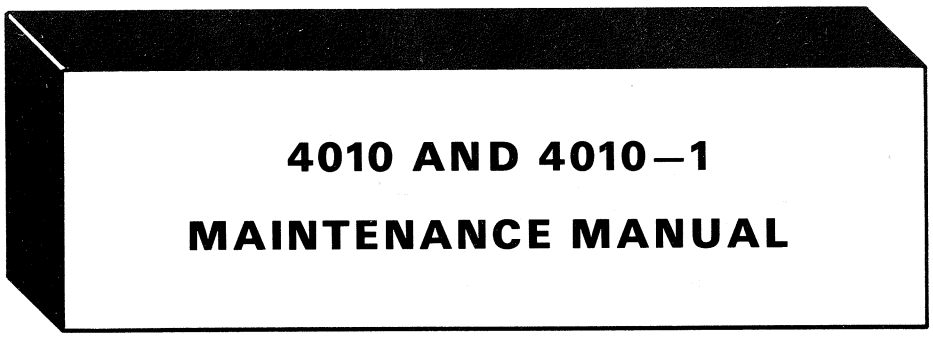

4010 AND 4010–1

MAINTENANCE MANUAL

Tektronix, Inc. P.O. Box 500 Beaverton, Oregon 97077

070-1183-01

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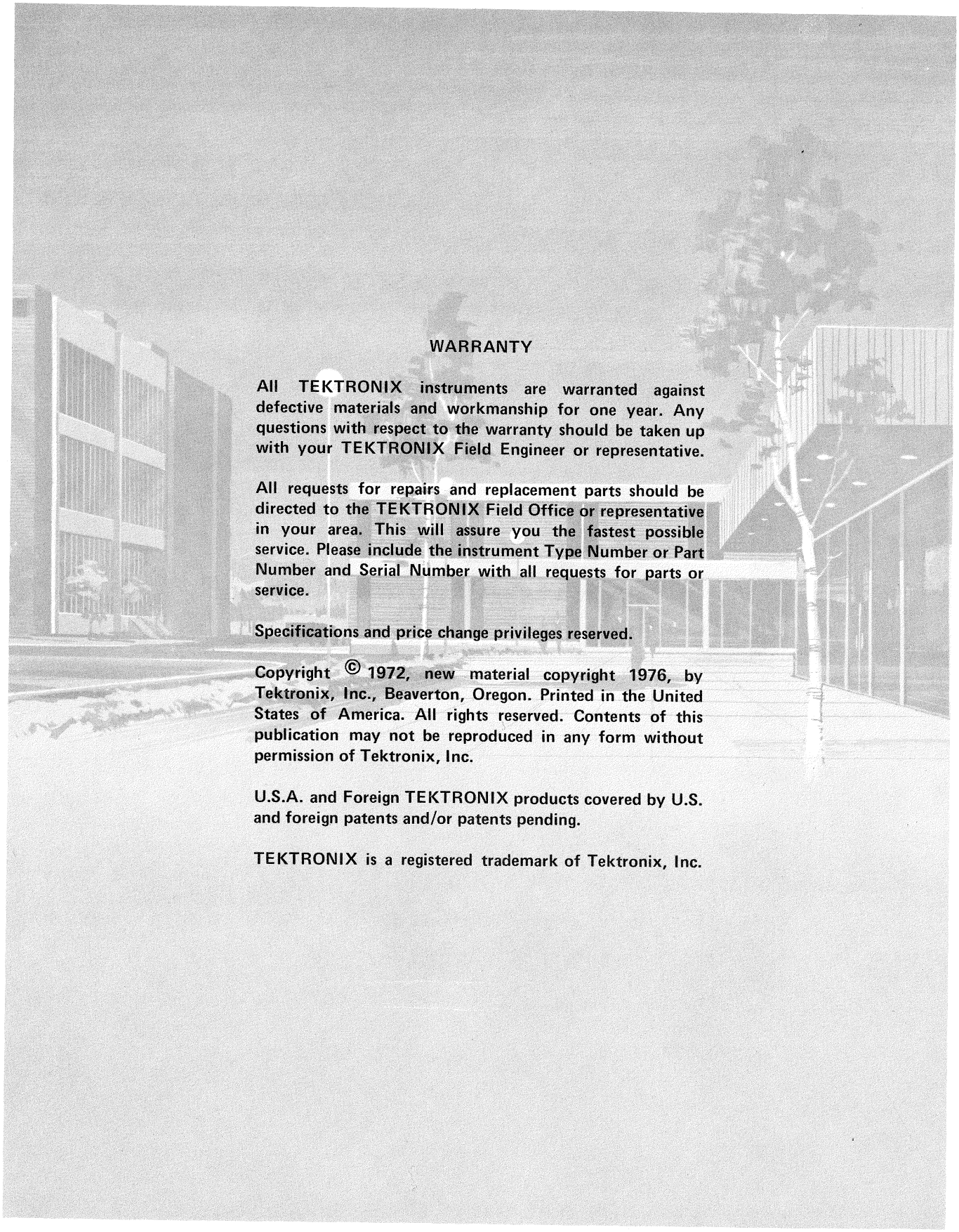


WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

Specifications and price change privileges reserved.

U.S.A. and Foreign TEKTRONIX products covered by U.S. and foreign patents and/or patents pending.

TABLE OF CONTENTS

Fig. 1-1. 4010 Computer Display Terminal.

INSTALLATION AND OPERATION

This manual is a part of the following set of documents which describe the 4010/4010-1 Computer Display Terminal:

OPERATOR'S HANDBOOK "Talking To The Computer"; TEKTRONIX Part No. 062-1445-00.

Contents—A general explanation of what the Terminal is and how it works.

4010 AND 4010-1 USERS MANUAL; TEKTRONIX Part No. 070-1225-00.

Contents—An explanation of how to operate and program the Terminal.

4010 AND 4010-1 MAINTENANCE MANUAL; TEKTRONIX Part No. 070-1183-01.

Contents—A comprehensive explanation of the Terminal. It includes operation, characteristics, servicing, adjustment, circuit diagrams, circuit descriptions, and parts lists.

Optional items used with the 4010/4010-1 Terminal are explained in separate manuals.

Introduction

The 4010 Computer Display Terminal interfaces between man and computer by permitting inputs through an integral keyboard and providing a display (alphanumeric or graphic) of computer output data. In addition, the Terminal can relay data bi-directionally between peripheral devices and a computer. An Interface Unit must be installed in the Terminal and connected to the computer — either directly or through a modem (modulator-demodulator)—to permit information interchange. The 4010-1 has all the features of the 4010, plus the ability to have copies made of its display, via a Hard Copy Unit.

INSTALLATION

General

The two main sections of the 4010 are the pedestal and the display unit. The pedestal section provides support for the display section, and contains the power supply, control circuits, and optional circuits. The display section contains the keyboard, the display storage CRT, and related circuits.

Desk-Top Operation

The display section can be detached from the pedestal and placed on a desk as far as four feet away from the pedestal. However, the pedestal section should remain in its upright position, and should have an air space at the bottom as shown, for proper cooling.

To remove the display section from the pedestal section, proceed as follows, referring to Fig. 1-2 as necessary.

1. Remove the four phillips-head screws that hold the display section to the pedestal.

2. Carefully push the display section back until the safety catch on the pedestal is free from the retainer slot.

3. Lift the display section up and away from the pedestal, guiding the extender cable as the display section is placed at the desired location.

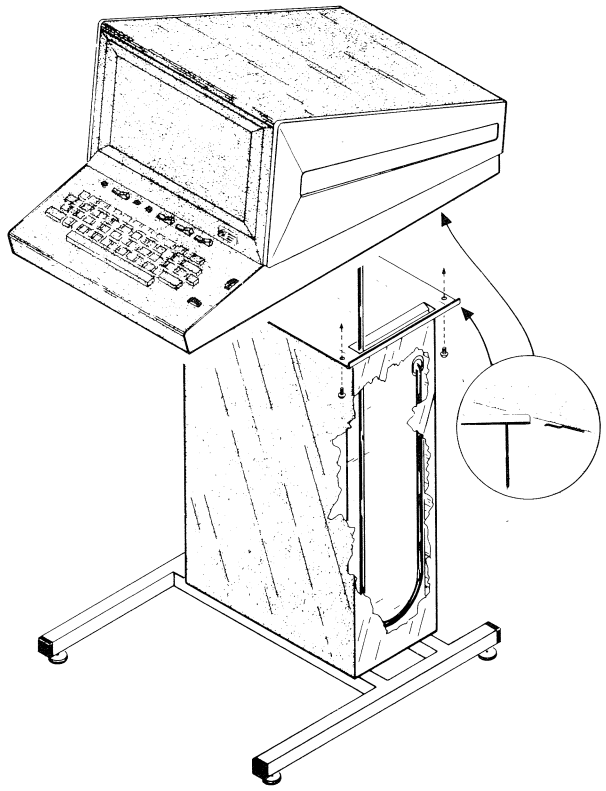


Fig. 1-2. Display Mounting.

4. To re-install the display section, reverse the procedure. For correct storage of the extender cable, feed it down into the storage bin as far as possible; then double it back and forth in the storage bin as the display section is placed on the pedestal.

Strappable Options

Strap options on circuit cards in the pedestal should be placed in the desired position upon installation. Refer to Table 2-13 for details.

Interfacing

Connect the Interface Unit to the computer or modem, as appropriate. The Interface Unit is installed in the pedestal section of the Terminal and the interconnecting cable(s) and plug(s) egress through the back of the pedestal unit. The configuration varies with the type of Interface Unit. The standard 4010 or 4010-1 contains a Data Communication Interface No. 021-0065-00. The Optional Data Communication Interface No. 021-0074-00 or the TTY Port Interface may be supplied as options in place of the Standard Data Communication Interface. Refer to the appropriate Interface documentation for specific installation instructions.

Optional Accessories

Refer to the documentation on the specific accessory for installation instructions.

Operating Power

The Terminal is intended to be operated from a single-phase power source which has one of its current-carrying conductors (the neutral conductor) at ground (earth) potential. Operation from other power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a multi-phase system, or across the legs of a 117–234 V single-phase three-wire system) is not recommended, as only the line conductor has over-current (fuse) protection within the instrument.

The Terminal is provided with a three-wire power cord with a three-terminal polarized plug for connection to the power source. The grounding terminal of the plug is directly connected to the instrument frame as recommended by national and international safety codes.

NOTE

The power cord on Tektronix instruments may conform to either of the following two electrical codes:

Conductor	*USA (NEC) & Canada*	*IEC*
Line	*Black*	*Brown*
Neutral	*White*	*Light Blue**
Safety-Earth	*Green w/yellow stripe*	*Green w/yellow stripe*

* Tinned copper conductor.

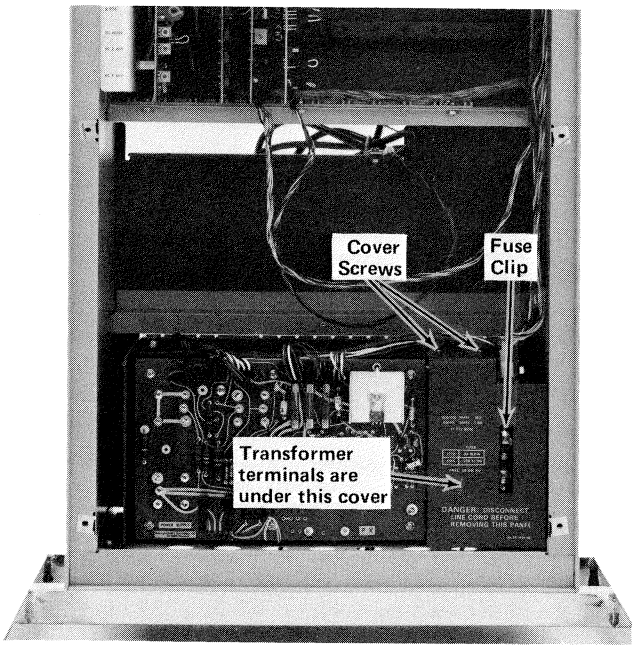


Fig. 1-3. Transformer terminals and fuse clip locations. (The fuse is contained on the pedestal front cover.)

The Terminal can be operated from either 110 or 220-volt nominal line voltage source. A clip-in fuse and a jumper arrangement on the transformer permits the Terminal to be modified to suit the supply. The fuse is mounted on the inside of the pedestal front cover, providing a cover interlock. The transformer and fuse clip are located in the bottom-right of the pedestal, as shown in Fig. 1-3. Fuse size is indicated on the transformer shield, and the wiring instructions are contained on the inside of the front cover. Wiring instructions are repeated in Fig. 1-4 for convenience. Fuse size is 2 A slo-blo for 110-volt operation and 1.25 A slo-blo for 220-volt operation. When changing fuses, the fuse should be pushed (rather than pulled) through the fuse holder.

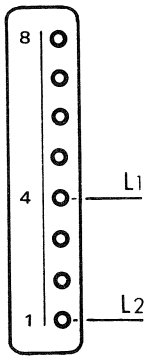
WARNING

Dangerous potentials exist at several places in the pedestal. Disconnect the Terminal from the power source before changing transformer connections.

INDICATORS AND CONTROLS

General

With the exception of the Power switch and the Hard Copy Intensity adjustment knob, the indicators and controls are located on the keyboard section of the display unit, as shown in Fig. 1-5. The Power switch is located on the upper right corner of the pedestal, immediately below the display unit. The Hard Copy Intensity adjustment knob is on the right side of the display unit.

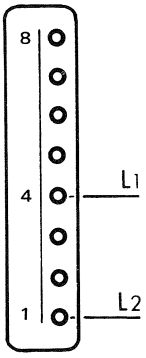


LINE CORD ALWAYS ATTACHED TO 1 & 4

JUMPER ARRANGEMENT

VOLTAGE ±10%	100	110	120	200	220	240
TERMINAL NO.	1-8 4-5	1-2 4-3	1-7 4-6	5-8	2-3	6-7
	TWO JUMPERS REQUIRED			ONE JUMPER REQUIRED		

(A) Below serial number B020256.



LINE CORD ALWAYS ATTACHED TO 1 & 4

JUMPER ARRANGEMENT

VOLTAGE ±10%	100	115	120	200	220	230	240
TERMINAL NO.	1-8 4-5	1-2 3-4	1-7 4-6	5-8	5-7	2-3	6-7
	TWO JUMPERS REQUIRED			ONE JUMPER REQUIRED			

(B) Serial number B020256 and above.

Fig. 1-4. Transformer terminals and jumper arrangement.

Indicators

Power lamp — Illuminated by the +5 V supply when the Power switch is turned on.

Indicator 1
Indicator 2 — Multiple use lamps whose functions are determined by the accessories and optional equipment used with the Terminal.

Switches

Power — Applies power to the Terminal. Located at the top-right corner on the front of the pedestal.

LOCAL/LINE — A two-position rocker switch. LOCAL position isolates the Terminal from the computer and permits keyboard inputs to be displayed or otherwise executed by the Terminal. LINE position permits communication with the computer, and keyboard inputs are not displayed or otherwise executed by the Terminal unless echoing is being done by the Interface Unit, modem, or computer.

Switch 1
Switch 2 — Two-position rocker switches whose functions are determined by the accessories and optional equipment used with the Terminal.

Switch 3 — A momentary-type switch which is labeled MAKE COPY on the 4010-1. If a Hard Copy Unit is attached to the 4010-1, the switch initiates making of a hard copy of the Terminal display.

Adjustments

Hard Copy Intensity — An adjustment knob located on the right side of the Display Unit on 4010-1 Terminals. For hard copy operation, turn the control up to the point where the Hard Copy Unit scanning signal stores on the 4010-1 screen; then back off the adjustment to a point just below the storing level.

Thumbwheels

These are located on the right side of the keyboard section. They position the crosshair cursor which is displayed in Gin (Graphic Input) Mode.

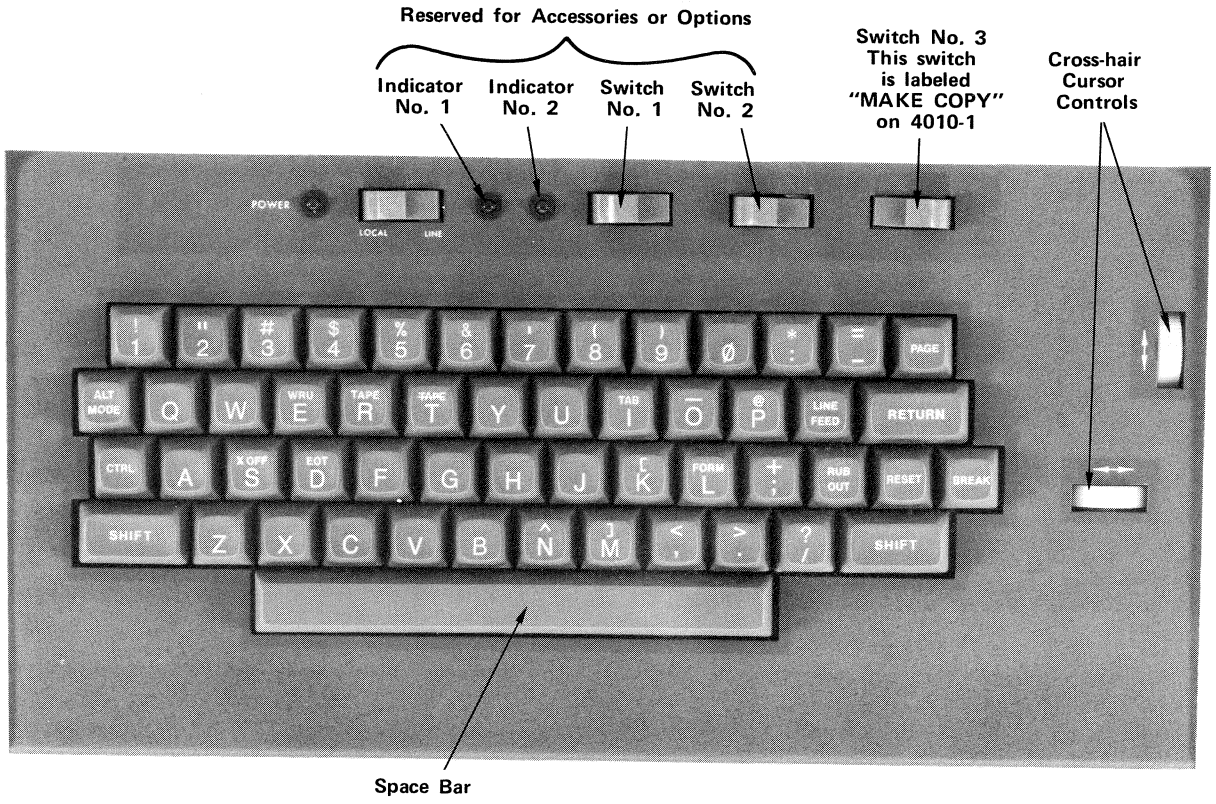


Fig. 1-5. 4010 Keyboard section.

NOTE

Keyboards with SN B055575 and up will not have the TTY codes (WRU, TAPE, ~~TAPE~~, TAB, X OFF, EOT, and FORM) on the keycaps. The 'FORM' label over the 'L' is replaced by /. Both keyboards function in the same manner.

Keys

The keyboard (shown in Fig. 1-5) is a TTY-type and is similar to a typewriter keyboard. It is designed for single key entry, dual key entry, and triple key entry. These are explained in the following paragraphs.

Single Key Entry — Causes transmission of ASCII-coded characters as indicated on the individual keys, with exceptions as listed here. Where two characters are shown on the key, the lower one applies. All letters are sent as upper case.

PAGE — Does not cause transmission, but erases and resets the Terminal to Alpha Mode, at home position.

ALT MODE — Sends the ASCII code for closing brace.

LINE FEED — Sends the ASCII-coded control character LF.

RETURN — Sends the ASCII-coded control character CR.

CTRL — Has no effect when used alone. Used for dual key and triple key entry.

RUB OUT — Sends the ASCII code for DEL.

RESET — Does not cause transmission, but resets the Terminal to Alpha Mode, home position.

BREAK — Sends an interrupt signal to the interface unit. The signal sent to the computer is interface dependent.

SHIFT — Resets the display from hold to view status in Alpha Mode. Has no other effect when used alone. Used for dual key and triple key entry.

Space Bar — Transmits ASCII-coded SP signal.

Dual Key Entry Using SHIFT Key

The Shift key can be used with any one of a number of other keys. The ASCII-coded characters sent are then as indicated on the upper section of the keys as shown in Fig. 1-5. E, R, T, I, S, D, and L are exceptions to this. The SHIFT L key combination sends the ASCII code for a reverse slant line. SHIFT plus any of the following keys sends the same character as the key alone: E, R, T, I, S, and D; the name on the upper portion of these keys refers to the TTY name for the code which is sent when the key is used with the CTRL key.

Dual Key Entry Using CTRL Key

The CTRL key can be used with any one of the alphabet keys to change their transmitted code to that required for ASCII control characters. The keys are shown in Fig. 1-5, and listed in Table 1-1 along with the ASCII-coded character that is sent when the key is pushed while the CTRL key is held down.

Triple Key Entry

Certain ASCII control character codes require that the CTRL and SHIFT keys both be held down before they can be transmitted in response to pressing a third key. The key combination and resultant characters are as listed in Table 1-2.

OPERATING MODES

General

Normal operation of the Terminal is achieved with the keyboard LOCAL/LINE switch at LINE position. The following operations are then possible:

Transmitting — ASCII-coded data is transmitted to the computer as entered at the keyboard.

Receiving — Alpha Mode causes alphanumeric characters to be written as received; control characters are executed as received; Terminal goes into a reduced intensity status (Hold) after approximately 90 seconds of inactivity; Terminal returns to View status upon keyboard entry or upon receipt of data from the computer. Graph Mode causes received data to be interpreted as specific addresses for the X and Y registers within the Terminal, resulting in moving the display unit beam to specific positions; the basic address positions are shown in Fig. 1-6. Control characters are executed as received.

TABLE 1-1

Dual Key Combinations vs ASCII Control Characters

Key Combination	ASCII Character	Comment
CTRL A	SOH	
CTRL B	STX	
CTRL C	ETX	
CTRL D	EOT	
CTRL E (WRU)	ENQ	WRU = Who are you?
CTRL F	ACK	
CTRL G	BEL	
CTRL H	BS	
CTRL I (TAB)	HT	TAB = Horizontal Tab
CTRL J	LF	
CTRL K	VT	
CTRL L (FORM)	FF	FORM = Form Feed
CTRL M	CR	
CTRL N	SO	
CTRL O	SI	
CTRL P	DLE	
CTRL Q	DC1	
CTRL R (TAPE)	DC2	Commonly used to start a tape punch unit.
CTRL S (X OFF)	DC 3	X OFF = Transmission Off. Commonly used to stop a tape reader unit.
CTRL T (~~TAPE~~)	DC 4	Commonly used to stop a tape punch unit.
CTRL U	NAK	
CTRL V	SYN	
CTRL W	ETB	
CTRL X	CAN	
CTRL Y	EM	
CTRL Z	SUB	

TABLE 1-2

Triple Key Combinations vs ASCII Control Characters

Key Combination	Character
CTRL SHIFT K	ESC
CTRL SHIFT L	FS
CTRL SHIFT M	GS
CTRL SHIFT N	RS
CTRL SHIFT O	US
CTRL SHIFT P	NUL

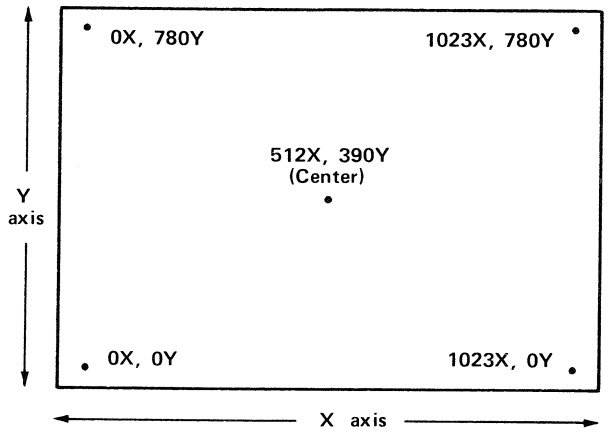


Fig. 1-6. Basic address positions on the display screen.

Interactive – Graphic Input (Gin) Mode causes the Terminal to automatically send its status and/or the address of the display beam to the computer in response to commands from the computer. A crosshair cursor may be displayed in Gin Mode as a preparatory status.

Local operation occurs when the keyboard LOCAL/LINE switch is placed in the LOCAL position. The Terminal is then isolated from the computer and keyboard entries are displayed or otherwise executed by the Terminal.

4010-1 Terminals have a Hard Copy Mode which permits a hard copy reproduction of the display to be made if a Hard Copy Unit is connected to the Terminal. The mode can be initiated by computer command, by a MAKE COPY key on the Terminal keyboard, or by a switch on the Hard Copy Unit.

Transmitting

If the keyboard switch is at LINE position, data entered at the keyboard is transmitted in ASCII-coded form to the computer. The keyboard generates an eighth bit which is always either high or low, depending upon a strap option in the keyboard. This may be sent as set at the keyboard, or may be determined by the interface unit. Except for closing brace (ALT MODE) or DEL (RUBOUT), the keyboard is not capable of sending data from the last two columns on the right in the ASCII code chart shown in Fig. 1-7.

Receiving

General. The Terminal receiving circuits are essentially divorced from the keyboard and transmitting circuits while the keyboard switch is at LINE position. Data is then received as a result of transmission from the computer, including data being echoed by the computer or modem. However, data entered at the keyboard is applied to the receiving circuits if an ECHO signal is being asserted by the interface unit. ECHO is controlled by a switch or a strap option, depending upon the type of interface. The ECHO signal creates a situation referred to as echoplexing.

The Terminal response to signals thus received is essentially the same in either case, and depends upon the operating mode.

Alpha Mode. The Alpha Mode is the initial condition of the receiving circuits. In addition, it occurs in response to receiving a US, CR, or ESC FF. It is also initiated by entering PAGE or RESET at the keyboard. A pulsating cursor indicates the writing position of the next character. Alphanumeric characters are written on the display screen; control characters are executed by the Terminal. Lower case characters are written as upper case; Grave Accent (opening single quotation mark) is written as Commercial At; and Opening Brace is written as an Opening Bracket. Space causes spacing only. The 4010 does not respond to Vertical Line, Closing Brace, or Overline (Tilde). Rubout (DEL) is accepted and sent as a character, but does not cause a space or print. Control characters and control character sequences cause effects as listed in Table 2-1. Optional accessories may respond to other commands or sequences as determined by the optional accessory. Refer to Table 2-2 for a listing of Alpha Mode specifications.

Graph Mode. Control character GS puts the Terminal in Graph Mode. Then the Terminal draws vectors (either written or unwritten) in response to graphic address inputs as explained in Tables 2-4 and 2-5. The Terminal can still respond to control characters and control character sequences as explained in Table 2-1. Graph Mode ends and Alpha Mode occurs upon receipt of control characters US, CR, or control character sequence ESC FF. Graph Mode also ends upon receipt of ESC SUB, which sets Gin Mode and displays the crosshair cursor. Graph Mode can also be ended by pressing PAGE or RESET at the keyboard. Refer to Table 2-3 for Graph Mode specifications.

Interactive

Gin Mode. Gin Mode occurs in response to receipt of ESC ENQ at any time the Terminal is "on line". It also occurs in response to an ESC SUB which turns on the crosshair cursor. ESC SUB should not be entered at the keyboard while "on line" because immediate and erroneous transmission may occur. Receipt of ESC ENQ while in Alpha Mode results in immediate transmission of the Terminal status and the address of the point at the lower left corner of the Alpha cursor. CR or CR and EOT will automatically be transmitted immediately after the address, if selected by a strap option on TC-2. (EOT can not be sent

ASCII CODE FUNCTIONS

BITS B7 B6 B5 / B4 B3 B2 B1	Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
	CONTROL		HIGH X & Y GRAPHIC INPUT		LOW X		LOW Y	
Ø Ø Ø Ø	Ø NUL	16 DLE	32 SP	48 Ø	64 @	8Ø P	96 `	112 p
Ø Ø Ø 1	1 SOH	17 DC1	33 !	49 1	65 A	81 Q	97 a	113 q
Ø Ø 1 Ø	2 STX	18 DC2	34 "	50 2	66 B	82 R	98 b	114 r
Ø Ø 1 1	3 ETX	19 DC3	35 #	51 3	67 C	83 S	99 c	115 s
Ø 1 Ø Ø	4 EOT	2Ø DC4	36 $	52 4	68 D	84 T	1ØØ d	116 t
Ø 1 Ø 1	5 ENQ	21 NAK	37 %	53 5	69 E	85 U	1Ø1 e	117 u
Ø 1 1 Ø	6 ACK	22 SYN	38 &	54 6	7Ø F	86 V	1Ø2 f	118 v
Ø 1 1 1	7 BEL BELL	23 ETB	39 '	55 7	71 G	87 W	1Ø3 g	119 w
1 Ø Ø Ø	8 BS BACK SPACE	24 CAN	40 (	56 8	72 H	88 X	1Ø4 h	12Ø x
1 Ø Ø 1	9 HT	25 EM	41)	57 9	73 I	89 Y	1Ø5 i	121 y
1 Ø 1 Ø	1Ø LF	26 SUB	42 *	58 :	74 J	9Ø Z	1Ø6 j	122 z
1 Ø 1 1	11 VT	27 ESC	43 +	59 ;	75 K	91 [	1Ø7 k	123 {
1 1 Ø Ø	12 FF	28 FS	44 ,	60 <	76 L	92 \	1Ø8 l	124 ¦
1 1 Ø 1	13 CR RETURN	29 GS	45 -	61 =	77 M	93]	1Ø9 m	125 }
1 1 1 Ø	14 SO	3Ø RS	46 .	62 >	78 N	94 ^	11Ø n	126 ~
1 1 1 1	15 SI	31 US	47 /	63 ?	79 O	95 _	111 o	127 RUBOUT (DEL)

Fig. 1-7. ASCII Code Chart.

without CR.) Echoplexing is suppressed during Gin Mode. Gin Mode ends upon completion of transmission. If CR is transmitted during Gin Mode AND is echoed by the computer, the Terminal will return to full Alpha Mode upon completion of the transmission. If CR is not echoed, the Terminal must be reset by one of the following before character writing can occur: BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, or VT. Note that if CR is echoed, or if any command affecting the display position is sent to the Terminal, it will cause the cursor to move away from the position which was referenced in Gin Mode; use BEL or US if the display position is to be left undisturbed.

Receipt of ESC ENQ while in Graph Mode also causes Gin Mode, sending the Terminal status and address of the Graph Mode beam position to the computer. The computer or modem may not echo Gin Mode data back to the Terminal if Graph Mode and beam position are to be retained after an ESC ENQ. (CR echoed will reset the Terminal to Alpha Mode, and will move the cursor to the left margin; echoing the status and address bytes will change the beam address to a point different from that sent to the computer.) Gin Mode ends automatically upon completion of transmission, and the Terminal returns to full Graph Mode if CR is not echoed.

Receipt of ESC SUB sets Gin Mode and turns on the crosshair cursor as a preparatory step in transmitting an address to the computer. The thumbwheels (located on the keyboard) can be used to position the crosshair cursor anywhere in the display area. The address at the crosshair intersection is sent to the computer in response to an ESC ENQ from the computer, or in response to entry of any keyboard character. The Terminal returns to full Alpha Mode upon completion of transmission if CR is sent and echoed. If CR is not echoed, one of the following must be sent before the Terminal can again write: BEL, BS, CR, ESC ETB, ESC FF, HT, LF, US, or VT. Refer to Table 2-6 for Gin Mode specifications.

Local

Operation with the LOCAL/LINE switch at LOCAL is much the same as just described for LINE operation. However, the following exceptions exist: (1) The Terminal is isolated from the computer; (2) data entered at the keyboard while in Alpha Mode results in writing or executing data at the Terminal; (3) data entered at the keyboard while in Graph Mode results in drawing vectors or executing control characters at the Terminal; (4) the crosshair cursor appears in response to CTRL SHIFT K and CTRL Z, and can be positioned by the thumbwheels — but it can only be removed by entering RESET or PAGE.

FIRST-TIME OPERATION

This operation procedure is intended to acquaint a user with the operating features of the Terminal. It can also be used as a Terminal check-out procedure. Although the Terminal is not connected to a modem or computer, all modes are exercised. Computer echoing is simulated by a local echo feature. Responses are explained for all options.

Preliminary

The Terminal should not be connected to a power source, modem, or computer at this time.

Line Voltage. If the Terminal is being initially installed, check that the line voltage agrees with the voltage written on the tag which is attached to the Terminal. If it does not, remove the front cover of the pedestal after removing the screws, and change the transformer wiring and fuse size so that they agree with the power source. Wiring instructions appear inside the pedestal cover; fuse sizes are written on the transformer cover plate. The tag information should be changed when the wiring is changed. Replace the front cover.

Power. Plug the power cord into the power source and turn the Terminal Power switch ON. The switch is located on the front at the top of the pedestal, just below the display unit.

Power Lamp. Check that the Power lamp on the left of the keyboard illuminates, and the display screen becomes bright.

Data Transmission. With the keyboard switch at LINE, keyboard data is sent to the computer. It goes to the Terminal receiving circuits only if it is presented to them by one of the following methods: (1) Echoed by the computer or modem; (2) Echoed by the Terminal's interface unit.

With the keyboard switch at LOCAL, the Terminal is isolated from the computer; data entered at the keyboard is applied to the Terminal receiving circuits in a manner similar to that which occurs when the keyboard switch is at LINE and the interface unit is echoing data. LOCAL provides a dual advantage. It permits an evaluation of the data being transmitted by the keyboard, and at the same time tests the Terminal receiving circuits. For these reasons, LOCAL operation is used for most of this procedure. Discrepancies between LOCAL and LINE operation are mentioned wherever they occur. *IT SHOULD BE KEPT IN MIND THAT THE KEYBOARD'S PRIMARY FUNCTION IS TO ACT AS A SOURCE FOR THE COMPUTER; THE RECEIVING CIRCUIT'S PRIMARY FUNCTION IS TO*

RESPOND TO DATA FROM THE COMPUTER; THE KEYBOARD IS SIMPLY BEING USED AS A SOURCE OF DATA FOR THE RECEIVING CIRCUITS WHILE IN LOCAL OPERATION.

Initialization

Press the PAGE key to erase the display screen. The screen must be initialized by erasing it each time the Terminal is turned on. PAGE also selects Alpha Mode and places the beam at the upper-left corner of the display (Alpha Mode "home" position).

Alpha Mode

Character Transmission and Character Effect. Press each key in the keyboard cluster and note the effect. Most of them will cause character writing, permitting a check of the code being transmitted by the keyboard and a check of the dot pattern being presented by the character generator in the receiving circuits. Keys which are an exception to this are as follows:

PAGE—Causes no transmission. A direct connection to the receiving circuits causes Alpha Mode to be selected. It also causes erasing and places the Alpha cursor to the top-left corner of the display (Alpha Mode "home" position).

ALT MODE—Causes neither writing nor spacing, although the keyboard transmits the ASCII character for closing brace.

LINE FEED—Transmits the control character LF. At the receiving circuits, LF causes the Alpha cursor to move down to the next line. The cursor may also move to the left margin if the "LF Causes Carriage Return" strap option on TC-1 is at IN position.

RETURN—Transmits the control character CR. At the receiving circuits, it causes the Alpha cursor to move to the left margin. There are two "left" margin positions. One is vertically aligned with the "home" position and is referred to as "Margin Ø". The second is near the horizontal center of the screen, and is referred to as "Margin 1". Margin 1 is automatically selected each time the Terminal line-feeds past the 35th (last) line while Margin Ø exists. Margin Ø is selected when the Terminal line-feeds past the 35th line while Margin 1 exists, and is also selected when ESC FF is received or when PAGE or RESET is entered at the keyboard.

CTRL—Has no effect as a single key entry. It causes the keyboard to transmit control characters when used with other keyboard keys. For example, entering a G while the CTRL key is held down rings the bell, since it transmits the control character BEL; and the receiving circuits accept that as the command to ring the bell. As a second example, holding down CTRL and SHIFT and pressing K transmits the control character ESC. No reaction is evident at the Terminal, since the receiving circuits recognize it as an arming command, and wait for a second command before they act. Now enter CTRL L and note that the control character FF is transmitted, accepted by the receiving circuits, causes the display to erase and the Alpha cursor to go home. FF alone cannot do it. It must be preceded immediately by ESC. A complete listing of control character effects appears in Table 2-1.

RUBOUT—This key sends the ASCII code for DEL. The receiving circuits accept it, but it causes no spacing, writing.

RESET—Causes no transmission. A direct connection to the receiving circuits causes Alpha Mode to be selected and causes the Alpha cursor to move to the home position.

BREAK—Sends a break signal to the interface unit, which may then transmit a break signal to the computer. Has no effect upon the receiving circuits.

SHIFT—Its only effect as a single key entry is to restore View condition without otherwise affecting transmission or the receiving circuits. When used with other keys, it causes the shifted (upper) character to be transmitted as indicated on each key. Exceptions to this occur on the E, R, T, I, S, D, and L keys, where the upper inscription indicates the TTY character which is sent when those keys are pressed while CTRL is held down. Except for L, those keys send the same character while the SHIFT key is held down as they do when pressed alone. The L key sends a reverse slant line if pressed while the SHIFT key is held down.

Automatic Line Feed and Carriage Return. By now, it probably has been noticed that the Terminal receiving circuits automatically perform a carriage return and line feed each time the last (74th) character in a line is written. If it hasn't been noticed, enter a full line of characters and observe the effect. Note that the Alpha Cursor returns to the effective margin position—Margin 0 or Margin 1.

Margins. Enter a PAGE command and note the cursor position at the left edge (Margin Ø) of the display. Enter LINE FEED commands until the cursor disappears past the bottom of the display screen, and note that it re-appears at

the top-center of the display, in Margin 1 position. Enter enough LINE FEED commands to again send the cursor past the bottom of the display; it will re-appear at the top in Margin Ø position. *THE EFFECTIVE MARGIN CONDITION CHANGES EACH TIME THE DISPLAY LINE-FEEDS PAST THE LAST (35TH) LINE.*

Again arrive at the Margin 1 position and enter several SP characters at the Space bar. Then enter CTRL M to send a CR to the receiving circuits. Note that the cursor returns to the effective margin position, in this case Margin 1. Now enter enough characters to space past the end of the line. Note that the cursor returns to Margin 1. *CR, RETURN, OR AUTOMATIC CARRIAGE RETURN SET THE CURSOR BACK TO THE EFFECTIVE MARGIN POSITION.*

Press RESET to set Margin Ø. Now enter characters until they cause spacing past the end of the line and subsequent line feed and carriage return. Note that character writing ignores Margin 1 position or Margin 1 information while Margin Ø exists. If two-column formatting is to occur, Margin Ø information must be kept to 36 characters or less.

View/Hold. Wait about 90 seconds and note that the Terminal automatically enters a reduced intensity condition referred to as Hold. This condition prolongs tube life, and occurs in Alpha Mode only. Therefore, the Terminal should always be placed in Alpha Mode when energized, but not in use.

Graph Mode

Note the position of the Alpha Cursor. Then send GS (CTRL SHIFT M) to the receiving circuits and note that the Alpha cursor disappears. Send the address 383Y, 512X to place the beam near the center of the screen. The required bytes can be determined from Fig. 1-8 through 1-11. They equate to + DEL Ø @ in ASCII code. Enter + RUBOUT Ø @ at the keyboard. (RUBOUT transmits DEL.)

Unwritten Vector. No obvious results occur in response to the just-entered commands, because it is the first address to be received after a GS, and the beam is blanked while the movement occurs.

Written Vector. Enter @ again. It will execute a second vector, which will be written. This vector appears as a dot near the center of the screen, since no change in position was commanded. (The @ contains the code for a Low X byte, which causes vector execution.) Now send the address for 32Y, 32X. This equates to SP DEL SP _ and is entered at the keyboard as SP RUBOUT SP _ to draw the vector. Note that nothing happens until the Low X (last) command is entered, but then a vector is drawn from the center to the lower left corner.

Resetting With US. Now go back to Alpha Mode, without otherwise disturbing the receiving circuits, by sending a US to the Terminal. Do it by entering a CTRL SHIFT 0 at the keyboard. Note that the Alpha cursor appears with its lower left corner at the end of the vector, since US causes no change in the Terminal position-register contents. Now send ten SP commands to the Terminal by pressing the keyboard Space bar. Note that the cursor moves away from the end of the vector.

Graph Memory. Put the Terminal back in Graph Mode by sending it a GS (CTRL SHIFT M). Then send the same Low X command as was last used, by again entering _ at the keyboard. The beam will move unseen back to the end of the vector because of the Graph Mode memory circuits. This can be confirmed by entering a second _ at the keyboard, to again send the Low X command to the receiving circuits. Note that the same Low X command as contained in the last address must be used, or the beam position will differ by the amount of difference between the two Low X bytes.

Resetting With CR. Now switch from Graph Mode to Alpha Mode by sending a CR to the receiving circuits. This can be done by pressing the RETURN key or entering a CTRL M at the keyboard. This places the Alpha cursor at the left margin, in line with the last graphic position of the beam.

Resetting With ESC FF. Send a GS to the receiving circuits by entering a CTRL SHIFT M at the keyboard. Enter two _ commands to confirm that the Terminal is back in Graph Mode, and is at the end of the drawn vector. Then send an ESC FF sequence to the receiving circuits. Do this by entering CTRL SHIFT K and then CTRL L. Note that this erases the display, selects Alpha Mode, and homes the Alpha cursor. This can also be done locally by pressing the PAGE key, regardless of the position of the LOCAL/LINE switch.

Resetting With RESET. Send another GS (CTRL SHIFT M) to the receiving circuits, enter _ to return to the last graphic address, and then draw a vector to 32Y, 1023X. This translates to SP DEL ? _ which can be sent by entering SP RUBOUT ? _ at the keyboard. Now press the RESET key at the keyboard. Note that the Alpha Mode is restored, and the Alpha cursor appears at the top left corner of the screen. No erasing occurs. This particular operation can only be accomplished from the keyboard. No program command equivalent to RESET can be sent.

Shortened Addresses. The sequence in Table 1-3 illustrates the ability of the receiving circuits to respond to various graphic commands of less than four bytes. The missing bytes remain as sent in the last address which contained them. Table 2-5 specifies the minimum bytes that can be sent in any one situation.

TABLE 1-3

Shortened Address Illustration

Address & Comment	Send	
	ASCII	Keyboard
543Y, 543X. (Initial address; send 4 bytes.)	ØDEL Ø _	ØRUBOUT Ø _
543Y, 512X. (Lo X changes; send only Lo X.)	@	@
541Y, 512X. (Lo Y changes; send Lo Y, Lo X.)	@	ALTMODE @
29Y, 512X. (Hi Y changes; send Hi Y, Lo X.)	SP @	SP @
29Y, 0X. (Hi X changes; send Lo Y, Hi X, Lo X.)	SP @	ALTMODE SP @
543Y, 0X. (Hi Y and Lo Y change; send Hi Y, Lo Y, Lo X.)	ØDEL @	ØRUBOUT @
31Y, 543X. (Hi Y, Hi X, and Lo X change; send four bytes.)	SP DEL Ø _	SP RUBOUT Ø _

View/Hold. The Hold feature is over-ridden while the Terminal is in Graph Mode. The Terminal should always be returned to Alpha Mode when energized, but not in use.

Gin Mode

Crosshair Cursor. Enter CTRL SHIFT K and CTRL Z and note that a crosshair cursor appears. (If the horizontal thumbwheel is in either limit, the vertical line may be the only line to appear; with the vertical thumbwheel at the lower limit, the horizontal line may be the only line to appear. Move both thumbwheels out of their limits to present both lines.) Check that the cursor can be moved via the thumbwheels. Press any key except PAGE or RESET and note that they have no effect. Press PAGE or RESET and note that the crosshair cursor disappears and the Alpha cursor returns. *THE RECEIVING CIRCUITS ARE INSENSITIVE TO SIGNALS FROM THE KEYBOARD WHILE IN LOCAL WITH THE CROSSHAIR CURSOR DISPLAYED. IT SHOULD ALSO BE NOTED THAT THE CROSSHAIR CURSOR CANNOT BE CALLED INTO VIEW BY THE KEYBOARD WHILE ON LINE; IN NORMAL OPERATION, AN ESC SUB FROM THE COMPUTER COMMANDS IT TO APPEAR.*

Gin Mode Transmissions. These cannot be demonstrated with the keyboard switch at LOCAL position. Refer to the Operating Modes information at the beginning of this section and/or refer to Table 2-6 for details concerning "on-line" Gin Mode operation.

View/Hold. The Hold feature is disabled while the crosshair cursor is displayed. Therefore, the Terminal should always be reset to Alpha Mode when energized, but not in use, to prolong tube life.

First Time Operation procedure has been completed for a 4010 Terminal. Continue with the next step only if a 4010-1 Terminal is being used.

Hard Copy Mode

This mode applies to 4010-1 Terminals only. A Hard Copy Unit must be connected to the Terminal and must be energized before the Hard Copy Mode can be exercised.

Switch the Terminal's LOCAL/LINE control to LOCAL. Enter a number of alphanumeric characters at the keyboard to create a display.

Transmit an ESC ETB signal to the receiving circuits by entering CTRL SHIFT K and CTRL W at the keyboard. (Pressing the MAKE COPY button on the keyboard, or pressing the Copy button on the Hard Copy Unit will achieve the same effects.) A scanning bar should appear and scan the display. A few seconds after scanning is completed, the Hard Copy Unit should eject a hard copy of the display. If the paper is blank, or if information dropout occurred, the Hard Copy Intensity control on the right side of the Terminal may be set too low. On the other hand, if the scanning bar caused storing on the display, the Hard Copy Intensity control may be set too high. Readjust the control while copy making is occurring, selecting a point just below that where the scanning bar stores. Then press PAGE, enter more characters on the display, and make another copy. If the adjustment was made properly, a clear copy of the display should result.

Low Order X ASCII	DEC.	X or Y Coordinate								Low Order Y ASCII	DEC.
@	64	0	32	64	96	128	160	192	224	`	96
A	65	1	33	65	97	129	161	193	225	a	97
B	66	2	34	66	98	130	162	194	226	b	98
C	67	3	35	67	99	131	163	195	227	c	99
D	68	4	36	68	100	132	164	196	228	d	100
E	69	5	37	69	101	133	165	197	229	e	101
F	70	6	38	70	102	134	166	198	230	f	102
G	71	7	39	71	103	135	167	199	231	g	103
H	72	8	40	72	104	136	168	200	232	h	104
I	73	9	41	73	105	137	169	201	233	i	105
J	74	10	42	74	106	138	170	202	234	j	106
K	75	11	43	75	107	139	171	203	235	k	107
L	76	12	44	76	108	140	172	204	236	l	108
M	77	13	45	77	109	141	173	205	237	m	109
N	78	14	46	78	110	142	174	206	238	n	110
O	79	15	47	79	111	143	175	207	239	o	111
P	80	16	48	80	112	144	176	208	240	p	112
Q	81	17	49	81	113	145	177	209	241	q	113
R	82	18	50	82	114	146	178	210	242	r	114
S	83	19	51	83	115	147	179	211	243	s	115
T	84	20	52	84	116	148	180	212	244	t	116
U	85	21	53	85	117	149	181	213	245	u	117
V	86	22	54	86	118	150	182	214	246	v	118
W	87	23	55	87	119	151	183	215	247	w	119
X	88	24	56	88	120	152	184	216	248	x	120
Y	89	25	57	89	121	153	185	217	249	y	121
Z	90	26	58	90	122	154	186	218	250	z	122
[	91	27	59	91	123	155	187	219	251	{	123
\	92	28	60	92	124	156	188	220	252	¦	124
]	93	29	61	93	125	157	189	221	253	}	125
^	94	30	62	94	126	158	190	222	254	~	126
_	95	31	63	95	127	159	191	223	255	RUBOUT (DEL)	127
		32	33	34	35	36	37	38	39		
		SP	!	"	#	$	%	&	'		

High Order X & Y

Fig. 1-8. Coordinate conversion chart, part 1 of 4. INSTRUCTIONS: Find coordinate value in body of chart; follow that column to bottom of chart to find decimal value or ASCII character which represents the High Y or High X byte; go to the right in the row containing the coordinate value to find the Low Y byte, or go the left to find the Low X byte. EXAMPLE: 200Y, 48X equals & h ! P in ASCII code and also equals 38 104 33 80 in decimal code.

Low Order X ASCII	DEC.	X or Y Coordinate								Low Order Y ASCII	DEC.
@	64	256	288	320	352	384	416	448	480	`	96
A	65	257	289	321	353	385	417	449	481	a	97
B	66	258	290	322	354	386	418	450	482	b	98
C	67	259	291	323	355	387	419	451	483	c	99
D	68	260	292	324	356	388	420	452	484	d	100
E	69	261	293	325	357	389	421	453	485	e	101
F	70	262	294	326	358	390	422	454	486	f	102
G	71	263	295	327	359	391	423	455	487	g	103
H	72	264	296	328	360	392	424	456	488	h	104
I	73	265	297	329	361	393	425	457	489	i	105
J	74	266	298	330	362	394	426	458	490	j	106
K	75	267	299	331	363	395	427	459	491	k	107
L	76	268	300	332	364	396	428	460	492	l	108
M	77	269	301	333	365	397	429	461	493	m	109
N	78	270	302	334	366	398	430	462	494	n	110
O	79	271	303	335	367	399	431	463	495	o	111
P	80	272	304	336	368	400	432	464	496	p	112
Q	81	272	305	337	369	401	433	465	497	q	113
R	82	274	306	338	370	402	434	466	498	r	114
S	83	275	307	339	371	403	435	467	499	s	115
T	84	276	308	340	372	404	436	468	500	t	116
U	85	277	309	341	373	405	437	469	501	u	117
V	86	278	310	342	374	406	438	470	502	v	118
W	87	279	311	343	375	407	439	471	503	w	119
X	88	280	312	344	376	408	440	472	504	x	120
Y	89	281	313	345	377	409	441	473	505	y	121
Z	90	282	314	346	378	410	442	474	506	z	122
[	91	283	315	347	379	411	443	475	507	{	123
\	92	284	316	348	380	412	444	476	508	¦	124
]	93	285	317	349	381	413	445	477	509	}	125
^	94	286	318	350	382	414	446	478	510	~	126
_	95	287	319	351	383	415	447	479	511	RUBOUT (DEL)	127
		40	41	42	43	44	45	46	47		
		(	)	*	+	,	-	.	/		

High Order X & Y

Fig. 1-9. Coordinate conversion chart, part 2 of 4. (Refer to part 1 for interpretation instructions.)

Low Order X										Low Order Y	
ASCII	DEC	X or Y Coordinate								ASCII	DEC.
@	64	512	544	576	608	640	672	704	736	`	96
A	65	513	545	577	609	641	673	705	737	a	97
B	66	514	546	578	610	642	674	706	738	b	98
C	67	515	547	579	611	643	675	707	739	c	99
D	68	516	548	580	612	644	676	708	740	d	100
E	69	517	549	581	613	645	677	709	741	e	101
F	70	518	550	582	614	646	678	710	742	f	102
G	71	519	551	583	615	647	679	711	743	g	103
H	72	520	552	584	616	648	680	712	744	h	104
I	73	521	553	585	617	649	681	713	745	i	105
J	74	522	554	586	618	650	682	714	746	j	106
K	75	523	555	587	619	651	683	715	747	k	107
L	76	524	556	588	620	652	684	716	748	l	108
M	77	525	557	589	621	653	685	717	749	m	109
N	78	526	558	590	622	654	686	718	750	n	110
O	79	527	559	591	623	655	687	719	751	o	111
P	80	528	560	592	624	656	688	720	752	p	112
Q	81	529	561	593	625	657	689	721	753	q	113
R	82	530	562	594	626	658	690	722	754	r	114
S	83	531	563	595	627	659	691	723	755	s	115
T	84	532	564	596	628	660	692	724	756	t	116
U	85	533	565	597	629	661	693	725	757	u	117
V	86	534	566	598	630	662	694	726	758	v	118
W	87	535	567	599	631	663	695	727	759	w	119
X	88	536	568	600	632	664	696	728	760	x	120
Y	89	537	569	601	633	665	697	729	761	y	121
Z	90	538	570	602	634	666	698	730	762	z	122
[	91	539	571	603	635	667	699	731	763	{	123
\	92	540	572	604	636	668	700	732	764	¦	124
]	93	541	573	605	637	669	701	733	765	}	125
^	94	542	574	606	638	670	702	734	766	~	126
_	95	543	575	607	639	671	703	735	767	RUBOUT (DEL)	127
		48	49	50	51	52	53	54	55		
		0	1	2	3	4	5	6	7		
		High Order X & Y									

Fig. 1-10. Coordinate conversion chart, part 3 of 4. (Refer to part 1 for interpretation instructions.)

Low Order X ASCII	DEC.	X or Y Coordinate								Low Order Y ASCII	DEC.
@	64	768	800	832	864	896	928	960	992	`	96
A	65	769	801	833	865	897	929	961	993	a	97
B	66	770	802	834	866	898	930	962	994	b	98
C	67	771	803	835	867	899	931	963	995	c	99
D	68	772	804	836	868	900	932	964	996	d	100
E	69	773	805	837	869	901	933	965	997	e	101
F	70	774	806	838	870	902	934	966	998	f	102
G	71	775	807	839	871	903	935	967	999	g	103
H	72	776	808	840	872	904	936	968	1000	h	104
I	73	777	809	841	873	905	937	969	1001	i	105
J	74	778	810	842	874	906	938	970	1002	j	106
K	75	779	811	843	875	907	939	971	1003	k	107
L	76	780	812	844	876	908	940	972	1004	l	108
M	77	781	813	845	877	909	941	973	1005	m	109
N	78	782	814	846	878	910	942	974	1006	n	110
O	79	783	815	847	879	911	943	975	1007	o	111
P	80	784	816	848	880	912	944	976	1008	p	112
Q	81	785	817	849	881	913	945	977	1009	q	113
R	82	786	818	850	882	914	946	978	1010	r	114
S	83	787	819	851	883	915	947	979	1011	s	115
T	84	788	820	852	884	916	948	980	1012	t	116
U	85	789	821	853	885	917	949	981	1013	u	117
V	86	790	822	854	886	918	950	982	1014	v	118
W	87	791	823	855	887	919	951	983	1015	w	119
X	88	792	824	856	888	920	952	984	1016	x	120
Y	89	793	825	857	889	921	953	985	1017	y	121
Z	90	794	826	858	890	922	954	986	1018	z	122
[	91	795	827	859	891	923	955	987	1019	{	123
\	92	796	828	860	892	924	956	988	1020	¦	124
]	93	797	829	861	893	925	957	989	1021	}	125
^	94	798	830	862	894	926	958	990	1022	~	126
_	95	799	831	863	895	927	959	991	1023	RUBOUT (DEL)	127
		56	57	58	59	60	61	62	63		
		8	9	:	;	<	=	>	?		

High Order X & Y

Fig. 1-11. Coordinate conversion chart, part 4 of 4. (Refer to part 1 for interpretation instructions.)