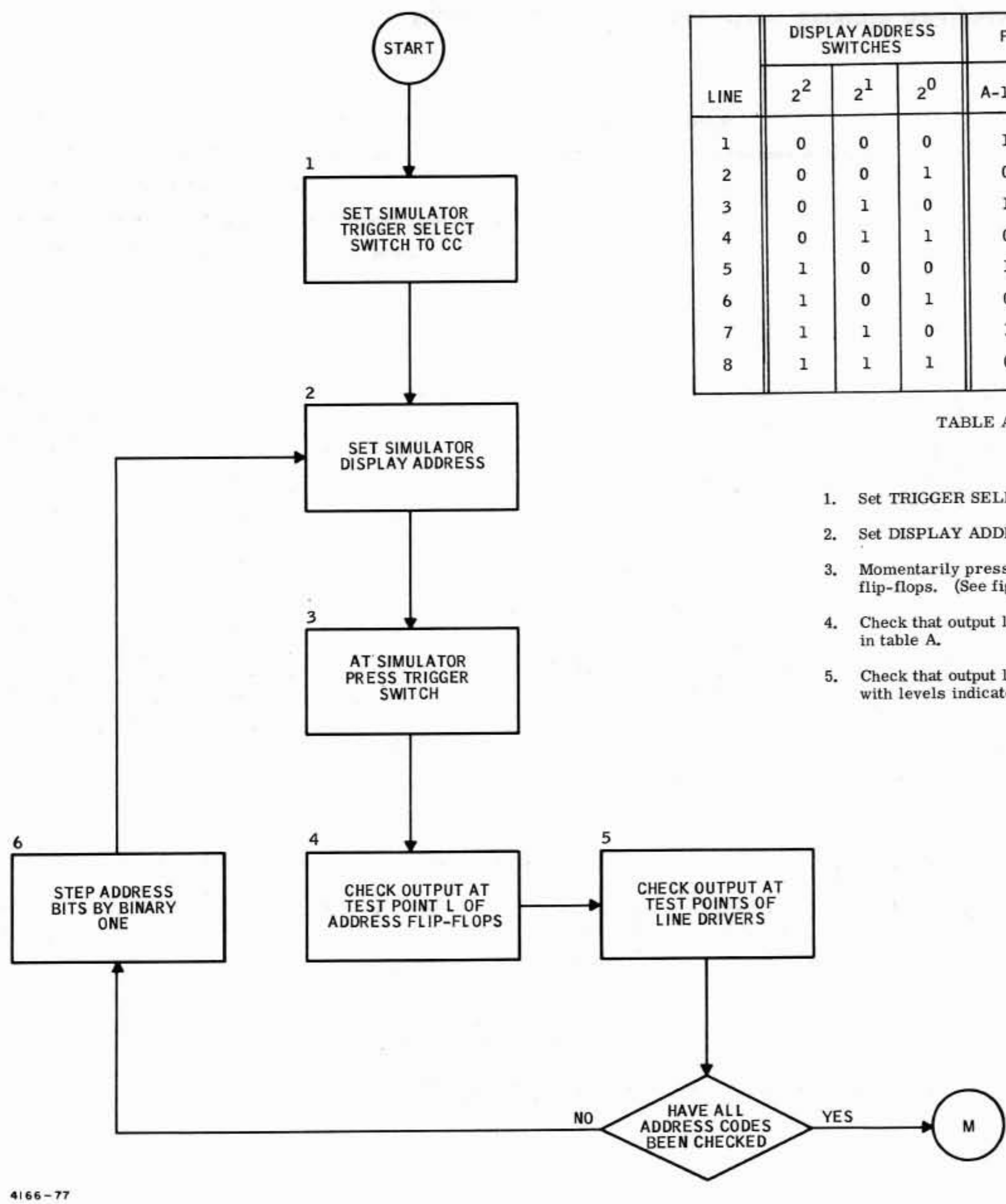
d. Replace plug connection at receptacle J1.

3.14 Front Cabinet Blower

The front cabinet blower is the blower assembly mounted at the base of the swinging frame. Removal and replacement is the same as for the console blower. Refer to instruction of paragraph 3.5 of this section.

4. TROUBLESHOOTING

Troubleshooting procedures utilizing the computer simulator are performed with the display set in the off-line status. Figures 5-30 through 5-37 provide a systematic trouble analysis routine to be employed when the malfunction cannot be located by means of the performance test procedures.



LINE	DISPLAY ADDRESS SWITCHES			FLIP-FLOP OUTPUT			LINE DRIVER OUTPUTS					
	2^2	2^1	2^0	A-13L	A-18L	A-23L	A-12E	A-15F	A-17G	A-20J	A-22L	A-25M
1	0	0	0	1	1	1	1	1	1	1	1	1
2	0	0	1	0	1	1	0	1	1	1	1	1
3	0	1	0	1	0	1	1	0	1	1	1	1
4	0	1	1	0	0	1	1	1	0	1	1	1
5	1	0	0	1	1	0	1	1	1	0	1	1
6	1	0	1	0	1	0	1	1	1	1	0	1
7	1	1	0	1	0	0	1	1	1	1	1	0
8	1	1	1	0	0	0	1	1	1	1	1	1

TABLE A. FLIP-FLOP AND LINE DRIVER LOGIC LEVELS

1. Set TRIGGER SELECT switch (16, figure 5-1) to CC.
2. Set DISPLAY ADDRESS 2^2, 2^1, 2^0 switches (21) down (Code 000). (See table A.)
3. Momentarily press TRIGGER switch (15). This strobes the address data into the address flip-flops. (See figure 6-2.)
4. Check that output logic levels of flip-flops A-13, A-18, and A-23 agree with levels indicated in table A.
5. Check that output logic levels of line drivers A-12, A-15, A-17, A-20, A-22, and A-25 agree with levels indicated in table A.

Figure 5-30. Address Decoding Trouble Analysis Flow Chart

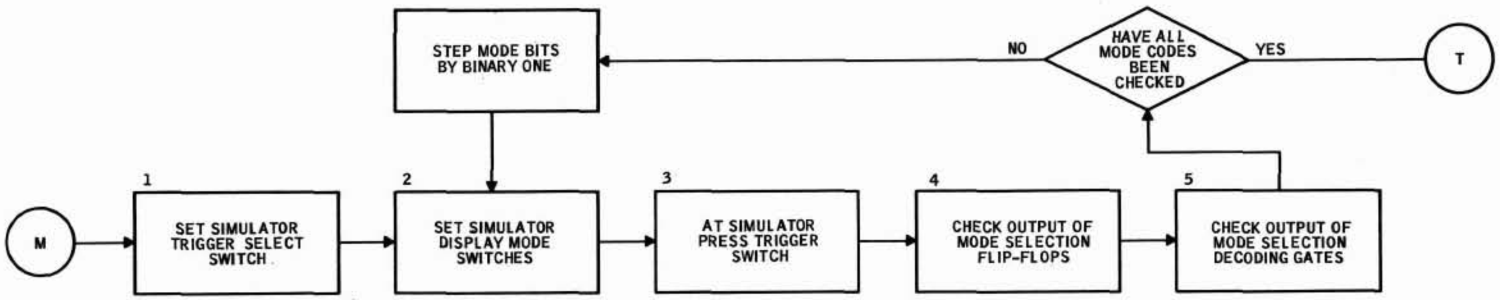


TABLE B. MODE SELECTION FLIP-FLOP AND DECODING GATE LOGIC LEVELS

	DISPLAY MODE SWITCHES				FLIP-FLOP OUTPUTS			MODE DECODING GATES																					
LINE	MODE	2^2	2^1	2^0	M-79L	M-82L	M-88L	M-68	M-74	M-80	M-83 M-101	M-85 M-100	M-90 M-99	M-94	M-98 M-102	M-97	M-86 M-89	M-91	M-69	M-84	M-75	M-81	M-70	M-96	M-87	M-95	C-10	M103	M104
1	NM	0	0	0	1	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	1
2	TM	0	0	1	0	1	1	1	0	0	0	0	0	1	0	0	1	1	0	1	1	1	1	1	0	0	1	1	0
3	GM	0	1	0	1	0	1	0	1	0	0	0	0	1	0	1	1	1	1	1	0	1	0	0	0	0	1	0	1
4	TEM	0	1	1	0	0	1	0	0	1	0	0	0	1	0	0	1	1	0	1	1	0	1	1	0	0	1	1	0
5	KSCM	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0	1	1	1	0	1	1	0	1	0	0	1	0	1
6	KCM	1	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	1	1	1	1	1	0	1	1	0	1	0	1
7	KEM	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	1	1	1	0	1	0	0	1	0	1
8	NM	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	1

1. Set TRIGGER SELECT switch (16, figure 5-1) to MODE.
2. Set DISPLAY MODE switches (17) down (Logical 000). (See table B.)
3. Momentarily press TRIGGER switch (15).
4. Check that output logic levels of flip-flops M-79, M-82, and M-88 (figure 6-7) agree with levels indicated in table B.
5. Check that output logic levels of decoding gates (figure 6-7) agree with levels indicated in table B.

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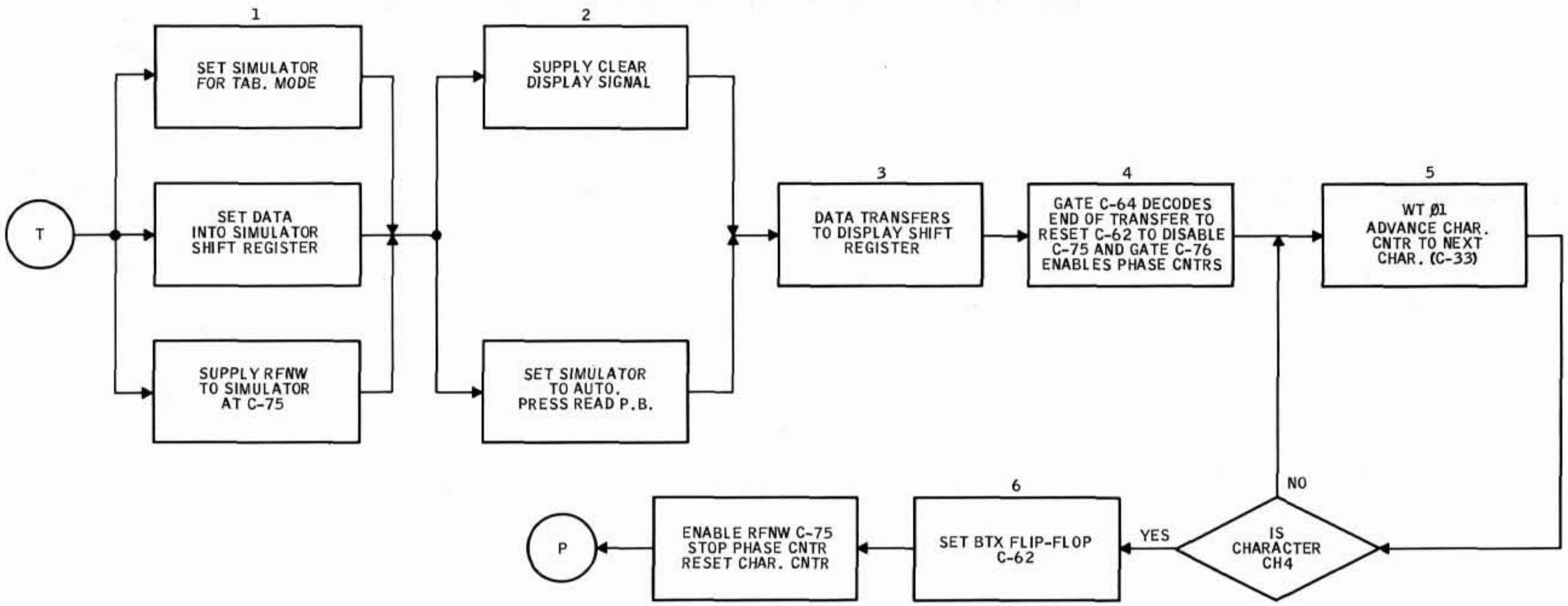
Figure 5-31. Mode Selection Trouble Analysis Flow Chart



1. a. Set CAB OPER/SENSE/BOTH switch (22, figure 5-1) to BOTH; and set DISPLAY MODE 2^0 switch (17) up, RESET CTRS switch (27) up, and momentarily press TRIGGER switch (15).
   b. Set TAB/KBD CHAR switches (1) to positions indicated at line 1 of figure 5-12.
   c. Set a logical 1 output at gate C-75. (See figure 6-3.)
2. a. Set CLEAR switch (23, figure 5-1) up, set TRIGGER SELECT switch (16) to CC, and momentarily press TRIGGER switch (15).
   b. Place AUTO/SINGLE WORD switch (13) to AUTO and momentarily press READ switch (10).
3. 24 bits of data transfers from the simulator shift register to the display shift register. (See figure 6-4, sheets 3 and 4.)
4. At end of transfer C-64 resets flip-flop C-62 which disables C-75 from sending a ready for next word (RFNW) signal, and gate C-76 starts the phase counter, T-15 through T-40 figure 6-11.
5. Gate C-33 advances character counter C-36, C-40, C-44 to count characters 1 through 4.
6. When character 4 is present flip-flop C-62 is set by C-52 thereby disabling the phase counter and sends a logical 1 to C-75 to produce a ready for next word signal. This transfer will continue until the AUTO/SINGLE WORD switch (13) is placed in SINGLE WORD position.

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Figure 5-32. Transfer Control Trouble Analysis Flow Chart

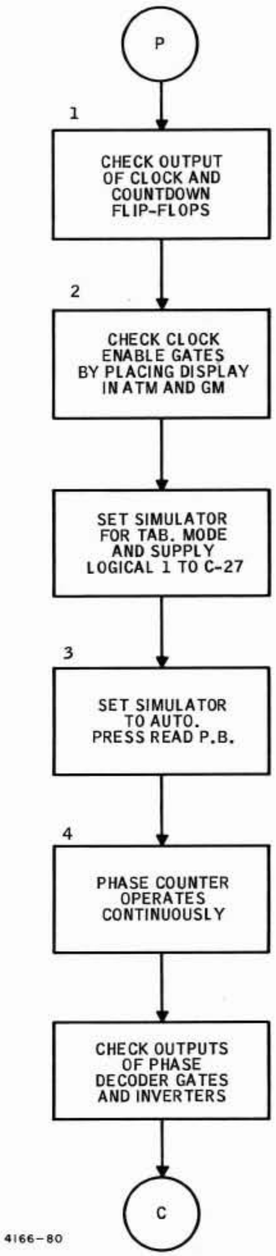


TABLE D. PHASE COUNTER OUTPUTS

PHASE	GATES	LOGIC LEVEL
ø0	T-13 T-14	1 0
ø1	T-18 T-16, T-19	1 0
ø2	T-24 T-25	1 0
ø3	T-27 T-28	1 0
ø4	T-30 T-31	1 0
ø5	T-33 T-34, T-35	1 0
ø7	T-37 T-38, T-39	1 0
ø9	T-21 T-20, T-22	1 0
ø15	T-41 T-42	1 0

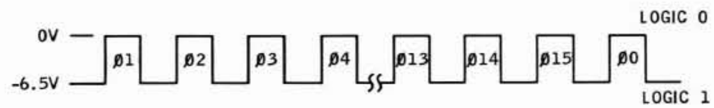


TABLE C. PHASE COUNTER FLIP-FLOP OUTPUT LOGIC LEVELS

PHASE	T-15	T-17	T-23	T-26	T-29	T-32	T-36	T-40
ø0	1	1	1	1	1	1	1	1
ø1	0	1	1	1	1	1	1	1
ø2	0	0	1	1	1	1	1	1
ø3	0	0	0	1	1	1	1	1
ø4	0	0	0	0	1	1	1	1
ø5	0	0	0	0	0	1	1	1
ø6	0	0	0	0	0	0	1	1
ø7	0	0	0	0	0	0	0	1
ø8	0	0	0	0	0	0	0	0
ø9	1	0	0	0	0	0	0	0
ø10	1	1	0	0	0	0	0	0
ø11	1	1	1	0	0	0	0	0
ø12	1	1	1	1	0	0	0	0
ø13	1	1	1	1	1	0	0	0
ø14	1	1	1	1	1	1	0	0
ø15	1	1	1	1	1	1	1	0
ø0	1	1	1	1	1	1	1	1

1. Check output of clock T-3 for 3 μsec symmetrical square wave. Check output of countdown flip-flop T-4 for 6 μsec symmetrical square wave. Check output of countdown flip-flop T-5 for 12 μsec symmetrical square wave. (See figure 6-11.)

2. a. Set DISPLAY MODE 2^2 and 2^1 switches (17, figure 5-1) down and 2^0 switch up, set AUTO/SINGLE WORD switch (13) to SINGLE WORD, set TRIGGER SELECT switch (16) to MODE, and momentarily press TRIGGER switch (15).

   b. Output of gate T-9 should be a 6 μsec symmetrical square wave, and the output at gate T-11 is the same as output of gate T-9 except with 180 degree phase shift. (See figure 6-11.)

   c. Set DISPLAY MODE 2^2 and 2^0 switches (17, figure 5-1) down and 2^1 switch up, then momentarily press TRIGGER switch (15).

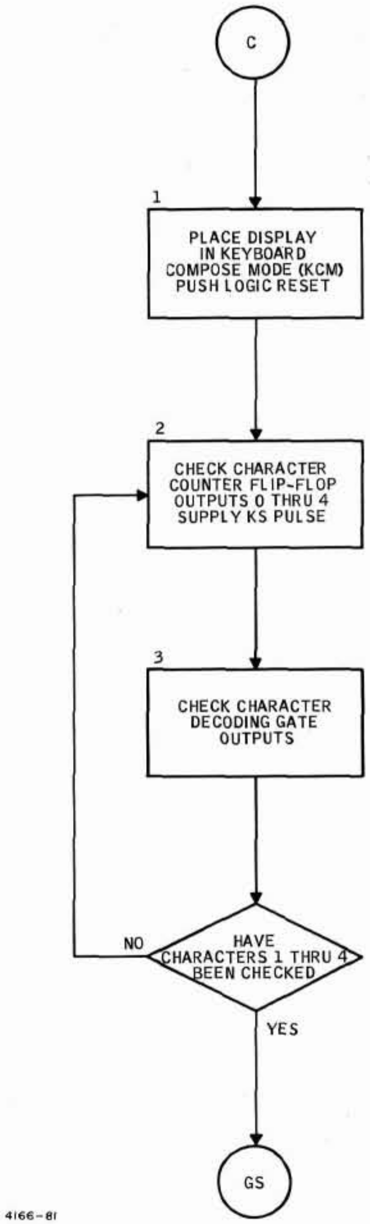
   d. Output of gate T-8 should be a 12 μsec symmetrical square wave and the output at gate T-11 is the same as output of gate T-8 except with 180 degree phase shift. (See figure 6-11.)

   e. Set DISPLAY MODE 2^2 and 2^1 switches (17, figure 5-1) down and 2^0 switch up, then momentarily press TRIGGER switch (15). Apply a console busy signal (logical 1) to terminating OR gate C-27. (See figure 6-3.)

3. Place AUTO/SINGLE WORD switch (13, figure 5-1) to AUTO and momentarily press READ switch (10).

4. Phase counter flip-flops T-15 through T-40 operate continuously. Table C shows phase counter flip-flop outputs. Check that phase counter decoder and inverter outputs agree with table D. Sync scope to ø0 at T-13. Output will be pulses of 3 μsec duration. (See figure 6-11.)

Figure 5-33. Phase Counter Trouble Analysis Flow Chart



CHARACTER	T-36	T-40	T-44
0 (RESET)	1	1	1
1	0	1	1
2	0	0	1
3	0	0	0
4	1	0	0

TABLE E. *CHARACTER COUNTER FLIP-FLOP LOGIC LEVELS*

1\. a. Set DISPLAY MODE 2^1 switch (17 figure 5-1) down and 2^2 and 2^0 switches up, set AUTO/SINGLE WORD switch (13) to SINGLE WORD, set TRIGGER SELECT switch (16) to MODE, and momentarily press TRIGGER switch (15).

b. Momentarily press RESET CTRS switch (27).

2\. a. Check that outputs of character counter flip-flops T-36, T-40, T-44 (figure 6-3) agree with logic levels indicated in table E. Sync scope phase 1 output (T-18, figure 6-11).

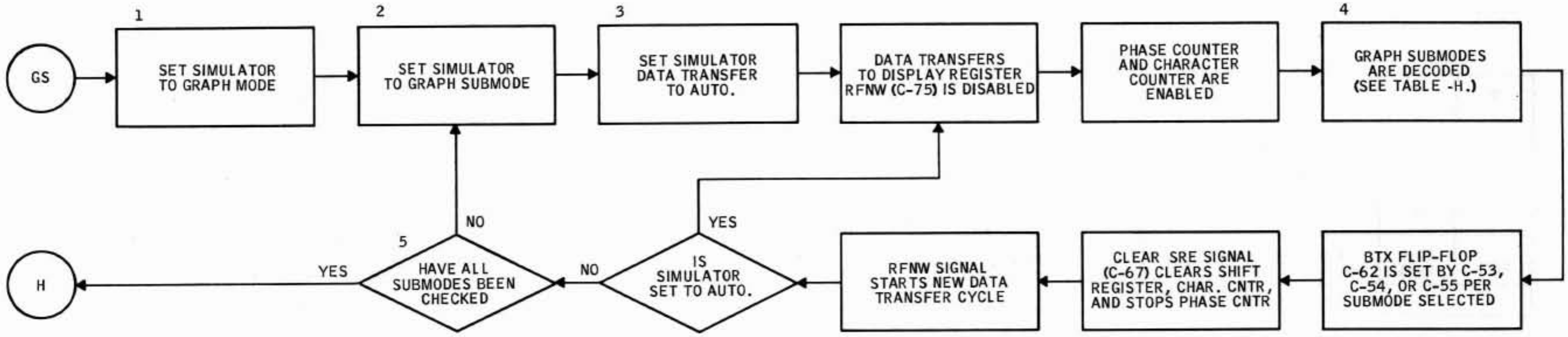
b. Set TRIGGER SELECT switch (16, figure 5-1) to CC and momentarily press TRIGGER switch (15).

3\. Check that outputs of decoding gates, figure 6-3, agree with logic levels indicated in table F.

TABLE F. CHARACTER COUNTER DECODING GATE LOGIC LEVELS

CHARACTER	DECODING GATE OUTPUTS							
	T-37	T-41	T-45	T-47	T-38	T-39 T-42	T-43 T-46	T-48
0	0	0	0	0	1	1	1	1
1	1	0	0	0	0	1	1	1
2	0	1	0	0	1	0	1	1
3	0	0	1	0	1	1	0	1
4	0	0	0	1	1	1	1	0

Figure 5-34. Character Counter Trouble Analysis Flow Chart



1. Set DISPLAY MODE 2^2 and 2^0 switches (17, figure 5-1) down and 2^1 switch up, set TRIGGER SELECT switch (16) to MODE, and momentarily press TRIGGER switch (15).
2. Set GRAPH CHAR 1 switches (1) to produce octal code 373, 376, 377 and 000.
3. Set AUTO/SINGLE WORD switch (13) to AUTO and momentarily press READ switch (10).
4. Check that submode decoding gate outputs agree with logic levels indicated in table H. (See figure 6-6.)
5. Repeat steps 2 through 4 for all submodes of table H. Code 000 checks the absense of submodes in graph plot submode.

TABLE H. GRAPH SUBMODE DECODING GATE LOGIC LEVELS

SUBMODE	DECODER GATES																		
	G-4	G-7	G-5	G-8	G-6	G-9	G-26	G-27	G-10	G-18	G-11	G-19	G-20	G-21	G-22	G-23	G-15	G-24	G-16
373	1	0	0	1	0	1	1	1	0	1	0	1	1	1	0	0	0	1	1
376	0	1	1	0	0	1	1	1	0	1	0	1	1	1	1	1	0	1	0
377	0	1	0	1	1	0	1	1	1	0	1	0	0	0	1	1	0	1	0
000	0	1	0	1	0	1	0	0	1	0	1	0	0	0	1	1	1	0	1

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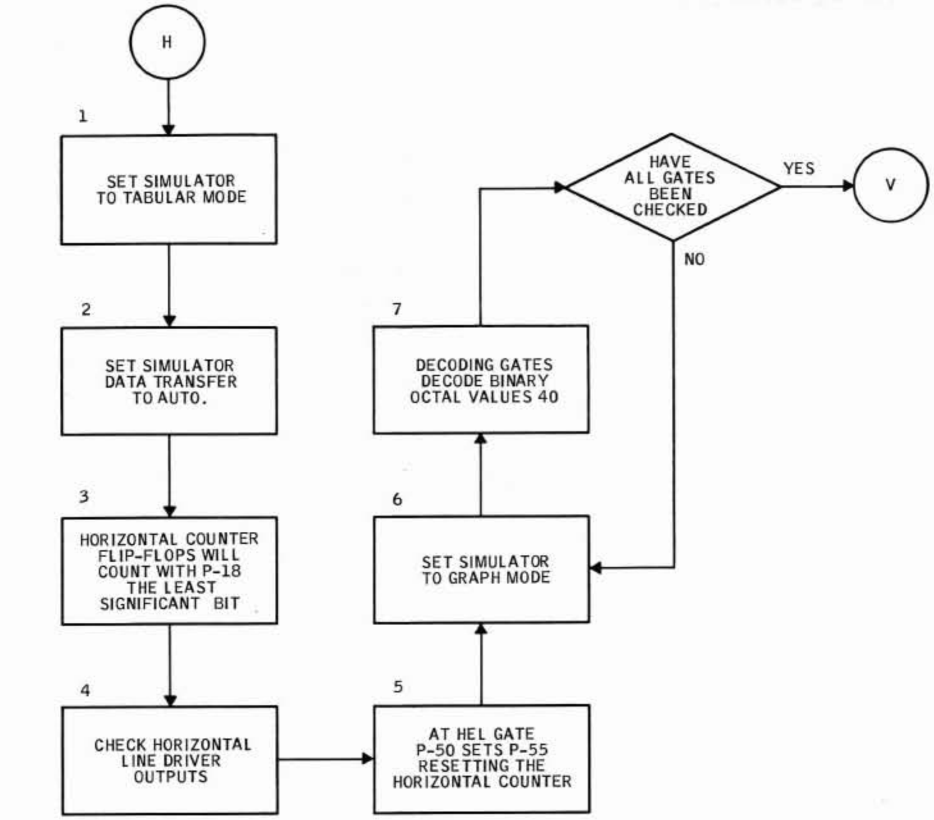
Figure 5-35. Graph Submode Trouble Analysis Flow Chart



1. Set DISPLAY MODE 2^2 and 2^1 switches (17, figure 5-1) down and switch 2^0 up, set TRIGGER SELECT switch (16) to MODE, set RESET CTRS switch (27) up, and momentarily press TRIGGER switch (15).
2. Set AUTO/ SINGLE WORD switch (13) to AUTO and momentarily press READ switch (10).
3. Horizontal counter flip-flops P-18, P-27, P-35, P-43, P-48, and P-49 continuously count, check that waveforms agree with time diagram figure A. (See figure 6-8.)
4. Check that horizontal counter line drivers P-136 through P-143 logic levels agree with waveforms of figure A.
5. At horizontal end of line (HEL) the counter is set to all logical 1's and begins counting. Check that P-55 is set at the $(51)_{10}$ count.
6. Set AUTO/ SINGLE WORD switch (13) to SINGLE WORD. When operation stops set DISPLAY MODE 2^2 and 2^0 switches down and switch 2^1 up, set TRIGGER SELECT switch (16) to MODE, and momentarily press TRIGGER switch (15). Set AUTO/ SINGLE WORD switch (13) to AUTO and momentarily press READ switch (15).
7. Check that horizontal flip-flops, step 3, and line drivers, step 4, timing agrees with table I.

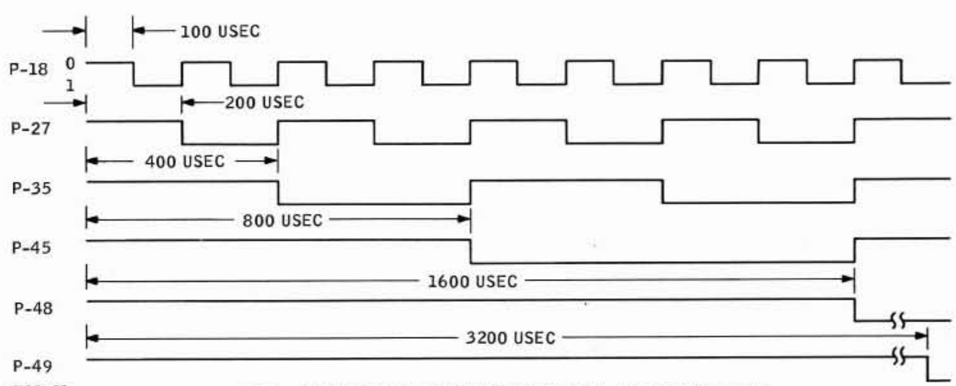
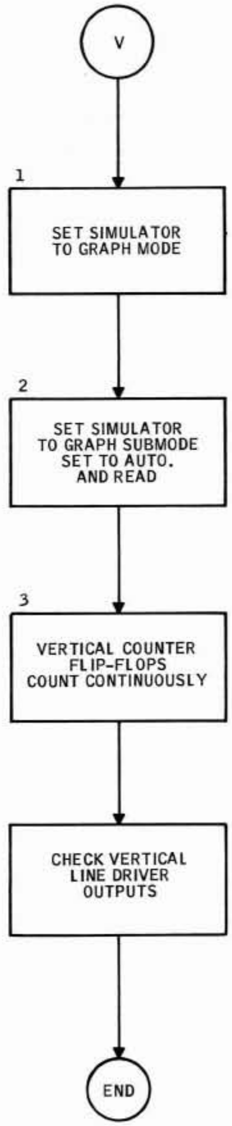


FIGURE A. HORIZONTAL COUNTER FLIP-FLOP TIMING DIAGRAM

TABLE I. HORIZONTAL COUNTER GRAPH MODE TIMING LEVELS

LINE DRIVER	FLIP-FLOP	TIME AT EACH LEVEL
P-143	P-4	200 USEC
P-142	P-14	400 USEC
P-141	P-18	800 USEC
P-140	P-27	1600 USEC
P-139	P-35	3200 USEC
P-138	P-43	6400 USEC
P-137	P-48	12.8 MS
P-136	P-49	25.6 MS

Figure 5-36. Horizontal Counter Trouble Analysis Flow Chart



1. Set DISPLAY MODE 2^2 and 2^0 switches (17, figure 5-1) down and switch 2^1 up, set TRIGGER SELECT switch (16) to MODE, and momentarily press TRIGGER switch (15).
2. Set GRAPH/CHAR 1 switch (1) to produce binary coded octal value of 376 and momentarily press READ switch (10).
3. Vertical counter P-65, P-66, P-73, P-86, P-92, P-98, P-104, and P-110 count until a vertical last line (VLL) signal is decoded at V121, which will set the counter to all logical 1's. A new transfer occurs and the counter again counts until a VLL is decoded. Check that vertical counter flip-flop and line driver P-128 through P-135 logic levels and timing agree with table J.

TABLE J. VERTICAL COUNTER GRAPH MODE TIMING LEVELS

FLIP-FLOP	LINE DRIVER	TIME AT EACH LEVEL
P-65	P-135	100 USEC
P-66	P-134	200 USEC
P-73	P-133	400 USEC
P-86	P-132	800 USEC
P-92	P-131	1600 USEC
P-98	P-130	3200 USEC
P-104	P-129	6400 USEC
P-110	P-128	12.8 MS

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Figure 5-37. Vertical Counter Trouble Analysis Flow Chart

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