

SCIENTIFIC DATA SYSTEMS





# MULTIPURPOSE KEYBOARD/DISPLAY

Models 7550/7555 (and options)

## REFERENCE MANUAL

for

**SDS Sigma Computers**

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## RELATED PUBLICATIONS

<u>Title</u>	<u>Publication No.</u>
SDS Sigma 2 Computer Reference Manual	90 09 64
SDS Sigma 5 Computer Reference Manual	90 09 59
SDS Sigma 7 Computer Reference Manual	90 09 50
SDS Sigma Character-Oriented Communications Equipment Reference Manual	90 09 81
SDS Sigma Message-Oriented Communications Equipment Reference Manual	90 15 68

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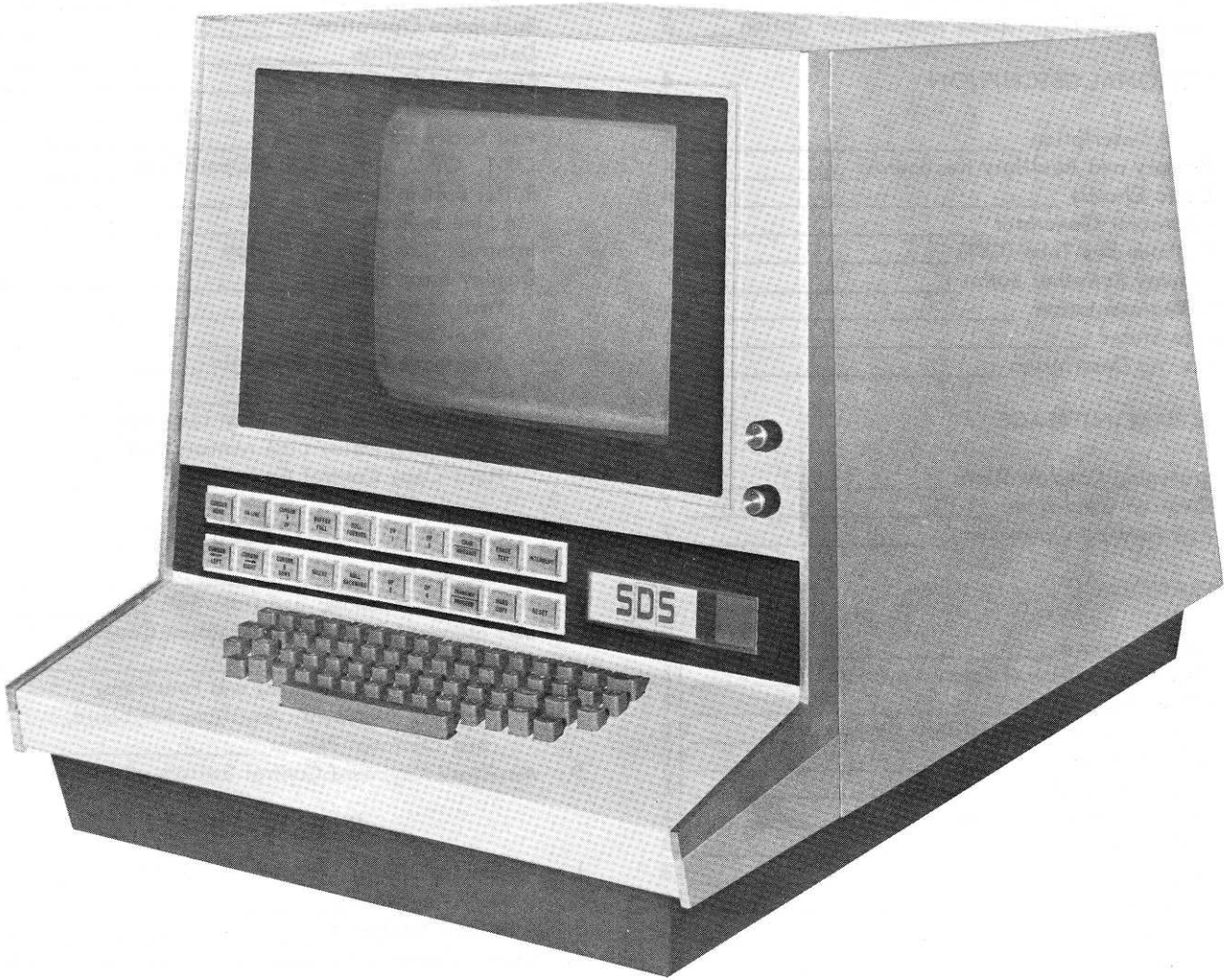
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Model 7550/7555 Multipurpose Keyboard/Display

# 1. GENERAL DESCRIPTION

## INTRODUCTION

SDS Multipurpose Keyboard/Displays are self-contained buffered terminal devices combining keyboard input with cathode ray tube (CRT) display (see Characteristics, Table 1). They offer on-line communication with Sigma computers via asynchronous data sets or direct cable connection (via COC Controller) at speeds from 10 to 180 characters per second. These units are compatible in code and graphic set with Teletype Model 37 Keyboard/Printers.

The character mode of operation permits character-by-character communication with the computer and lends itself to on-line text editing, time sharing, and interactive programming. The message mode of operation affords off-line text editing and information-retrieval capabilities. Text-editing features allow replacing, inserting, deleting, or erasing information; combining or separating displayed lines; and rolling text up and down. These editing functions are aided by a blinking character marker (cursor) that brackets the data character (if any) displayed in that position. The cursor may be moved to any displayable position on the screen through the use of control codes. These and other control codes received from the keyboards or communication line initiate all functions. Any function may thus be performed under either local (operator) or remote (computer) control.

Table 1. Characteristics

Operating Characteristics	
Data transmission rate <sup>†</sup>	
Model 7550	15 characters/second
Model 7555 (with high-speed option)	180 characters/second
Transmission code	USASCII (United States of America Standard Code for Information Interchange)
Display area	6-1/2 in. high, 9 in. wide
Number of lines	32
Characters per line	86
Total display spaces	2752
Displayable character set <sup>††</sup> (see Table 3)	96 <sup>††</sup> (uppercase and lowercase graphics and special symbols)
Number of concurrently displayable characters	2108 (approximately) <sup>†††</sup>
Control characters	32
Refresh rate	50 frames/second
Character generator	Monoscope tube
Keyboard	Compatible with Teletype Model 37

Table 1. Characteristics (cont.)

Physical Characteristics	
Height	21 in.
Width	21 in.
Depth	29 in.
Weight	150 lb
Cable Requirements	
Remote installations	50 ft cable connection to Model 103 or 202 (or equivalent) data set
Local installations (No data sets required)	Up to 250 ft cable (to 1800 baud) Up to 500 ft cable (to 1200 baud <sup>††††</sup> )
Environmental Characteristics	
Power requirements	115 V ac ± 10%, 45-66 Hz, 8 amp
Heat dissipation	400 watts
Operating temperature (preferred)	65° to 85°F
Operating humidity (preferred)	30% to 70%
<sup>†</sup> See Table 2 for detailed information.	
<sup>††</sup> Different character sets, up to 96 characters, are available as an option by special order.	
<sup>†††</sup> Depends on text format and number of control codes used in stored message.	
<sup>††††</sup> By special order.	

Table 2. Data Rates, Formats, and Data Sets

Rate	Data Format	Data Set
110 baud (10 char/sec) <sup>†</sup>	8 level/11 unit code	Model 103
150 baud (15 char/sec) <sup>††</sup>	8 level/10 unit code	Model 103
1200 baud (120 char/sec) <sup>†††</sup>	8 level/10 unit code	Model 202
1800 baud (180 char/sec) <sup>†††</sup>	8 level/10 unit code	Model 202
<sup>†</sup> Available only for Model 7550.		
<sup>††</sup> Standard.		
<sup>†††</sup> For Model 7555 equipped with Model 7556 High-Speed Transmission Option.		

Characters displayed are nonsegmented, sharply defined, and easily readable (see Table 3). The display refresh rate of 50 frames per second provides flicker-free viewing.

These keyboard/displays can operate in the character mode of transmission (full duplex) over common carrier communications networks via data sets; or they can operate locally via direct connection (without a data set) to an SDS Character-Oriented Communications (COC) Controller. Use of automatic dial facilities permits computer-controlled access via common-carrier-switched networks to a keyboard/display terminal.

The reader should be familiar with whichever of the following manuals are applicable to his installation:

Sigma Computer Reference Manual (especially input/output operations).

Sigma Character-Oriented Communications Equipment Reference Manual.

Sigma Message-Oriented Communications Equipment Reference Manual.

Bell System Data Communications Technical Reference Manuals (for data sets).

## KEYBOARD/DISPLAY EQUIPMENT

The equipment consists of two types of keyboard/displays and four associated options.

Model 7550 Multipurpose Keyboard/Display

Model 7555 Multipurpose Keyboard/Display

Model 7556 High-Speed Transmission Option  
(Model 7555 only)

Model 7551 Message Mode Option

Model 7552 DC Interface Option (Model 7550 only)

Model 7553 Hard Copy Output Option

### MODEL 7550 MULTIPURPOSE KEYBOARD/DISPLAY

Model 7550 operates in full-duplex transmission (simultaneous send and receive) at 15 characters per second (see Table 2). It may also be used as a remote terminal device for other systems that use USASCII code. The code, graphic character set, and keyboard are compatible with Teletype Model 37. A keyboard/display unit usually communicates with Sigma computers via the Sigma Character-Oriented Communications (COC) Controller, but may also be connected to the Sigma Message-Oriented Communications Controller. Remote installations require data sets to provide the interface to switched network or private lines; local installations (within 500 feet of communication equipment) do not require data sets.

Model 7550 cannot accommodate the high-speed transmission option.

### MODEL 7555 MULTIPURPOSE KEYBOARD/DISPLAY

Model 7555 differs functionally from Model 7550 only in that it can accommodate the high-speed transmission option, and cannot accommodate the DC Interface Option. All other characteristics are the same as for Model 7550.

### MODEL 7551 MESSAGE MODE OPTION

Model 7551 permits off-line message composition and text editing before transmitting a message. To transmit data in a unit equipped with this option, the operator positions the cursor to the starting point of desired text transmission and depresses the Transmit key, which causes all data to be transmitted from the cursor to end of text. To transmit an entire message, the operator sets the cursor to the Home position before depressing the Transmit key.

This option can be added to either a Model 7550 or 7555. Space and power are provided in the keyboard/display cabinet.

### MODEL 7553 HARD-COPY OUTPUT OPTION

Model 7553 allows a Teletype "receive only" printer unit to be attached to the keyboard/display for hard-copy print-out of messages. Since control is exercised by discrete character codes, this unit can be controlled locally or remotely. Depending on the combination of options, hard copy can be generated in the following ways:

1. When the hard-copy option is used with the standard keyboard/display, operating in the character mode at 15 characters per second, receipt of the Hard-copy On code causes information received on the communication line to drive the teleprinter and to be stored and displayed on the screen.
2. When the hard-copy option is used with the message mode option, receipt of Hard-copy On and Transmit codes causes all information from the cursor-marked position to the end of text to be printed on the teleprinter. These codes can be generated by the keyboard/display unit's function keys (by depressing first the HARD COPY key and then the TRANSMIT/PROCEED key) or they can be received from the communication line. In this mode of operation, information sent to the printer is not sent to the computer.
3. When Model 7555 is used with the high-speed option, hard copy can be generated only when the unit is operating in the message mode. Hard-copy data is transmitted (printer only) at 15 cps regardless of the high-speed capabilities of the line; the function is inoperative when the unit is in a high-speed character mode.

The hard-copy option can be added to either Model 7550 or 7555. Space and power are provided in the keyboard/display cabinet.

## MODEL 7552 DC INTERFACE OPTION

Model 7552 allows Model 7550 Keyboard/Display to communicate with the Sigma system using a DC current loop. With this option, distances up to 5 miles between Sigma computer and keyboard/display can be attained (with 4-wire telegraphic cable) without using data sets. This option does not provide signal line current; this must be supplied by the user, common carrier, or Model 7623 DC Power Supply. For half-duplex operation, message mode only, a 2-wire connection between COC Controller and keyboard/display is sufficient.

Model 7552 can be added only to Model 7550 Keyboard/Display and is not field-installable. Space and power are provided in the keyboard/display cabinet.

## MODEL 7556 HIGH-SPEED TRANSMISSION OPTION

Model 7556 permits Model 7555 Keyboard/Display to transmit and receive data at rates up to 180 characters per second. If used locally with a Sigma computer system, no data sets are required. For rates up to 120 characters per second, the computer and keyboard/display must be not more than 500 feet apart. For rates greater than 120 characters per second without using data sets, the distance is limited to 200 feet. If Bell Series 202 data sets are used, the keyboard/display can operate at rates up to 180 characters per second at any distance from its controller. A single controller accommodates both local and remote terminals operating at different rates.

Model 7556 can be added only to Model 7555 Keyboard/Display.



## 2. FUNCTIONAL DESCRIPTION

### PHYSICAL DESCRIPTION

Keyboard/display hardware consists of five major components: keyboard and control panel, logic chassis, character generator, cathode ray tube (CRT), and display refresher buffer.

#### PRIMARY AND AUXILIARY KEYBOARDS

The primary keyboard (Figures 1 and 2) can generate the full set of 128 USASCII characters. The auxiliary keyboard (Figures 1 and 3) contains additional control switches for generation of the more commonly used codes and includes switches for mode switching, hard copy monitoring, and resetting.

#### LOGIC CHASSIS

The logic chassis is located behind the keyboard and below the cathode ray tube. It houses plug-in modules required for control and timing of the keyboard/display.

#### CHARACTER GENERATOR

The character generator assembly consists of a monoscope tube, associated digital-to-analog converters required for character selection, a character raster sweep generator, and a video amplifier. The monoscope tube is shielded against stray magnetic fields.

#### CATHODE RAY TUBE (CRT)

The cathode ray tube, its deflection circuitry, and power supplies are located above the logic chassis and character generator. The rear plate of the display housing is angled forward from vertical to ensure adequate space between the cabinet and any surface behind the unit for exhaust air from the cabinet.

#### DISPLAY REFRESHER BUFFER

Two enclosed magnetostrictive delay lines are mounted on the baseplate of the unit. There is space on either side of the delay lines for air intake to the cabinet. The cabinet is also supported by rubber feet approximately one inch high to ensure adequate air intake from under the cabinet.

#### DATA REPRESENTATION

Models 7550/7555 perform all operations either as the result of the operator pressing keys and switches on the primary or auxiliary keyboards, or the appropriate code being received from the communication line.

The primary keyboard can generate the full USASCII character set of 96 graphics and 32 control codes. The 96 graphics consist of uppercase and lowercase alphabetic characters, numerals, and special symbols. The codes for these graphics and control characters are listed in Table 3.

Table 3. SDS Standard 7-Bit Communication Codes (USASCII)

Decimal (rows)	Binary (col's.)	Most Significant Digits							
		0	1	2	3	4	5	6	7
		x000	x001	x010	x011	x100	x101	x110	x111
0	0000	NUL	DLE	SP	0	@	P	'	p
1	0001	SOH	DC1	!	1	A	Q	a	q
2	0010	STX	DC2	"	2	B	R	b	r
3	0011	ETX	DC3	#	3	C	S	c	s
4	0100	EOT	DC4	\$	4	D	T	d	t
5	0101	ENQ	NAK	%	5	E	U	e	u
6	0110	ACK	SYN	&	6	F	V	f	v
7	0111	BEL	ETB	'	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
10	1010	LF NL	SUB	*	:	J	Z	j	z
11	1011	VT	ESC	+	;	K	[	k	{
12	1100	FF	FS	,	<	L	\	l	!
13	1101	CR	GS	-	=	M	]	m	}
14	1110	SO	RS	.	>	N	^	n	~
15	1111	SI	US	/	?	O	_	o	DEL

Note: Bit 8 (shown as x in the most significant bit position) is an even parity bit.

The functions of the USASCII control codes used with the keyboard/display are given below. The keyboard/display does not use some of the standard control codes—these are shown in parentheses in the following list. Some codes have different functions when the hard-copy option is used; and four codes, OP1, OP2, OP3, and OP4, are reserved for the programmer's special uses.

Code	Keyboard/Display Function	Hard-Copy Option
NUL	Null	
SOH	Start of header	
STX	Start of text	
ETX	End of text	
EOT	Disconnect data set	Motor off
ENQ	(Enquiry)	
ACK	Acknowledge transmission, enable keyboard	
BEL	Cursor up	Bell
BS	Backspace	Backspace
HT	Cursor right	Horizontal tab
NL (LF)	New line (line feed)	Carriage return and line feed

Table 3. SDS Standard 7-Bit Communication Codes (USASCII) (cont.)

Code	Keyboard/Display Function	Hard-Copy Option
VT	Cursor home	Vertical tab
FF	Hard copy on	Form feed
CR	Cursor return	Carriage return
SO	Insert	Normal printing mode
SI	Replace	Alternate printing mode
DLE	Hard copy off	
DC1	Roll forward	
DC2	(Device control 2)	
DC3	Roll backward	
DC4	(Device control 4)	
NAK	Transmit/disable keyboard	
SYN	(Sync)	
ETB	(End of transmission block)	
CAN	Erase text	
EM	Cursor left	
SUB	Cursor down	
ESC	(Escape)	Suppress printing
FS <sup>†</sup>	OP1 <sup>†</sup>	
GS <sup>†</sup>	OP2 <sup>†</sup>	
RS <sup>†</sup>	OP3 <sup>†</sup>	
US <sup>†</sup>	OP4 <sup>†</sup>	
SP	Space	Space
DEL	Delete	

<sup>†</sup>These codes (designated OP1, OP2, OP3, OP4 on the auxiliary keyboard) may be used for special programming purposes.

Data entered on the keyboard or received via the communication line is transmitted to the computer one byte at a time. Each byte consists of seven data bits and an even parity bit.

Data is held in a recirculating delay line memory that provides for a total storage of approximately 2285 characters (8-bit codes). Characters may be displayed in any one of 2752 character positions of the cathode ray tube (CRT) display matrix, but the total number of displayable characters depends on the number of characters displayed on each line and the number of control codes in the stored text. The CRT horizontal sweep steps left to right, allowing up to 86 characters on a line; the vertical sweep steps from top to bottom, allowing up to 32 displayable lines.

As each 8-bit character code passes through a buffer register (in series with the delay line), it is transferred to a D/A converter that translates the code to X and Y voltage signals. These signals position the monoscope beam on the target screen where there is a graphic representation of each displayable code. The monoscope electron beam sweeps the selected character, and the resultant video

signal modulates the intensity of the CRT beam to display the character on the display screen.

The contents of the buffer can also be transmitted to the communication line via the interface, to an optional hard copy unit (printer). Computer output is transmitted to the printer in bytes.

## DEVICE STATES

The keyboard/display is either "operational" or "not operational"; it is "operational" when power is on.

## OPERATING DESCRIPTION

Models 7550/7555 Multipurpose Keyboard/Displays, operating in full-duplex mode, transmit characters directly from the keyboard to the receiving terminal, bypassing the delay line memory. The receiving terminal either (1) "echoes" each character back to the delay line memory, (2) sends new information to it, or (3) reconstructs and returns the data to it in a new format. "Echoing" is an operational feature that permits positive operator verification of the accuracy of transmission and reception of data.

For details of the operations described briefly in this section, see Chapter 4.

To create a new display image, either (1) the operator presses the CURSOR HOME and ERASE TEXT buttons on the keyboard, thereby placing the cursor in the upper left corner of the screen (Home position) and erasing all text currently in the delay line and displayed on the screen; or (2) the operator presses the RESET button. The operator or the program may then enter new information. Entry of each character causes the cursor to move to the next available character position. A New Line (NL) code moves the cursor to the first displayable character position of the next line down; data entry continues on the new line, minimizing the amount of space required.

To replace a displayed character, the operator moves the cursor to the desired character position and enters the new character. (See the last paragraph of this chapter.)

To delete a displayed character, the operator moves the cursor to the desired character position and enters a Delete code. When a character is deleted, all characters to the right of it automatically move to the left one character position.

Deletion of an existing NL code causes the next line down to move up and to be appended to the right end of the current line; all succeeding lines automatically move up one line. If the appended line exceeds 86 characters, the excess characters are not displayed, but are retained in the buffer. In this case, a special character (■) is displayed in the 87th character position to indicate that the buffer contains information not displayed on that line; insertion of an NL code brings this undisplayed information to the next line and shifts all succeeding lines down.

To insert a character in displayed text, the operator moves the cursor to the desired position, enters the Insert mode, and then enters the new character. Insertion of data automatically moves existing text in the current line to the right to provide space for each character entered. Again, displayable line length can be exceeded without loss of information because excess data is stored in the buffer.

Inserting an NL code causes all data to the right of the cursor in the current line to move down one line and to be left-justified. All succeeding lines then automatically move down one line. An NL code also terminates each line stored in the delay line memory, except the last line, which is automatically terminated by an ETX code.

The BUFFER FULL light automatically turns on whenever the buffer no longer accepts additional data.

Roll Forward and Roll Backward codes cause all data to move one line up or down. Roll Forward causes the first line of text to be deleted from the display (and from the delay line memory) and causes all succeeding lines to move up one line. If the delay line memory contains more than 32 lines, the 33rd line now appears at the bottom of the display. For example, the computer can transmit information to the delay line memory before the operator calls for it, making it

immediately available for display when the operator enters a Roll Forward code.

The Backspace code permits character superposition for the generation of composite characters, such as " $\leq$ ", or for efficiency in underlining selected text.

To erase an entire block of information from the cursor-marked position to the end of text, the operator enters the Erase Text code.

The operator may use a Cursor Return code to move the cursor to the first character position of the current line or a Cursor Home code to move the cursor to the home position. The Cursor Up<sup>†</sup> code causes the cursor to move to the first character position of the previous line. The Cursor Down<sup>†</sup> code causes the cursor to move to the first character position of the following line. The Cursor Left<sup>†</sup> and Cursor Right<sup>†</sup> codes cause the cursor to move one character position to the left or right.

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<sup>†</sup>For detailed information, see "Cursor Operations", Chapter 4, and Figure 4.

### 3. PROGRAM INTERFACE

If the keyboard/display is connected to a COC Controller, see the SDS Sigma Character-Oriented Communications Equipment Reference Manual, Publication 90 09 81, for COC Controller Programming, Start Input/Output, Unusual and Channel End Conditions and Status Responses. If the keyboard/display is connected to a Data Set Controller (DSC), see the SDS Sigma Message-Oriented Communications Equipment Reference Manual, Publication 90 51 68, for the same information.

Programming Considerations are given in the following paragraphs.

#### PROGRAMMING CONSIDERATIONS

The flow chart shown as Figure 1, "Controlling System/CO Controller Actions", in SDS Sigma Character-Oriented Communications Equipment Reference Manual, Publication 90 09 81, illustrates the sequential relationship of the key events that occur during the operation of the keyboard/display with the COC Controller. Appendix A of the same manual contains programming examples for Sigma 5/7 and Sigma 2 computers.

#### OVERRUN CONDITIONS

Because execution times of the control codes vary, the programmer must ensure that a data overrun does not result in either Model 7550 or 7555.

##### MODEL 7550

Maximum data rate is 15 characters (150 bits) per second, i.e., 66.67 milliseconds per character, but some operations take up to 140 milliseconds to execute. To avoid data overrun, the programmer must insert null codes or provide an equivalent amount of time during which no transmission

occurs. The long-execution-time operations and required programming actions are as follows:

<u>Operation</u>	<u>Time (ms)</u>	<u>Preventive Action</u>
Roll Back	100	Insert at least one null code or equivalent idle time
Insert New Line (NL)	140	Insert two null codes or equivalent idle time
Replace ETX or NL with NL	120	Insert two null codes or equivalent idle time
Replace all codes except ETX or NL with NL	100	Insert two null codes or equivalent idle time

##### MODEL 7555

The maximum data rate for Model 7555 equipped with the high-speed option is 180 characters (1800 bits) per second, that is, 5.5 milliseconds per character. To prevent data overrun, two high-speed buffer memories temporarily hold incoming data. A maximum of 15 characters can be held while a control code is being executed. Therefore, a data overrun can occur only if the unit receives a series of control codes, or a constant repetition of characters followed by a control code. To prevent this occurrence, the programmer must insert at least eight null codes or the equivalent amount of idle time following the control code.

Note: This does not apply to the Backspace code.

#### ROLL FORWARD OPERATION

If a roll forward operation is executed with the cursor in the first (top) line of text, a cursor home operation must follow it immediately; otherwise, the cursor is removed from the delay line memory, resulting in lock-out of further data entry or transmission.

## 4. OPERATIONS

### PRIMARY KEYBOARD

The primary keyboard (see Figures 1 and 2) provides the full USASCII character set of 96 graphics and 32 control codes. The 96 graphics, consisting of uppercase and lowercase alphabetic characters, numerals, special symbols, and the 32 control codes are listed in Table 4. Each USASCII code

consists of seven data bits and one even parity bit. The codes are generated by the data keys and by the data keys used in combination with the shift or control keys. Control codes require that the control key be pressed in conjunction with the associated graphic key. However, BACKSPACE, CURSOR RETURN, ESC, NEW LINE, DELETE, and CURSOR RIGHT appear on key tops without graphics, and do not require concurrent pressing of the control key.

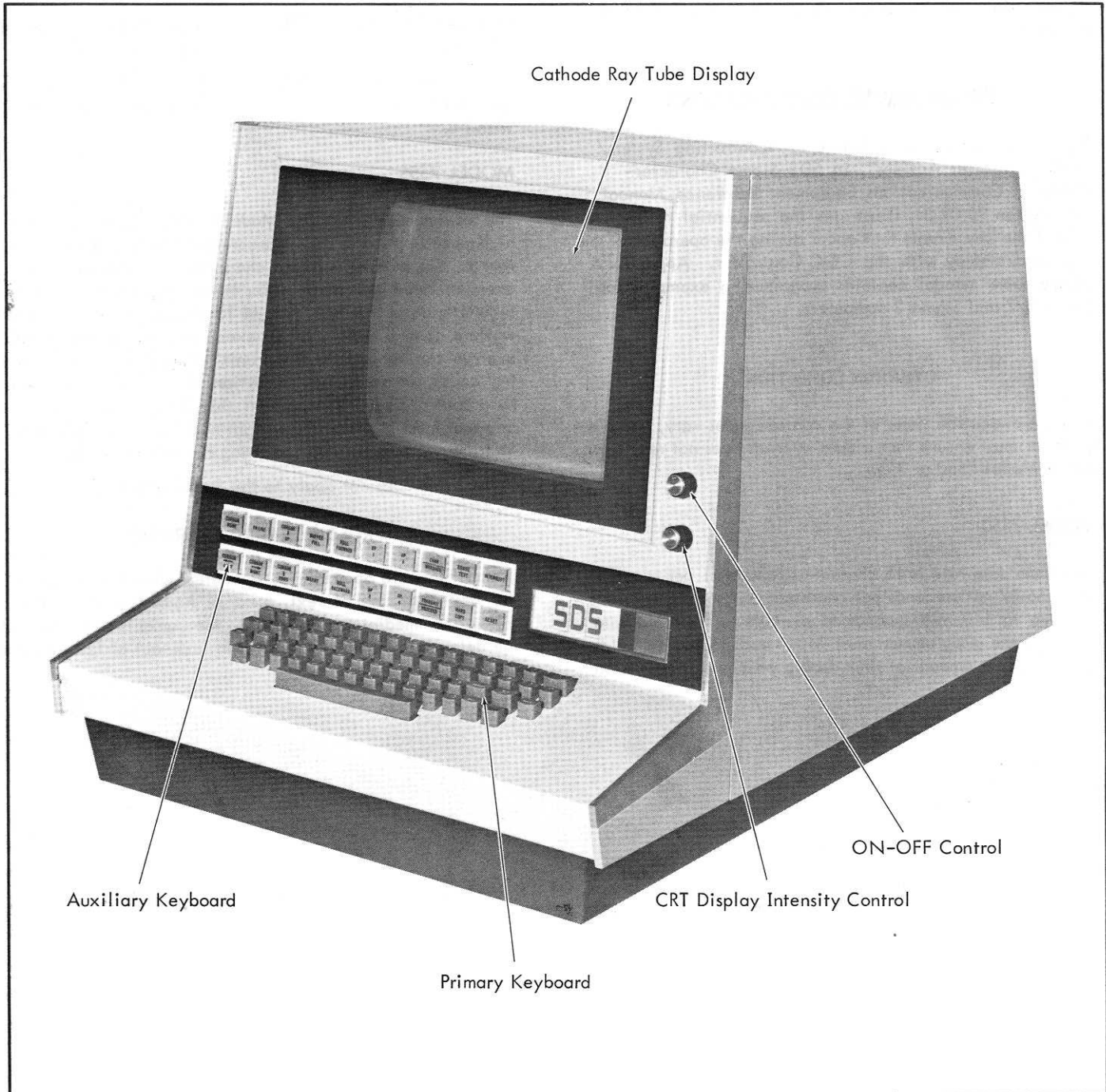
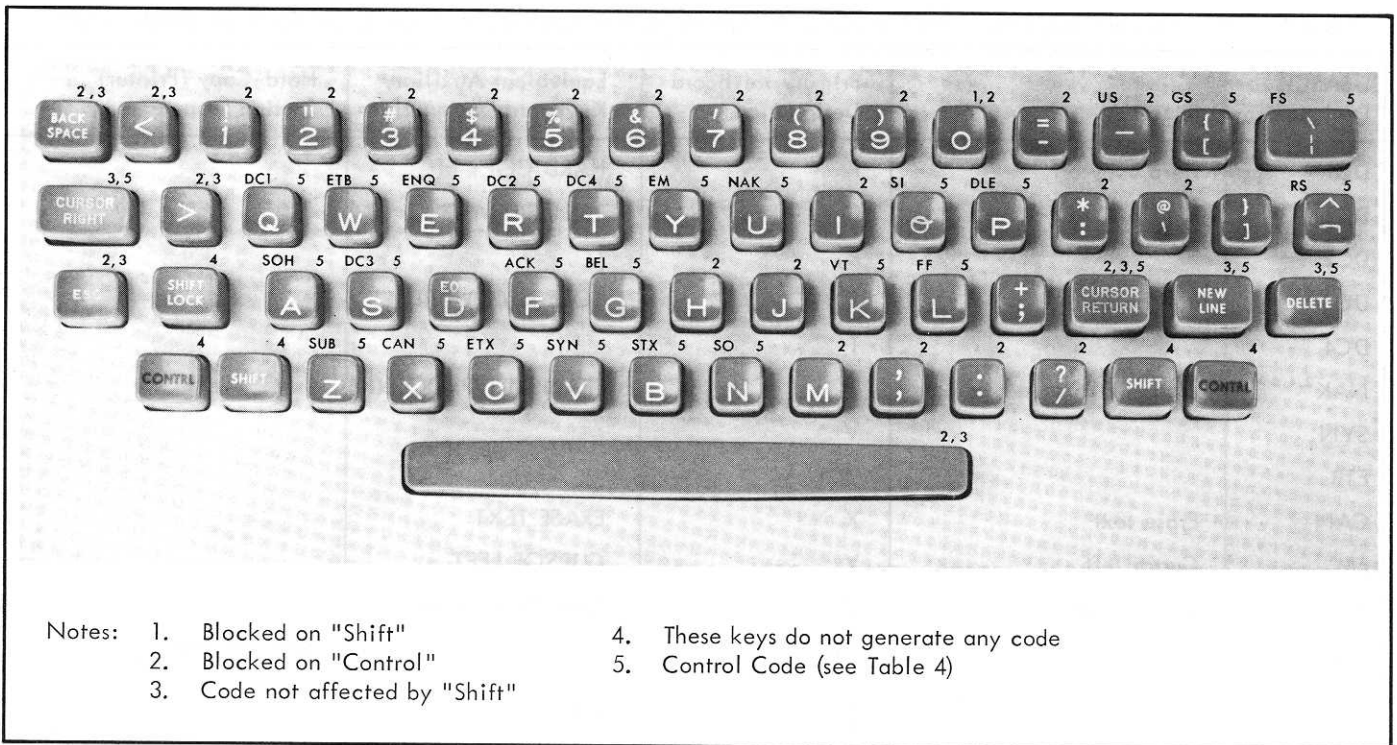


Figure 1. Keyboard/Display, Model 7550/7555





- Notes:
- 1. Blocked on "Shift"
  - 2. Blocked on "Control"
  - 3. Code not affected by "Shift"
  - 4. These keys do not generate any code
  - 5. Control Code (see Table 4)

Figure 2. Primary Keyboard

Table 4. Control Code Designations and Functions, Primary Keyboard, Auxiliary Keyboard, and Optional Printer

USASCII Designation	Function	Primary Keyboard Designation	Equivalent Auxiliary Keyboard Designation	Hard-Copy (Printer) Option Response
NULL <sup>2</sup>	Null code			
SOH <sup>2</sup>	Start of heading	A		
STX <sup>3</sup>	Start of text	B		
ETX <sup>2</sup>	End of text	C		
EOT	Disconnect data set	D		Motor off (subject to switch setting on printer)
ENQ		E		
ACK <sup>6</sup>	Acknowledge transmission, enable keyboard	F	TRANSMIT/PROCEED	
BEL	Cursor up	G	CURSOR UP	Bell
BS <sup>1</sup>	Backspace	BACKSPACE <sup>7</sup>		Backspace
HT	Cursor right	CURSOR RIGHT <sup>7</sup>	CURSOR RIGHT	Horizontal tab
NL (LF) <sup>1</sup>	New line	NEW LINE <sup>7</sup>		Carriage return and line feed
VT	Cursor home	K	CURSOR HOME	Vertical tab
FF	Hard copy on	L	HARD COPY on	Form feed
CR	Cursor return	CURSOR RETURN <sup>7</sup>		Carriage return
SO	Insert	N	INSERT on	Normal printing mode
SI	Replace	O	INSERT off (Replace)	Alternate printing mode
DLE	Hard copy off	P	HARD COPY off	

Table 4. Control Code Designations and Functions, Primary Keyboard, Auxiliary Keyboard, and Optional Printer (cont.)

USASCII Designation	Function	Primary Keyboard Designation	Equivalent Auxiliary Keyboard Designation	Hard-Copy (Printer) Option Response
DLE	Hard copy off	P	HARD COPY off	
DC1	Roll forward	Q	ROLL FORWARD	
DC2		R		
DC3	Roll backward	S	ROLL BACKWARD	
DC4		T		
NAK <sup>2,4,6</sup>	Transmit/Disable keyboard	U	TRANSMIT/PROCEED	
SYN		V		
ETB		W		
CAN	Erase text	X	ERASE TEXT	
EM	Cursor left	Y	CURSOR LEFT	
SUB	Cursor down	Z	CURSOR DOWN	
ESC		ESC <sup>7</sup>		Suppress printing
FS		\	OP 1	
GS			OP 2	
RS		^	OP 3	
US		⌋	OP 4	
SP <sup>1</sup>	Space	(Space bar) <sup>7</sup>		Space
DEL <sup>7</sup>	Delete	DELETE <sup>7</sup>		

1 Backspace (BS), New Line (NL), and Space (SP), can be entered into the delay line memory from either the keyboard or the communication line.

2 Null, Start of Header (SOH), End of Text (ETX), and Transmit/Disable (NAK) are stored in the delay line memory as a result of logic conditions. They are not stored when received from the keyboard or from the communication line. When the delay line contents are transmitted in the message mode, the null codes that exist between the cursor and the ETX codes are transmitted. SOH and NAK, which are stored in the delay line memory for control purposes, are not transmitted in the message mode.

3 The Start of Text code (STX) is not stored in the delay line memory, but when the contents are transmitted in the message mode, this code is transmitted as the first character of the message.

4 The Transmit/Disable code (NAK) is temporarily stored in the delay line memory during the transmit operation. This code is used to indicate the position from which the next character is to be obtained for transmission.

5 The Delete (DEL) code causes the character marked by the cursor to be deleted. DEL is never stored in the delay line memory.

6 When the keyboard/display is in the character mode, reception of NAK code causes the keyboard to lock. The keyboard is unlocked when the TRANSMIT/PROCEED switch is pressed, or when an ACK code is received from the communication line.

7 These keys do not require concurrent pressing of the control key. All other control codes require that the control key be pressed in conjunction with the associated graphic key (i. e., pressed before the graphic key and held down while the graphic key is pressed).

## REPEAT OPERATION (PRIMARY KEYBOARD)

Holding a key down on a low-speed keyboard/display causes the associated character to be generated repetitively at the rate of the transmission line. If a unit is equipped with the optional high-speed transmission/reception feature, codes are generated at a maximum rate of 25 characters per second. All keys on the primary keyboard except SHIFT, SHIFT LOCK, and CONTROL have the Repeat function. A mechanical interlock prevents activating more than one key simultaneously except when one of the keys is SHIFT, SHIFT LOCK, or CONTROL.

## AUXILIARY KEYBOARD

The auxiliary keyboard (see Figures 1 and 3) provides duplicate switches that are physically and functionally separate from the primary keyboard. The designation and function of each switch are shown in Table 5; a cross reference to the primary keyboard is in Table 4.

### REPEAT OPERATION (AUXILIARY KEYBOARD)

The cursor motion switches on the auxiliary keyboard have the Repeat function. Holding a switch down on a low-speed keyboard/display unit causes the associated character to be generated repetitively at the rate of the transmission line. If a unit is equipped with the optional high-speed transmission/reception feature, codes are generated at a maximum rate of 25 characters per second.

## OPERATING MODES

Two modes of data transmission are used in the keyboard/display unit, character and message. The character mode is standard. If the unit is equipped with the message mode option, the CHAR/MESSAGE alternate action switch on the auxiliary keyboard must be pressed to establish desired mode of operation. These modes are not selectable under program control.

### CHARACTER MODE

In the character mode, data entered from the primary or auxiliary keyboard is directly transmitted to the data set or communication line. Data characters received from the data set or communication line are stored in the delay line memory.

### MESSAGE MODE (OPTIONAL)

In the optional message mode, it is possible to perform off-line message composition and text editing with transmission of complete messages under control of the keyboard or the computer. After a message is composed and edited, the displayed message may be transmitted to the data set or communication line by pressing the TRANSMIT/PROCEED switch or by reception of a NAK code from the communication line. All text-editing features are made directly available to the keyboard, but are not transmitted. All data received in this mode is stored in the delay line memory.

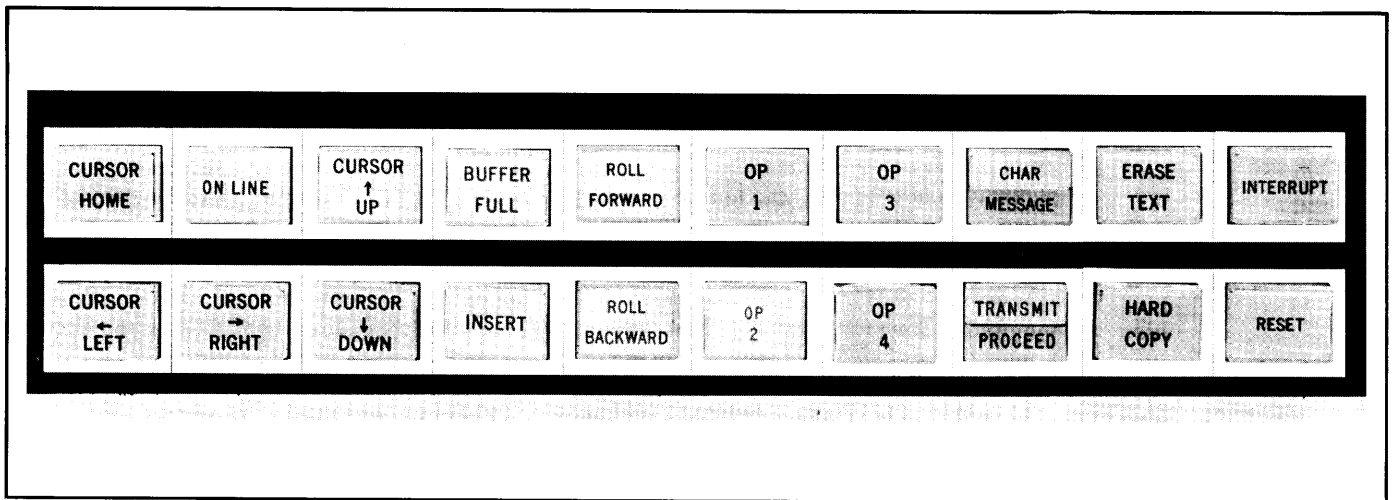


Figure 3. Auxiliary Keyboard

Table 5. Auxiliary Keyboard Control Switches/Indicators

Switch/Indicator <sup>1</sup>	Function
BUFFER FULL	Indicator only. Lights if delay line memory will no longer accept entry of data (i.e., already holds maximum number of characters).
ON LINE	Indicator only. Lights if data set is operative.
CURSOR HOME	Moves cursor to home position (upper left corner of display).
CURSOR RIGHT	Moves cursor one character position to right.
CURSOR LEFT	Moves cursor one character position to left.
CURSOR UP	Moves cursor up to first character position of preceding line.
CURSOR DOWN	Moves cursor down to first character position of following line.
ROLL FORWARD	Moves display raster up one line. Top line (i.e., line at home position) is deleted.
ROLL BACKWARD	Moves display raster down one line and inserts blank line at top of display.
OP 1 } OP 2 } OP 3 } OP 4 }	Code for program control.
ERASE TEXT	Erases displayed text from cursor-marked position to end of displayed text.
INTERRUPT	Sends long space (break) greater than one character duration.
RESET	Clears CRT screen of all data, places cursor in home position, and initializes keyboard/display unit.
HARD COPY <sup>3</sup>	Indicator-switch. If not lighted, sends FF code and lights lamp. If lighted, sends DLE code, turns off hard-copy circuits, and extinguishes lamp.
TRANSMIT/ PROCEED <sup>2,3</sup>	Indicator-switch. If pressed while PROCEED lamp is on and display is in message mode, generates NAK code and transmits message. TRANSMIT lamp goes on while message is being transmitted and goes off at end of transmission. PROCEED lamp goes off on reception of NAK code, indicating that keyboard is disabled. PROCEED lamp goes on when ACK code is received, indicating that keyboard is enabled.
CHAR/MESSAGE	Alternate action switch-indicator. Places unit in character mode if in message mode and vice-versa. Individually backlighted to indicate current mode. MESSAGE portion operational only if message option is installed.
INSERT <sup>3</sup>	Alternate action switch-indicator. If lighted, an input character from the keyboard or from the communication line is being inserted into the delay line memory. If off, an input character from the keyboard or from the communication line replaces the character currently marked by the cursor in the delay line memory.

<sup>1</sup> Some of the above are identified as switch-indicators; some are indicators only; the others are switches.

<sup>2</sup> The TRANSMIT/PROCEED switch and indicator is multifunctional. The upper half of the switch (TRANSMIT) lights when the contents of the delay line memory are being transmitted. When transmission is ended, the light goes off. The lower half of the switch (PROCEED) lights when the keyboard is enabled, and goes off when the keyboard is disabled. A transmit operation is enabled when the message mode option is installed and an NAK is received from the keyboard or transmission line. Transmission begins at the cursor-marked character in the delay line memory and continues until ETX is detected by the control logic or until a long space is received from the communication line. The NAK signal causes PROCEED to go off and stay off until either the ACK signal is received, or until the TRANSMIT/PROCEED switch is pressed while both TRANSMIT and PROCEED indicators are off.

<sup>3</sup> The TRANSMIT/PROCEED, HARD COPY, and INSERT switches function electrically as alternate action switches. If, for example, the HARD COPY light is on and the button is pressed, the light goes off and the HARD COPY off (DLE) code is generated; if the lamp is off and the button is pressed, the light goes on and the HARD COPY on (FF) code is generated.

## TRANSMIT OPERATION

The transmit operation is used only in a keyboard/display that has the message mode option and is operating in this mode.

When the TRANSMIT/PROCEED switch is pressed, an NAK code is generated which causes the following sequence to take place:

1. An STX code is transmitted.
2. All data from the cursor-marked character to the end of text is transmitted.
3. An ETX code is transmitted.

The keyboard is locked out during transmission and until an ACK code is received, or the TRANSMIT/PROCEED switch is pressed when both indicators are off.

Reception of an NAK code causes the keyboard to lock when the unit is in the character mode. The keyboard is unlocked when the TRANSMIT/PROCEED switch is pressed, or when an ACK code is received from the communication line.

## RESET OPERATION

Pressing the RESET button on the auxiliary keyboard establishes initial operating conditions. This action

1. Clears the delay line memory.
2. Initializes the logic for all subsequent operations.
3. Inserts cursor into the delay line memory and displays it in the home position.

The cursor is used as a flag to mark the position where the character is to be inserted, replaced, or deleted. It appears on the screen as two vertical lines (| |) bracketing and blinking alternately with the displayed character. In some cases explained below the cursor may also bracket a blank space; in other cases only one of the two cursor lines is displayed.

The cursor is stored in the delay line memory as a special character; it occupies the character position preceding the character it marks. The cursor may be displayed when marking any character in the 87 by 32 display matrix. The cursor may mark a character outside the matrix but will not be displayed. If the cursor is displayed in the first line of text, a roll forward operation removes the cursor and the first line from the display; if the cursor is displayed in the last line of text, a roll backward operation removes it and the last line from the displayable portion of the screen. In the roll forward operation, the cursor must be moved to Home before any other operation may occur. After a roll backward operation, the operator may restore the line to view by a roll forward operation. Cursor operations (see Figure 4) are explained later in this chapter.

## DATA ENTRY

Two modes of data entry are available in the keyboard/display, the Replace mode, which is the normal mode, and the Insert mode.

### REPLACE OPERATION

An operator may perform a replace operation any time the unit is in the Replace mode. The unit is placed in the Replace mode after a reset operation or when the SI code (insert off) is received from the communication line or auxiliary keyboard. The Replace mode may also be entered from the keyboard if the unit is equipped with and operating in the message mode.

To replace a character, position the cursor on the character to be replaced and enter the new character. The new character is then displayed in place of the old, and the cursor moves one character position to the right. This is illustrated below where "F" is replaced with "E". If F is the last letter on the line, the cursor will bracket a blank space, which can be either End of Text (ETX), New Line (NL), or Space.

<u>Before</u>	<u>After</u>
A B C D   F	A B C D E

If a new character is added to the line, it goes into the blank space marked by the cursor, and the cursor moves an additional space to the right. If the code marked by the cursor was NL or ETX, the cursor will move one character position to the right but the NL or ETX code is not replaced. (See Figure 4.)

An NL code may also replace a character. If this new NL code is entered in a current line of text, all the text to the right of the newly entered NL code will move down one line, left-justified and all succeeding lines will move down one line. In the following example, the character C is replaced with NL code.

<u>Before</u>	<u>After</u>
A B   C   D E F	A B
G H I J	D   E F
	G H I J

If the cursor is marking an NL code and a new NL code is entered, all succeeding lines are moved down one line, introducing a blank line on the screen, and the cursor moves to the first displayable character position of the blank line. This is illustrated in the following example:

<u>Before</u>	<u>After</u>
A B C D	A B C D
E F G H	
	E F G H

If a full 32 lines of information are displayed when an NL code is received, the last (32nd) displayed line of the



message disappears from view but remains stored in the delay line memory. If the cursor is off screen, the displayable text will not be affected.

### INSERT OPERATION

The Insert mode is entered and the INSERT indicator is turned on upon receipt of the Insert code (SO). The Insert mode is temporarily entered when data is being inserted that would replace an NL or an ETX code (this will not be indicated by the INSERT indicator and does not require program intervention).

In the Insert mode, a new character is inserted into the delay line memory to the left of the character marked by the cursor. The cursor and all data following on the line are moved one character position to the right.

In the following example, the character F is inserted.

<u>Before</u>	<u>After</u>
A B C D E  G H	A B C D E F  G H
I J K	I J K

In the following example, a New Line code is inserted.

<u>Before</u>	<u>After</u>
A B  C D E F	A B
G H I	C D E F
J K L	G H I
	J K L

## CURSOR OPERATIONS

### CURSOR

The cursor or character marker determines the position into which a character is to be inserted or replaced, or from which a character is to be deleted. The cursor appears on the display screen as two blinking vertical lines (| |) along with the character it marks. The cursor is stored in the delay line memory as a special character and occupies the position preceding the marked character. The cursor is displayed on the screen if it marks any one of the 86 displayable positions (or the 87th position) on any of the 32 displayable lines. The cursor is always stored in the delay line memory but disappears from view if marking a character position beyond the display matrix.

Since the cursor is stored in the delay line memory, it can only mark data that is already stored (including the ETX code). For example, a cursor operation after a reset operation leaves the cursor in the home position where it is marking the ETX code. To move the cursor to a position other than home after a reset operation, it is necessary to use an appropriate number of NL and space codes.

### CURSOR LEFT

The Cursor Left code (EM) moves the cursor one character position to the left.

<u>Before</u>	<u>After</u>
A B C  D  E F	A B  C  D E F

If the cursor marks the first character position of the message, Cursor Left moves the cursor to the ETX code.

<u>Before</u>	<u>After</u>
A  B C D E	A B C D E
F G	F G
H I	H I
J K L	J K L

If the cursor marks the first character of any line other than the first line, Cursor Left will move it to mark the NL code of the next line above.

<u>Before</u>	<u>After</u>
A B	A B
C D E	C D E
E  F G H	E F G H

See also Figure 4.

### CURSOR RIGHT

The Cursor Right code (HT) moves the cursor one character position to the right.

<u>Before</u>	<u>After</u>
A B  C  D E	A B C  D  E

If the cursor marks an NL code, Cursor Right moves it to the first character position of the next line down.

<u>Before</u>	<u>After</u>
A B C D E	A B C D E
F G H	F  G H

If the cursor marks the end of text, Cursor Right moves it to the home position.

<u>Before</u>	<u>After</u>
A B C	A  B C
D E F G	D E F G
H I	H I

See also Figure 4.

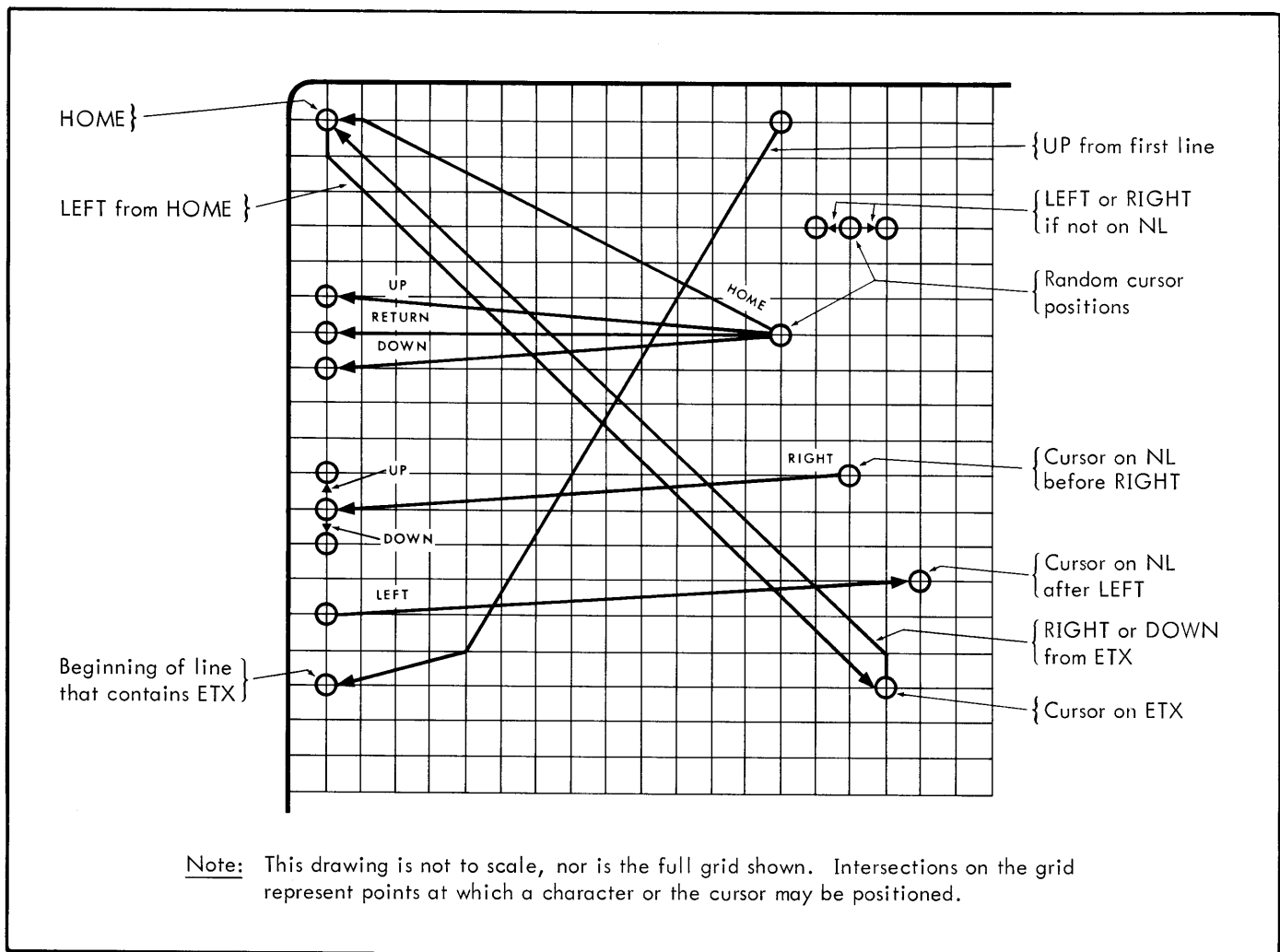


Figure 4. Cursor Operations

### CURSOR UP

The Cursor Up code (BEL) moves the cursor to the first character position of the next line up. Note that the last line of text may or may not be displayed.

<u>Before</u>	<u>After</u>
A B C D	A B C D
E F G	E  F G
H I  J  K	H I J K

If the cursor is in the first line of text, Cursor Up moves it to the first character position of the last line of text.

<u>Before</u>	<u>After</u>
A B  C  D	A B C D
E F G	E F G
H I J K	H  I J K

If only one line of text is displayed, the cursor moves to the home position.

<u>Before</u>	<u>After</u>
A B C D E  F  G	A  B C D E F G

See also Figure 4.

### CURSOR DOWN

The Cursor Down code (SUB) moves the cursor to the first character position of the next line down.

<u>Before</u>	<u>After</u>
A B  C  D	A B C D
E	E
F G H I J K	F G H I J K

if the cursor is displayed in the last line of text, Cursor Down moves it to the home position. The last line of text may or may not be displayed.

<u>Before</u>	<u>After</u>
A B C D	A  B C D
E	E
F G H  I  J K	F G H I J K

See also Figure 4.

### CURSOR RETURN

The Cursor Return code (CR) moves the cursor to the first character position of the line on which it is currently displayed.

<u>Before</u>	<u>After</u>
A B	A B
C D E F G  H  I	C  D E F G H I

### CURSOR HOME

The Cursor Home code (VT) moves the cursor to the first character position of the first line of text. See the following two examples and Figure 4.

<u>Before</u>	<u>After</u>
A B C	A  B C
D E	D E
F G  H  I	F G H I

<u>Before</u>	<u>After</u>
F  G H I	F G H I

### NEW LINE (NL) CODE

The NL code moves the cursor to the first displayable character position of the next line down. The NL code is entered into the delay line memory (along with five Null codes needed by the deflection system). If the cursor is currently displayed in the 32nd line of text, entry of an NL code causes the cursor and all subsequent data to disappear from view, but not from the delay line memory.

(On deleting an NL code, the five Null codes that followed the NL code are automatically removed from the delay line memory.)

### BACKSPACE OPERATION

The Backspace (BS) code moves the cursor one character position to the left on the display screen. If the cursor is marking a BS code, a half cursor (left half) is displayed

and blinks superimposed on the character in the position that it marks.

The BS code permits character superposition to generate such symbols as "±", or to underline text.

If a backspace operation is attempted from the first character position of a line, the BS code is entered into the delay line memory, but the solid error symbol (■) is displayed in the first character position and the cursor moves one character position to the right.

### DELETE OPERATION

The Delete code (DEL) causes the character marked by the cursor to be removed from the display screen and from the delay line memory. All data in the current line of text left-shifts to the character preceding the cursor. The cursor remains in position, marking the left-shifted character.

<u>Before</u>	<u>After</u>
A B C  D  E F	A B C  E  F

Deletion of a New Line code moves all data from the next line down up to the current line and to the right of the character preceding the cursor. All subsequent lines are moved up one line.

<u>Before</u>	<u>After</u>
A B C D E	A B C D E  F  G
F G	H I J K
H I J K	

If this action results in one or more characters (except BS or NL in the 87th position) being placed in a character position beyond the 86th, the parity error symbol (■) is displayed in the 87th position and the remaining data on that line is not displayed.

Deletion of an over-written character such as "±" requires three delete operations, one to delete "+", the second to delete the backspace, and the third to delete "-".

### ERASE TEXT OPERATION

The Erase Text code (CAN) removes all data from the cursor-marked position to the end of text and places the ETX code in the position following the cursor.

<u>Before</u>	<u>After</u>
A B C D E	A B C D E
F  G H	F
I J K L M	

## ROLL FORWARD OPERATION

The Roll Forward code (DC1) moves all data on the display screen up one line. The first line of text is removed from both the screen and the delay line memory, and a blank line or a 33rd line of text (if more than 32 lines were stored in the memory) is introduced below the last line of text. If the cursor is in the first line of text, it is removed from the display memory. When this occurs, a Cursor Home operation must be executed to restore the cursor in the memory before any further operations can take place. If this Cursor Home operation is not executed, the control logic may lock. In this case, recovery is possible only via the reset operation.

The following is an example of a roll forward operation.

<u>Before</u>	<u>After</u>
A B C D E	C
C	D E F
D E F	

## ROLL BACKWARD OPERATION

The Roll Backward code (DC3) moves all displayed lines down one line on the screen. This action introduces a blank line in the first line position on the screen. If 32 lines of data are displayed, the 32nd line disappears from view at the bottom of the screen but remains stored in the display memory. This line can be restored to view by a roll forward operation. The position of the cursor is not affected in relation to the character it is marking. A roll backward operation cannot be executed if display memory is full.

The following example illustrates a roll backward operation.

<u>Before</u>	<u>After</u>
A B C	
D E F	A B C
G H   I   J K L	D E F
	G H   I   J K L

## OP1,OP2,OP3,OP4 OPERATIONS

The operation of these switches transmit special control codes but produce no local action. Used in the character mode, they permit the computer to transmit a software-controlled response (assuming, of course, that the software has been written to recognize and act upon these codes).

The control code shown above the graphic key on the primary keyboard (see Figure 2) has exactly the same effect as the corresponding switch on the auxiliary keyboard, as follows:

<u>Primary Keyboard</u>	<u>Auxiliary Keyboard</u>
FS	OP 1
GS	OP 2
RS	OP 3
US	OP 4

## BUFFER FULL INDICATOR

The BUFFER FULL indicator lights if the delay line memory will no longer accept entry of data, that is, it holds the maximum number of characters. It will be extinguished when one or more characters have been deleted.

Whenever the Buffer Full condition exists, data insertion into the delay line memory is inhibited, but control code actions (cursor motions, delete, etc.) may be executed.

## ON LINE INDICATOR

The ON LINE indicator on the auxiliary keyboard lights if the data set is ready to accept data from the keyboard/display unit. This indicator also lights when the unit is connected via direct cable to the computer and the communications controller is ready to receive data.

## INTERRUPT (LONG SPACE) SWITCH

Pressing the INTERRUPT switch on the auxiliary keyboard sends long space as long as the switch is held down, either in the character or message mode. This is similar to the break function on a Teletype. Receipt of long space by the keyboard/display locks the keyboard, turns the TRANSMIT/PROCEED indicator off, and terminates the transmission, if one is in progress.

## DISPLAY ERROR SYMBOL

### PARITY ERROR

If a character contains a parity error, a blinking solid error symbol (■) is displayed in place of the character.

### EXCESSIVE LINE LENGTH

Line lengths of more than 86 characters may be stored in the delay line memory. However, if a displayable character appears in the 87th or higher position, the solid error symbol (not blinking) will be displayed in the 87th position. A Backspace (BS) or New Line (NL) code may be placed in the 87th position without causing the error symbol to be displayed. Since the BS code decrements the horizontal counter, enough BS codes may be inserted to allow for underlining or overprinting a complete line.

### BACKSPACE FROM LEFT MARGIN

If a BS code tries to decrement the horizontal counter beyond the first position, a blinking solid error symbol is displayed.

## HARD-COPY UNIT

Pressing the CHAR/MESSAGE switch and the HARD COPY button on the auxiliary keyboard routes data to the optional hard-copy unit. Several modes of hard-copy operation are available. These modes are described in the following paragraphs.

### **MONITORING COMMUNICATION LINE INPUT DATA**

Monitoring of communication line input data is effected only in the low-speed unit. All input data is stored in the display buffer, displayed on the screen, and monitored by the hard-copy unit. For this operation, the following switches must be activated:

CHAR (character mode)

HARD COPY on

### **MONITORING DELAY LINE MEMORY DATA**

Hard copy of data stored in the delay line memory may be obtained with either the high-speed or low-speed keyboard/display, but they must be equipped with the hard copy and message mode options.

The following switches must be activated:

MESSAGE (message mode)

HARD COPY on

TRANSMIT

Pressing the TRANSMIT/PROCEED switch transmits all data, from the cursor-marked position to the end of text, to the hard-copy unit. Data is not sent to the communication line (or data set) in this mode of operation.

### **HARD-COPY CONTROL CODES**

Besides the auxiliary keyboard switch for selecting the hard-copy unit, two control codes are available for hard-copy control. The Hard Copy On code (FF) allows the hard-copy unit to receive data and inhibits transmission of data to the communication line. The Hard Copy Off code (DLE) stops routing information to the hard-copy unit.





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