INSTRUCTION MANUAL

Serial Number _____

INTERACTIVE BUFFER

for

4014/4015 TERMINALS

CM 018-0120-00

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SECTION 1

DESCRIPTION

GENERAL

The CM 018-0120-00 Interactive Buffer provides local, fast-access storage for 4014/4015 Computer Display Terminals. The Buffer has a capacity of 1023 ASCII characters. Data may be entered into the Buffer from a normally interfaced computer, the terminal keyboard, or from an attached peripheral. Data is entered sequentially starting at location zero. The area of storage from location zero up to and including the last entered data character is termed "the buffer". Continuous dumping of the buffer to the terminal screen using the write-thru feature of the terminal allows the buffer contents to be displayed in refresh.

All ASCII codes with the exceptions of the control codes <BS> (back-space) and <CR> (carriage return) may be stored in the buffer, therefore allowing different character sizes, alphanumerics, graphics, and control functions to be intermixed. Limited editing is also available with "delete character" (BS) from the end of the buffer only, and "clear buffer" (ESC = Ø, Reset) functions.

The buffer can be used to compose messages from the terminal keyboard since the contents are displayed on the terminal screen simultaneously with the entry and editing of data. The message is transmitted to the computer by depressing the keyboard RETURN key, and is automatically terminated with a strap selectable line terminator character.

A "relocation mode", selected manually by a keyboard switch, allows refreshed displays to be moved around the screen using the keyboard thumbwheel controls, or an attached joystick. The contents of the buffer can be commanded to store at selected locations. At the end

of a store operation, the strap selectable line terminator character is sent to the computer as before, to signal the completion of the operation. Relocation cannot be controlled by the computer since this is a manual operation only. As the keyboard thumbwheel, or an attached joystick, is used for relocation, its position and therefore the position of the crosshair cursor bears a fixed relationship to the relocation bias. The relocation bias can therefore be determined in the computer by first setting up the crosshair cursor and then using the interrogation feature of the terminal in the normal way.

The CM 018-0120-00 Interactive Buffer consists of a single circuit board which plugs into the terminal minibus (a motherboard extender is required) and a modification kit for the 4014/4015 terminal. (See Fig. 1).

DOCUMENTATION. This instruction manual, for CM 018-0120-00 INTERACTIVE BUFFER, supplements 4014/4015 User's Manual 070-1647-00 and Service Manual 070-1648-00. It supercedes conflicting data in either manual.

ABBREVIATIONS. All ASCII Control signals used in this manual are placed between brackets: < >.

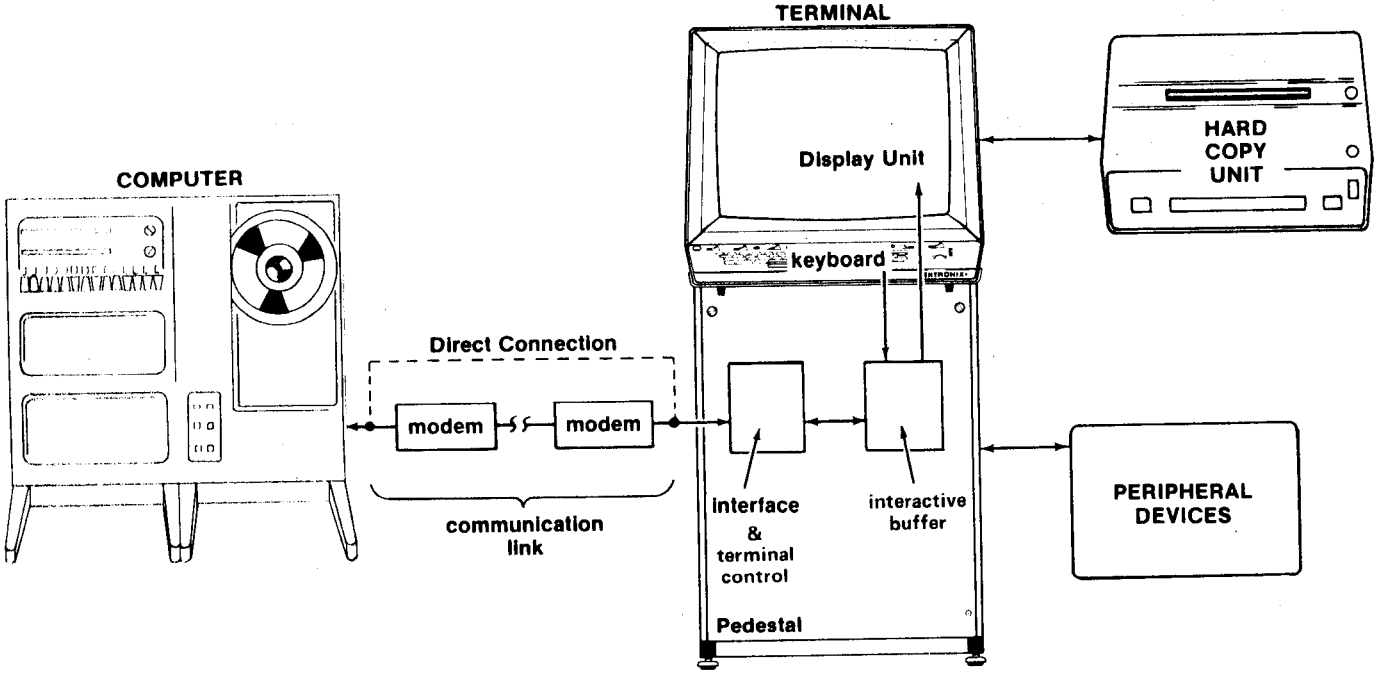


FIGURE 1. A TYPICAL INTERACTIVE BUFFER SYSTEM.

OPERATING MODES

Several general principles guide operation of the Interactive Buffer in the 4014/15 Terminal:

1. The operating modes of the Buffer are controlled by the three-code ASCII sequence:

   <ESC> = X

   where X is one of the ASCII characters Ø, 1, 2, or 3.

2. The ASCII control codes <BS> (Back Space) and <CR> (Carriage Return) have an effect in some modes.

3. The relocation mode is selected by either keyboard switch 1 or keyboard switch 2, according to a strap option.

4. Simultaneously depressing the SHIFT and PAGE keys on the terminal keyboard provides a general reset to the Interactive Buffer as well as to the terminal.

5. On power-up, and after a general reset, the Interactive Buffer is in the so called "neutral mode".

The operating modes (Fig. 2) are summarized here:

NEUTRAL

- Entered:
  on POWER UP,
  or on PAGE + RESET,
  or on the three-code ASCII sequence: <ESC> = 0,
  from NEUTRAL mode or from HOLD mode.

- Result:
  The Interactive Buffer is disarmed. It has no effect on the terminal operation. RELOCATION does not operate in this mode.

  Entry to BUFFER mode or COMPOSE mode is possible from this mode.

BUFFER

- Entered:
  on ASCII three-code sequence <ESC> = 1,
  from NEUTRAL mode or from HOLD mode.

- Result:
  The terminal keyboard is locked. Characters received from the computer, or from an attached peripheral, are stored in sequential locations of the buffer, starting at location zero. The terminal is suppressed. A received <BS> is not stored in the buffer. It deletes the last character in the buffer.

  The mode is terminated by a received <CR> and REFRESH mode is entered directly.

COMPOSE

- Entered:
  on ASCII three-code sequence <ESC> = 2,
  from NEUTRAL mode or from HOLD mode.

- Result:
  Characters received from the terminal keyboard are stored in sequential locations of the buffer, starting from location zero. (If the terminal is ON LINE, a local echo condition is not necessary for characters transmitted from the terminal keyboard to be received by the Interactive Buffer in this mode. In other modes, LOCAL ECHO is a necessary requirement for this purpose.) The buffer contents are simultaneously refreshed on the terminal screen. Characters from the terminal keyboard are inhibited from being sent to the computer. A received <BS> is not stored in the buffer. It deletes the last character in the buffer.

  The mode is terminated by a received <CR>, and COMP DUMP mode is entered.

COMP DUMP

- Entered:
  on receipt of ASCII control code <CR>,
  from COMPOSE mode.

- Result:
  The terminal keyboard is locked. The contents of the buffer are transmitted once to the computer, followed by a "line terminator" character (this may be strap selected to any code contained in column 0 of the ASCII code chart).

  On completion of the operation, REFRESH mode is automatically entered.

REFRESH

- Entered:
  from BUFFER mode or from COMP DUMP mode as previously specified. Entered from STORE mode or from HOLD mode on termination of those modes (other transitions from HOLD mode are possible, see below).

- Result:
  The buffer contents are refreshed on the terminal screen. Characters received are not stored in the buffer. Transmissions from the terminal keyboard, or an attached peripheral, to the computer are possible. RELOCATION is normally used in this mode.

  HOLD mode is entered on receipt of the ASCII control code <ESC>, or if a HARD COPY is commanded. Other than Reset, HOLD mode is the only exit possible from REFRESH mode.

HOLD

- Entered:
  from REFRESH mode on receipt of the ASCII control code <ESC>, or if a HARD COPY is commanded.

- Result:
  The refresh operation is suspended until the uncertain <ESC> control sequence is complete or, if a HARD COPY was commanded, while the HARD COPY operation is in effect. If the <ESC> control sequence results in the Graphic INput (GIN) mode of the terminal, the Interactive Buffer remains in the HOLD mode until the GIN mode becomes inactive.

  A return to REFRESH mode normally occurs from HOLD mode, unless an <ESC> = X control sequence specifies a transfer to any one of NEUTRAL, BUFFER, COMPOSE or STORE modes.

STORE

- Entered:
  from HOLD mode on receipt of the ASCII three-code sequence <ESC> = 3

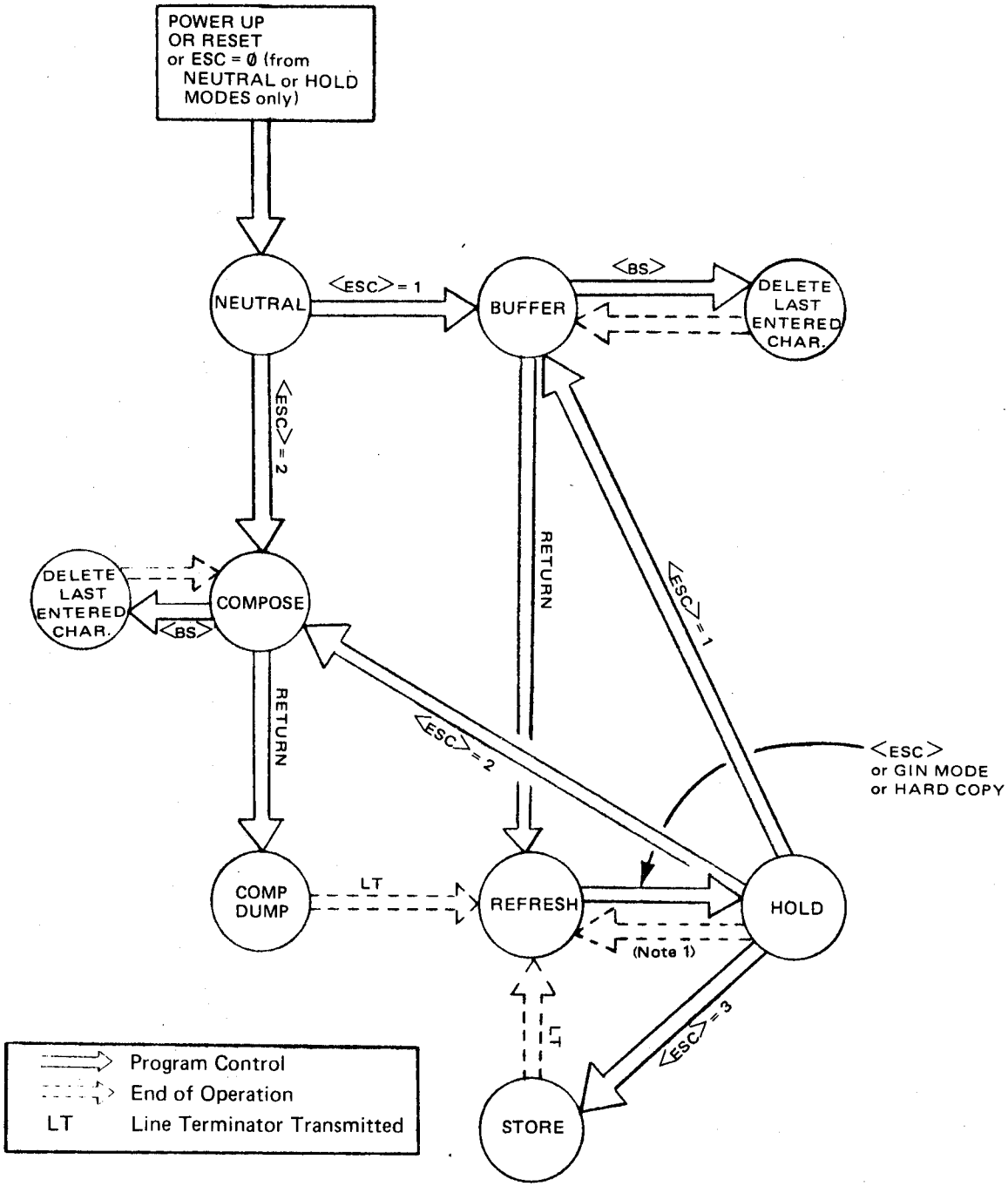
- Result:
  The terminal keyboard is locked. The contents of the buffer are stored once on the terminal screen. At the end of the operation the "line terminator" is sent to the computer to signal completion. RELOCATION is normally used in this mode.

  On completion of the operation, REFRESH mode is automatically re-entered.

RELOCATION

- Entered:
  by switching either keyboard switch 1 or 2 (according to strap option) to OFF. RELOCATION does not operate in NEUTRAL mode.

- Result:
  With the exception of NEUTRAL mode, this mode can co-exist with the other modes of the Interactive Buffer.



NOTE 1. Return on < ESC > not followed by "=" or "End of GIN MODE" or "End of HARD COPY".

FIGURE 2. OPERATING MODES

The keyboard thumbwheel controls (or an attached joystick) can be used to relocate the buffer contents, when refreshed on the terminal screen.

NOTE

The buffer contents may constitute a relocatable picture element. Zero relocation occurs when the crosshair cursor is positioned to the zero-volt deflection point on the terminal screen. This is normally close to the physical center of the screen at coordinates X = 512, Y = 390, but the actual point must be determined using the procedure detailed in Section 4 of this manual.

Relocation is then relative to this ZERO RELOCATION BIAS point. For example, movement of the keyboard thumbwheel controls (or attached joystick) which results in a new crosshair cursor intersection point of X = 256, Y = 512 would relocate the picture element by -256 points in the X direction, and +122 points in the Y direction; to the left and up.

RELOCATION mode is temporarily suspended during the GIN mode of the terminal, during HARD COPY scanning, and when the Interactive Buffer is in Neutral mode.

BUFFER DUMP CYCLING

REFRESH

The buffer is dumped continuously to the terminal screen during COMPOSE mode and REFRESH mode and the write-thru feature of the terminal is activated.

The buffer is dumped as fast as the terminal can display (or otherwise process) the data. At the beginning of each buffer dump cycle, the cursor is "jammed" to screen coordinates, X = Ø, Y = 33. That is, the cursor is positioned to the lower left-hand corner of the screen (coordinates X = Ø, Y = 33) and continues from that point. (Throughout this text, the word "jam" is used to describe this positioning.) The terminal is reset to alphanumerics mode if it was in graphics mode, and a timer is triggered.

This "jamming" allows two lines of the largest alphanumeric character size to be entered into the buffer and displayed at the bottom of the terminal screen before the second margin is set. (Three lines of the smallest alphanumeric character size can be entered before the second margin is set). However, the flicker-free refresh capabilities of the terminal should be considered. This is fully explained later in this Section.

If alternative alphanumerics placing is required, this can be accomplished by either placing control codes which affect screen formatting (for example <VT> vertical tab), in the buffer, or by using a graphic addressing sequence. As the first vector of any graphics display is usually a dark vector, the jam is of no consequence to the display of pure graphics. (Refer to Section 2 of 4014 and 4014-1 Computer Display User's Manual.)

When the complete buffer has been dumped once to the terminal screen, the electronics examines the timer. If this has already timed out, another dump cycle is immediately initiated. Otherwise, the electronics waits until the timer has timed out. The timer period is factory set to approximately 40 ms. This maintains flicker-free refresh displays, at the same time ensuring that buffers containing a relatively small amount of information do not refresh at too high a rate which would result in the picture beginning to store. (See Fig. 3 .) The timer period can be changed to provide for special user requirements by replacing one or two components (depending on the extent of the change required).

COMPUTER DUMP

The buffer is dumped once to the computer during COMP DUMP mode. A line terminator character is then transmitted. This can be strap selected to any code from column 0 of the ASCII code chart. On completion of the operation, the REFRESH mode is entered.

STORE

The buffer is dumped once to the terminal screen during STORE mode. The write-thru feature of the terminal is not activated, and therefore the picture stores on the terminal screen. The line terminator character is then transmitted to the computer as for "computer dump". This is a signal to the computer that the operation is complete. The REFRESH mode is re-entered.

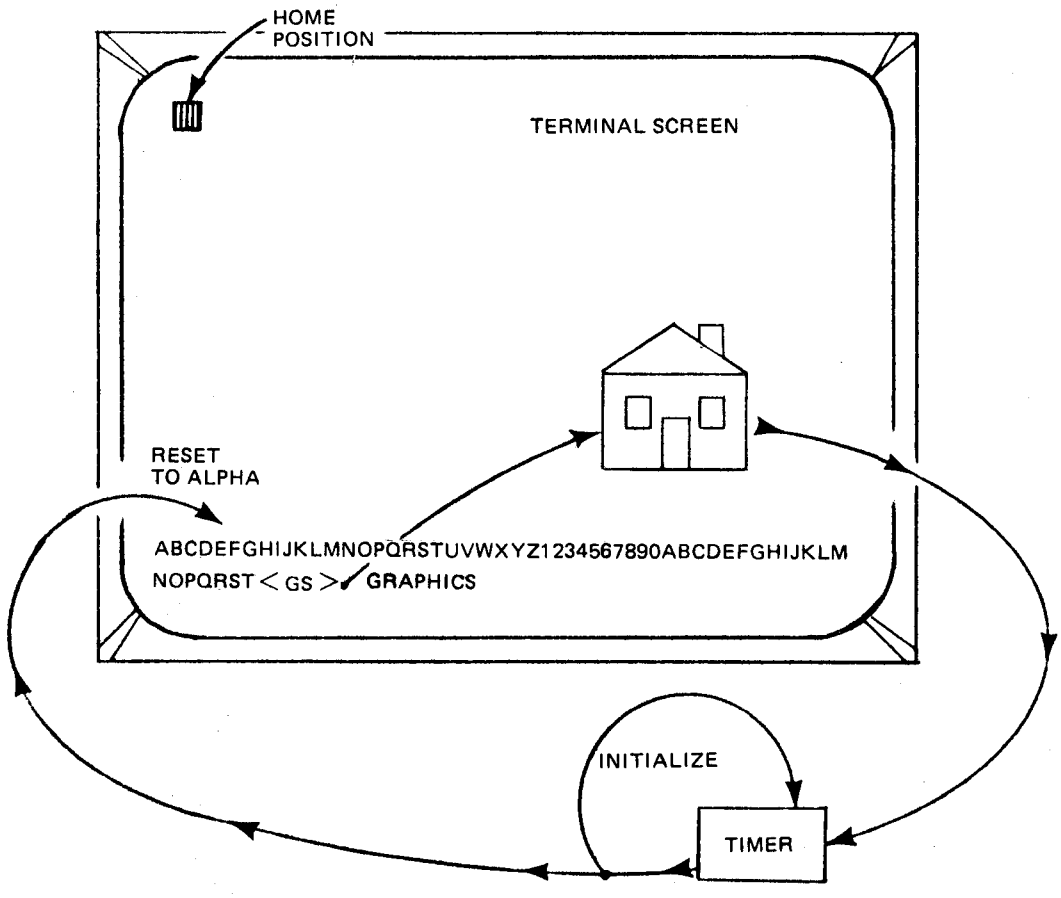


FIGURE 3. REFRESH CYCLE

CONTROLS

The following ASCII code sequences are active:

<ESC>	If in REFRESH mode, sets HOLD mode.
<ESC> =	Arming Sequence.
<ESC> = 0	If in REFRESH mode, the <ESC> sets HOLD mode and, subsequently, the sequence sets NEUTRAL mode and provides a general reset to the terminal. The current end-point of the buffer is reset to zero.
<ESC> = 1	If in REFRESH mode, the <ESC> sets HOLD mode and, subsequently, the sequence sets BUFFER mode. The current end-point of the buffer is preserved, and data may only be entered from this point. The ASCII control code <BS> may be used to delete the last character in the buffer. This procedure allows modifications to be made at the end of the buffer without the need to retransmit the whole buffer. If the Interactive Buffer was in NEUTRAL mode, the sequence sets BUFFER mode, but in this case the end point of the buffer is location zero.
<ESC> = 2	If in REFRESH mode, the <ESC> sets HOLD mode and, subsequently, the sequence sets COMPOSE mode. The current end point of the buffer is preserved, and data may only be entered from this point. The ASCII control code <BS> may be used to delete the last character in the buffer in the same way as for BUFFER mode. If the Interactive Buffer was in NEUTRAL mode, the sequence sets COMPOSE mode, but in this case the end point of the buffer is location zero.
<ESC> = 3	If in REFRESH mode, the < ESC> sets HOLD mode and, subsequently, the sequence sets STORE mode. At the end of the resulting store operation, the LINE TERMINATOR is sent, and REFRESH mode is reentered automatically.
<BS>	If in BUFFER mode or COMPOSE mode, the last character in the buffer is deleted.
<CR>	If in BUFFER mode, this mode is terminated and REFRESH mode is entered directly. If in COMPOSE mode, this mode is terminated and COMP DUMP mode is set. At the end of the resulting computer dump operation, REFRESH mode is set automatically.

The following keyboard controls are active.

PAGE + SHIFT	From the terminal keyboard. This causes an unconditional reset to the Interactive Buffer and terminal electronics. In any mode, all current operations are terminated, NEUTRAL mode is set and the end point of the buffer is reset to location zero.
SWITCH 1 or SWITCH 2	According to a strap option, RELOCATION mode is set when the appropriate switch is switched to the OFF position. RELOCATION is inhibited in NEUTRAL mode, or when the terminal is in GIN mode, or when HARD COPY scanning is in process.
LED 1 or LED 2	According to a strap option, the appropriate LED is turned on when the Interactive Buffer activates "keyboard lock" at the terminal. This occurs during BUFFER, COMP DUMP, and STORE modes.

SPECIFICATIONS

Current requirements:

-15V , 25ma from terminal bus

+15V , 25ma from terminal bus

+ 5V , 660ma from terminal bus

General:

Storage Capacity	1023 ASCII Characters.
Modes	Neutral
	Buffer
	Compose
	Comp Dump
	Refresh
	Store
	Relocation
Dump Rates:	
To Computer	Set by Baud Rate of Interface
To Terminal Screen	At Maximum Rate of Display

Refresh Rate	25/sec. (unless buffer takes longer than 40ms to display)
Relocation	Full Screen for Elements Located at Center Screen
Relocation Accuracy	Crosshair Cursor Bias Position Reflects Picture Element Relocation Bias from Zero Relocation Bias Point - Accurate to ± 1 Tek Point.
Rotation and Scaling	Not Possible
Prompt Mode	Not Possible

REFRESH CAPABILITY

The flicker-free refresh capability is limited by two factors: the maximum capacity of storage, and the maximum display rate of the terminal.

In write-thru mode, the terminal has the capability to display 4000 alphanumerics per second, or 12000 centimeters of vectors per second. Assuming that the picture must be refreshed at least 25 times per second to avoid unacceptable flicker, the terminal can display 160 alphanumerics or 480 centimeters of vectors essentially flicker-free when the write-thru feature is active.

Alphanumerics:
The Interfactive Buffer takes approximately 7 μs to output each character. The maximum essentially flicker-free display of 160 characters then is mainly a limitation of the terminal.

Graphics:
The time for the Interactive Buffer to output one vector depends on the number of characters used to define the vector. The approximate times are given below.

TABLE A

VECTOR OUTPUT TIMES

No. Characters/Vector	Time in μs
5	45
4	35
3	26
2	16
1	7

The length of a vector usually bears some relation to the number of characters required to display the vector. Therefore, the extra time imposed by the Interactive Buffer on the display of each vector

will on the average degrade the essentially flicker-free graphics support by approximately 5%, making the length about 450 centimeters. However, if a large number of small vectors are stored, and graphic redundancy is not used, this graphics support is reduced.

NOTE

The discussion on REFRESH CAPABILITY is provided as a guide only. Practical situations are more complicated (for example, when alphanumerics and graphics are mixed and the optimum would rarely be attained.)

SECTION 2

INSTALLATION

GENERAL

The CM 018-0120-00 Interactive Buffer consists of a single circuit card which plugs into the terminal minibus (a motherboard extender is required), and a modification kit for the 4014/4015 terminal. See Figure 1.

The modification kit is designed to implement 3 changes:

1. Provide a "reset graf" line on pin 21 (SPD1) of the terminal minibus (to TC1). No other cards plugged into the minibus can use this signal line when the Interactive Buffer is installed.

2. Provide a connection for the thumbwheel controls (or attached joystick) to the Interactive Buffer circuit card (to TC2).

3. Increase the bandwidth of the character matrix deflection circuit (to Character Generator Card).

Those 4014/4015 Terminals which are equipped with either a Standard Communications Interface or a TTY Port Interface need a special modification. A small daughter board (Data Delay board) must be added to the Interface card. This modification increases the delay to 9.6 μsec between the time the computer activates $\overline{\text{CPUNT}}$ and the point when the computer starts using the terminal minibus. Instructions for installing the daughter board are included at the end of this section. For further information on the Standard Communications Interface or the TTY Port Interface, refer to the Instruction manuals: Standard Communications (021-0065-00), P.N. 070-1458-00; TTY Port Interface (021-0072-00), P.N. 070-1356-00.

INSTALLATION PROCEDURE

NOTE

Turn power OFF before installing or remove circuit cards.

1. Ensure that a motherboard extender is installed in the terminal.

2. Disconnect the cable that plugs into J36 on the TC3 card and reconnect to J1 on the Interactive Buffer card, noting plug orientation.

3. Take the 2-wire shielded cable supplied in the modification kit. On one end is a plug P2. Solder the other end to the back of J21 on the TC2 card. The wire connected to pin 1 of P2 solders to pin 2 of J21, (black) and the wire connected to pin 2 of P2 solders to pin 20 of J21 (red).

NOTE

If it is desired that an attached joystick be used instead of the thumbwheel controls for the purposes of controlling relocation, connections to J20 must be made instead of the connections to J21. This option should be selected at installation time. It is an "either/or" selection. Both cannot be used. The options and required wiring are summarized below -

Cable	For Thumbwheel Controls		For Joystick Controls
J2	J21		J20
1	2	on TC-2 card	2
2	20		7

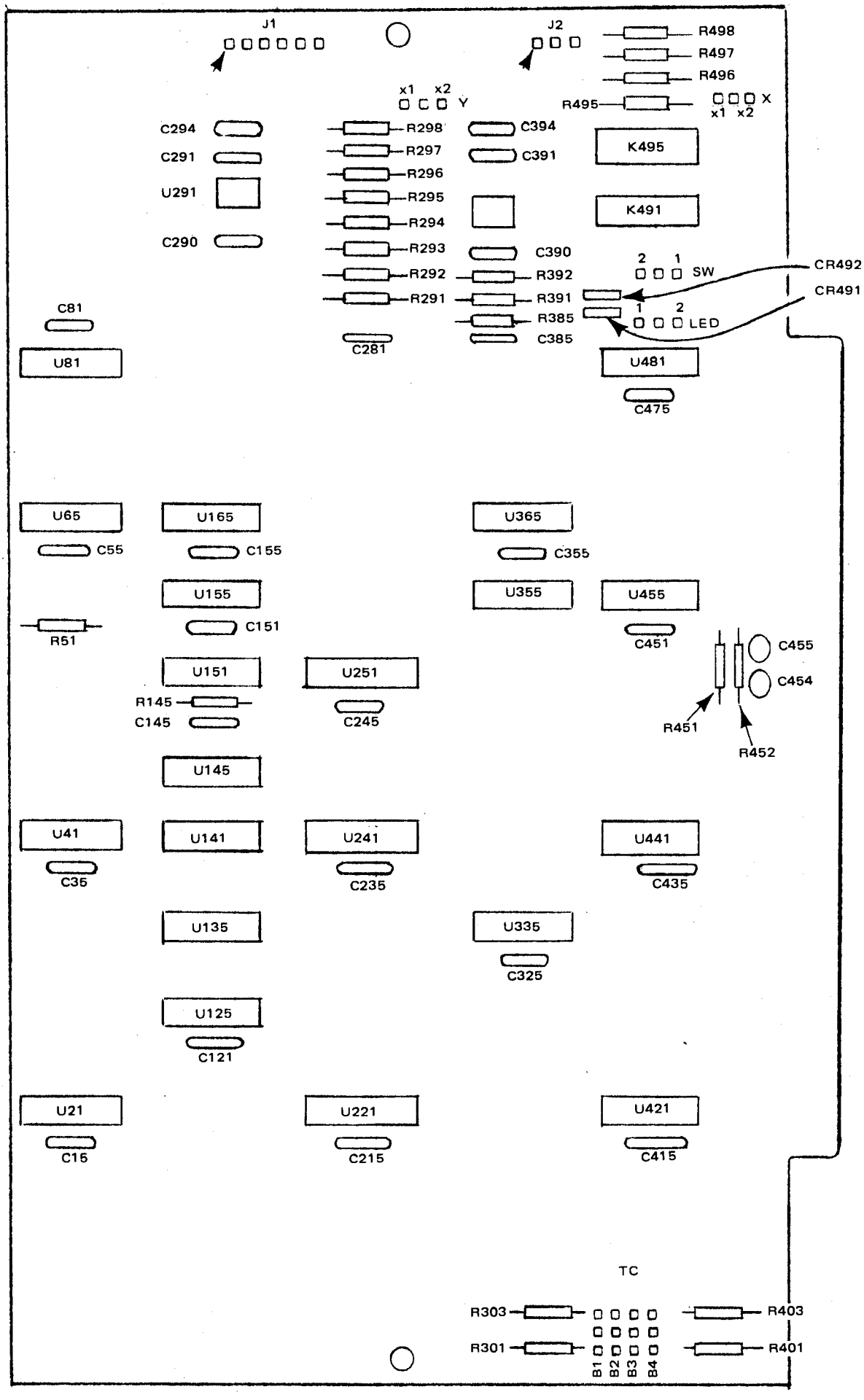


FIGURE 4. INTERACTIVE BUFFER BOARD LAYOUT.

4. Remove the TC1 and the Character Generator card from the terminal minibus.

5. On the TC1 card, identify I.C. U151. Cut the connection between pin 11 and pin 12 of U151. Run a wire on the back side of the circuit board, from pin 12 of U151 to edge connector pin 21 (SPD1). Connect a 1K resistor on top side of the board between pins 12 and 14 of U151.

6. Taking the Character Generator card, remove the I.C. U381. (NOTE: the following instructions in #6 refer to Character Generator Cards No. J-3674-00. Any cards numbered J3674-01 and above will need only to replace U485 with the new I.C. The capacitors included in the kit are not needed.) Replace U381 with the I.C. amplifier supplied in the modification kit. This is a TO-99 package which is pin compatible with the DIP package removed. Install decoupling capacitors supplied in the kit - one between pin 7 of U285 and pin 8 of the amplifier, and the other between pin 7 of U371 and pin 4 of the amplifier.

7. Attach the new labels (supplied in the kit) and re-install the Character Generator and TC1 cards.

8. Set the strap options (SWITCH, LED, TERMINATION CHARACTER, and XY GAIN) according to requirements. (See Table B, Strap Options)

9. If it is desired to change the Interactive Buffer card timer period, do so by changing the resistor/capacitor pair, R51 and C151. The time is approximately given by: 0.3 Capacitance x Resistance.

NOTE

There are no adjustments on the Interactive Buffer Card.

10. Install the Interactive Buffer Card in the terminal minibus.

11. Users having STANDARD COMMUNICATIONS INTERFACES or TTY PORT INTERFACE CONTROL boards must perform further installation. Instructions for doing so are supplied in the following pages.

12. Power up the terminal and verify that the Interactive Buffer is operating correctly as outlined in the next paragraphs.

Installing the Data Delay Daughter board to the STANDARD COMMUNICATIONS Interface board (021-0065-00).

1. Turn the Standard Communications Interface board so the component side is facing away from the installer (i.e. board is turned "up-side-down").

2. Using a sharp-bladed instrument (such as an "exacto knife"), cut away about 1/8" of the gold which makes up the run between pin 1 of U32 and U9.

3. Turn the Interface board so the component side is facing the installer (i.e. board is turned "right-side-up"). Using the hardware supplied, attach the Data Delay daughter board to the tooling hole near U39 on the Standard Communications Interface board. (The ribbon cable on the Data Delay board should face the center of the Standard Communications board, and the washers supplied with the kit should be placed between the spacer and each board.)

4. Plug the Data Delay board ribbon cable onto J1, observing pin-1 keying.

5. Separate each wire in the Data Delay board ribbon cable, and strip 1/8" insulation from the end of each wire. Using the guide table below, solder each wire to the appropriate pin on U32.

Wire Code	Wire Color	Pin Number
9-1	wht/brn	1
9-2	wht/red	11
9-3	wht/orn	4
9-4	wht/yel	14

6. Re-install modified Standard Communications Interface in the terminal.

Installing the Data Delay daughter board to the TTY PORT INTERFACE CONTROL board (021-0072-00).

1. Using the hardware supplied, attach the Data Delay daughter board to the tooling hole near U59 on the TTY Port Interface Control board. (The ribbon cable on the Data Delay board should face the center of the Standard Communications board, and the washers supplied with the kit should be placed between the spacer and each board.)

2. Plug the Data Delay board ribbon cable into J1, observing pin-1 keying.

3. Cut and lift pin 5 of U83.

4. Separate each wire in the Data Delay ribbon cable, and strip 1/8" insulation from the end of each wire. Using the guide table below, solder each wire to the appropriate pin on U83.

Wire Code	Wire Color	Pin Number	
9-1	wht/brn	5	(solder to pin only - do not
9-2	wht/red (+5V)	16	allow solder to con-
9-3	wht/orn (GND)	8	nect the pin to the
9-4	wht/yel	4	board.)

5. Re-install the modified TTY Port Interface Control board into the terminal.

TABLE B

STRAP OPTIONS

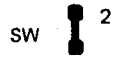
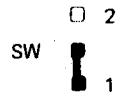
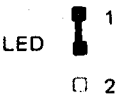
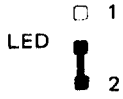
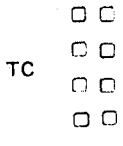
Strap	Setting	Description
SWITCH		Selects SW2 to control RELOCATOR mode.
		Selects SW1 to control RELOCATOR mode.
LED		LED 1 is lit to reflect keyboard LOCK condition.
		LED 2 is lit to reflect keyboard LOCK condition.
		Comes from BUFFER, COMP DUMP, and STORE modes. LED 1 is commonly used by the Option 1 Data Communications Interface for reflecting the keyboard lock condition, and so it is normally strapped for LED 1 on the Interactive Buffer card. The strap can be left out if no indication of the keyboard lock condition is desired.
TERMINATION CHARACTER (T.C.)		The Terminating Character is a strap selectable control character from the first column of the ASCII Code Chart. A strap in place causes a "Ø" and no strap produces a "1" for each selected bit. Example: with a strap at only B2, the termination character will be "CR" (Carriage Return). Table C gives all 16 possible strap combinations and the resulting Termination Character.

TABLE B (cont.)

STRAP OPTIONS

Strap	Setting	Description
DEFLECTION GAIN	Y ▮ x1 / ▢ x2 X ▮ x1 / ▢ x2	X and Y DEFLECTION GAIN controls relocation. If both X and Y straps are set for x1, relocation (to anywhere on the screen) occurs only when refreshed graphics are originally "drawn" within a given space at the center of the screen. (See Fig. 5 for parameters.)
	Y ▢ x1 / ▮ x2 X ▢ x1 / ▮ x2	If both X and Y straps are set for x2, relocation (anywhere on the screen) is possible regardless of where graphics or alphanumerics are originally "drawn". NOTE *When x2 is selected, the positioning accuracy is somewhat diminished. The display may move farther in relation to thumbwheel or joystick movement than desired (nonlinearity), or it may "back-up" slightly when the thumbwheel or joystick is released (backlash).*
		This strap is used in conjunction with the keyboard thumbwheels or optional joystick.

TABLE C

TERMINATION CHARACTER
STRAP SELECTION

Straps				Term. Char.
B1	B2	B3	B5	
IN	IN	IN	IN	NUL
OUT	IN	IN	IN	SOH
IN	OUT	IN	IN	STX
OUT	OUT	IN	IN	ETX
IN	IN	OUT	IN	EOT
OUT	IN	OUT	IN	ENQ
IN	OUT	OUT	IN	ACK
OUT	OUT	OUT	IN	BEL
IN	IN	IN	OUT	BS
OUT	IN	IN	OUT	HT
IN	OUT	IN	OUT	LF
OUT	OUT	IN	OUT	VT
IN	IN	OUT	OUT	FF
OUT	IN	OUT	OUT	CR
IN	OUT	OUT	OUT	SO
OUT	OUT	OUT	OUT	SI

VERIFICATION

Preparing Terminal for Verification.

1. Erase Screen.

2. Push keyboard switch (which is strapped to control RELOCATION mode) to ON (push down on right side of switch as the user faces Terminal).

3. Switch terminal to LOCAL.

4. Check that cursor resides at HOME POSITION.

NOTE

The Interactive Buffer should not interfere with the normal operation of the terminal.

Verifying the Interactive Buffer for proper operation.

1. Space cursor to center of screen and enter graphics mode by depressing CONTROL SHIFT M at the terminal keyboard.

2. Enter <ESC> = Ø at the terminal keyboard.

3. Verify that the terminal is in alphanumerics mode and that the cursor resides at HOME POSITION.

4. Enter <ESC> = 2

5. Verify that the cursor is jammed to bottom left-hand corner of screen (as user faces terminal).

6. Enter <GS> (f , @
Ø @
f 4 @
(@
f , @
Ø f 4 @
<GS> f , @
(f 4 @
<US> T E K T R O N I X

7. Verify that the picture shown in Figure 5 is refreshed at the center of the screen.

8. Enter <BS>.

9. Verify that for each <BS> the last character in the buffer is deleted.

10. Re-enter characters to restore the picture.

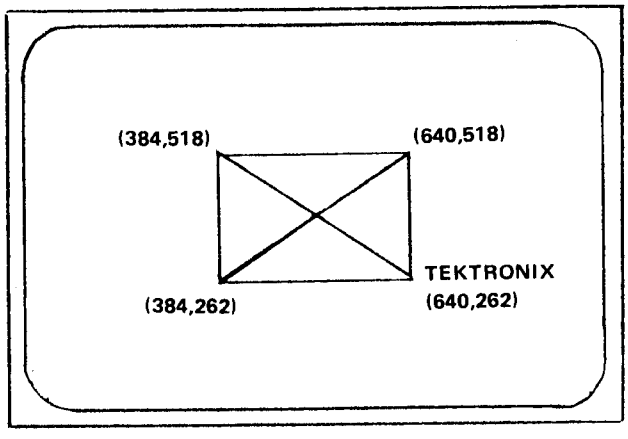


FIGURE 5. SAMPLE DISPLAY. (Coordinate data is not displayed. It is given here for information purposes only.)

11. Verifying Interactive Buffer ON LINE. If it is possible to verify the Interactive Buffer ON LINE, or connected back-to-back with another Tektronix terminal, the terminal should be placed ON LINE as follows:

    a. Enter <CR>.

    b. Verify that the buffer contents are transmitted to the remote device.

    c. Switch terminal to LOCAL.

12. If Verifying Interactive Buffer in LOCAL:

    a. Enter <CR>

    b. Verify that the buffer can no longer be modified by entering characters or by entering a <BS>.

13. Enter <ESC> = 3

14. Verify that the picture stores on the terminal screen.

15. Switch ON the "relocator" by placing the keyboard switch which is strapped to control RELOCATION mode to OFF (as user faces screen, push switch down on the left).

16. Verify that the picture can be relocated around the terminal screen using the keyboard thumbwheel controls (or attached joystick, if installed for joystick operation). It should be possible to relocate the center of this picture to all points on the screen.

17. Enter <ESC> = 3 at various locations.

18. Verify that the picture stores on the terminal screen at selected locations.

19. Align the refresh picture accurately over the original stored picture at center screen.

20. Switch relocator ON and OFF and verify that the two pictures, refreshed and stored, remain one on top of the other. This is the zero-relocation point.

21. Enter <ESC><SUB>.

22. Verify that crosshair cursor is at the approximate center of the screen.

23. Switch terminal to ON LINE.

24. Enter a keyboard character to remove the crosshair cursor.

25. Switch terminal back to LOCAL.

26. Erase screen.

27. Verify that refreshed picture remains on screen.

28. Enter <ESC> = 0

29. Verify that refreshed picture disappears and that the terminal is in alphanumerics mode with the cursor at HOME POSITION.

30. The Interactive Buffer should not interfere with the normal operation of the terminal. This can be verified in the usual way.

NOTE

This verification shows some of the many user features available, and it also checks the operation of the Interactive Buffer. Other modes, which the user may wish to test, are not dealt with here.

SECTION 3

CIRCUIT DESCRIPTION

BLOCK CONCEPT

GENERAL

The Block Diagram of the Interactive Buffer is shown in Figure 11.

A signal's active state is indicated by the signal name; i.e. those with overlines indicate that the source must pull the signal line low to cause that function to occur. For a description of internal signals, see SIGNAL LINE DEFINITIONS in this section.

PRINCIPAL CIRCUITS

Circuits contained in the Interactive Buffer are listed below.

INPUT DECODE — Decodes the ASCII 3-code sequence < ESC> = X. Depending only on BIT 1 and BIT 2 of the last character a defined function is performed as shown in TABLE D.

TABLE D
CONTROL CHARACTER SEQUENCE EFFECTS

DECODE OF THIRD CHARACTER OF ESC = X		
BIT 2	BIT 1 (LSB)	OPERATION
0	0	SET NEUTRAL MODE
0	1	SET BUFFER MODE
1	0	SET COMPOSE MODE
1	1	SET STORE MODE

Decodes the character codes < CR> and < BS>.

STATUS REGISTER — Consists of four status signals: LOAD, COND, CPUD and STOR.

CONTROL LOGIC — Controls the loading process of characters into the MEMORY.

Controls the suppress signals TSUP, CSUP and CGZSUP.

OUTPUT SEQUENCER Controls the buffer dump cycling.

Limits the refresh rate for buffer dump cycles.

Controls at the beginning of each buffer dump cycle the cursor jam to coordinates X=0, Y=33.

MEMORY — The memory consists of seven RAM chips, which are parallel loaded and read with ASCII characters. The maximum buffer contents is 1024 x 7 bits.

LOAD COUNTER — Provides the addressing for loading the buffer.

Serves as end-of-buffer pointer for the buffer dumping cycle.

DUMP COUNTER — Provides the addressing for the buffer dumping cycle.

MULTIPLEXER — Controls which counter (LOAD or DUMP COUNTER) actually addresses the MEMORY.

COMPARATOR — Provides a signal when the end-of-buffer is reached.

LINE TERMINATOR — When activated, issues a "line terminator" character (this may be strap selected to any code contained in column Ø of the ASCII code chart) to the computer.

RELOCATOR — When activated allows the keyboard thumbwheel controls to be used, to relocate the buffer contents when refreshed on the terminal screen.

NEUTRAL MODE

On power-up, and after a general reset, the Interactive Buffer is in the so-called "neutral mode".

A general reset is provided to the Interactive Buffer (as well as to the terminal) after:

1. Simultaneously depressing the SHIFT and PAGE keys on the terminal keyboard, enabling (via the signal HOME) the INPUT DECODER to generate RSET signal.

2. By sending the ASCII 3-code sequence <ESC> = 0 to the Refresh Buffer. The INPUT DECODER generates HOME as well as RSET.

In NEUTRAL mode the Interactive Buffer does not affect communications between terminal and computer in any way.

BUFFER MODE

BUFFER mode is entered after receipt of the ASCII 3-code sequence <ESC>=1, from NEUTRAL or HOLD mode.

Upon receipt of <ESC> the INPUT DECODER activates $\overline{\text{DLCE}}$ low, which selects HOLD mode. The "=" activates $\overline{\text{LCAR}}$ and arms the Refresh Buffer. At the same time $\overline{\text{TSUP}}$ is activated in order to inhibit the next character from being written on the terminal screen. Now BIT 1 and BIT 2 of the third character are decoded by the INPUT DECODER, which in this case generates an $\overline{\text{SBUF}}$ pulse. $\overline{\text{SBUF}}$ sets LOAD true and activates $\overline{\text{KLOCK}}$ in order to inhibit further keyboard entries. A strap option allows either LED 1 or LED 2 to turn on, if $\overline{\text{KLOCK}}$ is active.

In BUFFER mode only $\overline{\text{TSTROBE}}$ enables $\overline{\text{GSTB}}$ if $\overline{\text{BTSUP}}$ and $\overline{\text{GATE}}$ are inactive. Now each subsequent character sent from the computer via the Minibus signal lines BIT 1-7, except <CR> and <BS>, enables $\overline{\text{GSTB}}$ to generate a $\overline{\text{WRIT}}$ signal to the MEMORY and LOAD COUNTER. This causes the character on the data lines BIT 1-7 to be stored in the buffer.

Upon receipt of <BS> the INPUT DECODER activates $\overline{\text{BTSP}}$ to the CONTROL LOGIC, which enables $\overline{\text{DCRL}}$ to decrement the LOAD COUNTER. It deletes the last character in the buffer but is not stored in the buffer. Decoding the ASCII control code <CR> on the data lines, terminates BUFFER mode by generating $\overline{\text{CRRT}}$ from the INPUT DECODER to the STATUS REGISTER in order to enter REFRESH mode and deactivate LOAD and KLOCK.

REFRESH MODE

In REFRESH mode, the buffer contents are refreshed on the terminal screen and characters received are not stored in the buffer. During one character dump cycle the OUTPUT SEQUENCER dumps one character to the terminal screen, in Write-Thru mode. The $\overline{\text{COND}}$ flipflop is activated and enables $\overline{\text{SELW}}$. Pulling the $\overline{\text{SELW}}$ line of the Minibus low causes the terminal to select Write-Thru mode.

The dump cycle begins with activating $\overline{\text{CKIN}}$ to allow the sequence of character dump cycles to be interrupted. $\overline{\text{CKIN}}$ allows interruption by $\overline{\text{CPUNT}}$, $\overline{\text{TBUSY}}$, $\overline{\text{DLCE}}$, $\overline{\text{LCAR}}$, $\overline{\text{TIME}}$, $\overline{\text{GIN}}$ or $\overline{\text{F PAUSE}}$. If the interruption is finished the OUTPUT SEQUENCER generates $\overline{\text{CPUNT}}$, which allows any keyboard action to finish.

Then the OUTPUT SEQUENCER activates $\overline{\text{GATE}}$, which causes:

1. the MULTIPLEXER to select the DUMP COUNTER to address the MEMORY,
2. the addressed buffer location to place its data on the Minibus BIT 1-7.
3. the INPUT DECODER not to decode characters generated by the Refresh Buffer.

Then a $\overline{\text{TSTROBE}}$ is issued by the OUTPUT SEQUENCER followed by a $\overline{\text{INCD}}$ signal to increment the DUMP COUNTER. When the address of the DUMP COUNTER is greater than the address of the LOAD COUNTER, the COMPARATOR enables $\overline{\text{DGTL}}$ signaling the end-of-buffer to the OUTPUT SEQUENCER.

At the beginning of each buffer dump cycle, consisting of one or more character dump cycles, a timer is initiated to inhibit each next buffer dump cycle within approx. 40 msec. Subsequently, at the beginning of each buffer dump cycle, the cursor is jammed to X=0, Y=33. This is done by the Output Sequencer activiating: HIY, LOY (twice), BIT1, HIX, LOXE and END COUNT. The terminal is reset to alphanumerics mode if it was in graphics mode by SPD 1.

Finally the OUTPUT SEQUENCER enables RSTD to reset the DUMP COUNTER.

Every character from the following : <BS>,<HT>,<LF>,<VT>,<FF>,<CR>, <SO> and <SI>, causes the INPUT DECODER to generate CCHS which activates CGZSUP to inhibit cursor spread.

During the jam, TIME remains low and inhibits the CONTROL LOGIC to clock CLOK.

The character dump cycles are synchronized with the 614 KHz system clock and the 4.9 MHz system clock is used to generate a 200 µsec delayed version of the 614 KHz clock so-called 614 KS.

REFRESH mode is ended by a general reset or the ASCII 3-code sequence <ESC>=X.

HOLD MODE

HOLD mode is entered on receipt of the ASCII control code <ESC>, or if a HARD COPY is commanded. The buffer dump cycles are suspended until the uncertain< ESC> control sequence is complete or, if a HARD COPY was commanded during the time the HARD COPY operation is in effect.

When CKIN goes low HOLD mode can be entered by stopping CLOK from the CONTROL LOGIC to continue clocking the OUTPUT SEQUENCER.

COMPOSE MODE

The COMPOSE mode is entered after receipt of the character sequence <ESC> = 2, from NEUTRAL or HOLD mode. The INPUT DECODER generates SCMP and sets the bistables LOAD and COND active and enables SELW and CSUP. CSUP inhibits keyboard characters from being sent to the computer.

COMPOSE mode is accomplished by activating BUFFER mode concurrent with REFRESH mode. The CONTROL LOGIC writes each character entered from the keyboard into the buffer. The OUTPUT SEQUENCER provides continuous refreshing of the buffer contents until the last received character to the terminal screen.

The MEMORY is always ready to accept a character, except when a character is output from the Refresh Buffer. During the time a character can be accepted, TSUP remains low in order to inhibit that character from going to the terminal screen as well. CPUNT controls the interleaving of using one data bus for writing into the buffer and dumping from the buffer.

A received ASCII code <BS> is not stored in the buffer, but deletes the last character by generating DCRL which decrements the LOAD COUNTER.

The mode is terminated when the INPUT DECODER decodes <CR> and triggers CRRT. CRRT enables RSTD to clear the DUMP COUNTER and selects COMP DUMP mode.

COMP DUMP MODE

COMP DUMP mode is always automatically entered after the COMPOSE mode is terminated. The terminal keyboard is locked by an active KLOCK. The contents of the buffer are transmitted once to the computer by allowing, for one buffer dump cycle only, a CSTROBE to be generated simultaneously with the TSTROBE. During COMPOSE mode CSUP was active, but the first GATE signal when CPUD is low resets CSUP high. During COMP DUMP mode CPUD remains low, and CBUSY is allowed to interrupt the buffer dump cycle.

After each character dump cycle INCD is activated to increment the DUMP COUNTER. The DUMP COUNTER is incremented until its address is greater than the LOAD COUNTER address and the COMPARATOR enables DGTL. DGTL resets CPUD high and initiates the jam cycle.

Upon entering COMP DUMP mode the Line Terminator flipflop was set. This enables TIM 3 to send a "line terminator" character, which may be strap selected to any code contained in column 0 of the ASCII code chart, to the computer. (See Strap Options.)

On completion of the operation, REFRESH mode is automatically entered.

STORE MODE

The STORE mode is entered after receipt of the character sequence <ESC> = 3, from HOLD mode. The INPUT DECODER enables DSTR causing the STOR flipflop of the STATUS REGISTER to set low.

STOR activates KLOCK to lock the keyboard. The contents of the buffer are stored once on the terminal screen by allowing only for one buffer dump cycle SELW not to be active low. When DGTL is enabled it resets STOR high again and triggers the jam procedure.

Because the Line Terminator flipflop was set by STOR, TIM 3 generates the strap selected "line terminator" at the end of the operation.

On completion of the operation REFRESH mode is automatically re-entered.

RELOCATION MODE

When RELOCATION mode is not selected the Y ANALOG and X ANALOG signals are passed unaltered to the terminal deflection system via Y DEF and X DEF, respectively.

RELOCATION mode is entered by switching either SWITCH 1 or SWITCH 2 (according to strap option). During RELOCATION mode the analog value of the signals Y POT and X POT are added to Y ANALOG and X ANALOG respectively, before the last two signals are passed through. The values of Y POT and X POT are controlled by the keyboard thumbwheels and determine the offset of the deflection system.

CIRCUIT DESCRIPTION

MEMORY

(Refer to Figure 6 for timing.) The memory consists of seven 1024 bit RAM's: U205, U215, U221, U305, U315, U405, and U415. The RAM's are all parallel addressed by signals ADDØ through ADD9 and have their Chip Enable ($\overline{CE}$) input always active low.

A low $\overline{WRIT}$, which is gated with 614KS, causes U235 D, pin 11 to go low and store the character available on the Minibus lines BIT 1-7 in RAM.

A high active GATE causes the character on the location addressed by ADDØ through ADD9 to be placed on the Minibus lines BIT 1-7.

INPUT DECODE

When it is desired to enter a mode other than the current one, an ASCII 3-code sequence must be sent to the Interactive Buffer. The first two codes of this sequence are <ESC>= and "arm" the Refresh Buffer. The third character "conditions" the Refresh Buffer according to BIT 1 and BIT 2.

When the ASCII code <ESC> is received, it is decoded by the decoder, consisting of: U245 and U241A. Only when the current mode is REFRESH or NEUTRAL and $\overline{RFON}$ (U145A, Pin 2) remains low, a high ESCP concurrent with an active $\overline{GSTB}$ sets flipflop U45B, Pin 8 ($\overline{DLCE}$) low.

Receiving ASCII code "=" during a low $\overline{DLCE}$ causes ARCH to occur. ARCH concurrent with an active $\overline{GSTB}$ enables the Q output (U45A Pin 5) to set high. Without ESCP, $\overline{GSTB}$ resets $\overline{DLCE}$ high again.

Only $\overline{BIT\ 1}$ and $\overline{BIT\ 2}$ of the third character are decoded by U241B, which causes either $\overline{DSTR}$, $\overline{SCMP}$, $\overline{SBUF}$ or $\overline{NEUT}$ output to go active. These signals modify the STATUS REGISTER to set the new requested mode.

Signals $\overline{BKSP}$, $\overline{WRIT}$ and $\overline{CRRT}$ are only decoded when LOAD is active by gates: U351A, U351D, U145B, U421A, J475B, U345A, U251B, and U235A. U151B is a one-shot that limits the refresh rate by inhibiting each next refresh cycle within approximately 40 msec. For the first refresh cycle, U151B is triggered on the negative going edge of $\overline{COND}$ (U381C, pin 5). For the following refresh cycles, U151B is initiated on the positive edge of $\overline{TIM\ 3}$ (U265B, pin 4), and activates $\overline{TOUT}$ (U151B, pin 9) for approximately 40 msec.

OUTPUT SEQUENCER AND LINE TERMINATOR

OUTPUT OF CHARACTERS. (Refer to Figure 7 for timing.) In order to output a character, a 6-bit shift register consisting of U281 and U181B is clocked by CLOK when $\overline{\text{COND}}$ is low. Q output of U181B (pin 9) is preset to a low and all other outputs QB through QF are preset high. When the shift-register is clocked, the low of QA is shifted sequentially along the other outputs.

While QA is low, CKIN (U181B pin 8) is high and allows the buffer dumping cycle to be interrupted by, for instance, CPUNT coming from the computer interface to warn that data is coming and so the Minibus data lines cannot be used until the computer is finished. If the computer is finished and no other interrupt occurs the Interactive Buffer activates $\overline{\text{CPUNT}}$ during QB - QF (U281 pin 15, 14, 13, 11 and 10) and acts as the computer. After initiating CPUNT a pause of 3.2 µsec allows any keyboard action to finish.

Then GATE is activated, which causes:

1. The MULTIPLEXER to select the DUMP COUNTER to address the MEMORY.
2. The addressed buffer location to place its data on the Minibus BIT 1-7.
3. The INPUT DECODER not to decode characters generated by the Interactive Buffer.

QE generates a STRB (U381D pin 8) which, when COND is high enables TSTROBE. QF is gated with 614 KS to enable a 400 µsec INCD (U81B pin 6) pulse on the trailing edge of QF. Not earlier than 9.6 µsec after activating CPUNT the computer interface should start using the Minibus, because the whole cycle of the Interactive Buffer outputting a character takes 9.6 µsec.

NOTE

For the Optional Data Communication Interface this delay is already 13 µsec. The STANDARD COMMUNICATION and TTY PORT interfaces however, should be modified to increase the delay to 9.6 µsec between the time the computer activates $\overline{\text{CPUNT}}$ and the point when the computer interface places its data on the Minibus signal lines BIT 1-7.

During COMP DUMP mode CPUD (U435B pin 4) remains high only for one complete buffer dumping cycle and allows STRB to enable CSTROBE (U435B pin 6) simultaneously with $\overline{\text{TSTROBE}}$.

During COMPOSE mode, if $\overline{\text{GATE}}$ is high, data going to the screen is suppressed by activating OUTP (U481D pin 11) which enables $\overline{\text{TSUP}}$.

JAM. (Refer to Figure 8 for timing.) At the beginning of each buffer dumping cycle the cursor "jams" to screen location X=0, Y=33. The jam is triggered by DGTL (U51C pin 9) going high, which causes $\overline{\text{TIME}}$ (U375B pin 6) to go active low and stops CLOK to the shift-register.

If $\overline{\text{CPUNT}}$, $\overline{\text{TBUSY}}$, $\overline{\text{TOUT}}$, CKIN and $\overline{\text{LINT}}$ are all high, then $\overline{\text{JMTL}}$ (U65A pin 6) is set low, JMTL enables $\overline{\text{CPUNT}}$ (U355F pin 12) and $\overline{\text{JMTL}}$ removes the clear from counter U135B, which now starts counting. The counter output of U135B is decoded by the BCD-to-DECIMAL decoder U41 and sequentially causes TIM 1, TIM 2, TIM 3 and TIM 4 to go active. TIM 1 (U351 pin 11) enables BIT 1 (U355A pin 2) and also after being gated with 614KS activates HIY and LOY.

TIM 2 (U75 pin 2) after being gated with $\overline{\text{614KS}}$ activates $\overline{\text{RSDS}}$ (U355E pin 10), HIX, LOXE, END COUNT, SPD 1 and LOY.

TIM 3 (U75 pin 4) enables RSJL (U75 pin 10) to go low, which resets JMTL causing counter U135B to be cleared and TIM 3 to end. The jam is now finished.

LINE TERMINATOR. (Refer to Figure 9 for timing.) Either $\overline{\text{STOR}}$ or $\overline{\text{CPUD}}$ have set line-terminator flipflop U275B pin 8 low, subsequently enabling a line-terminator to be generated after the jam. In this case TIM 3 does not generate $\overline{\text{RSJL}}$ (U75E pin 10) but TIM 3 causes a strap selected line-terminator character to be issued to the computer with a $\overline{\text{CSTROBE}}$ (U435C pin 8) and $\overline{\text{TIM 4}}$ (U41 pin 7) causes $\overline{\text{RSJL}}$ to go active. JMTL clears counter U135B and the combined jam and line-termination is done.

ADDRESS CONTROL

The multiplexer (U105, U115, U121) selects either the LOAD COUNTER (U5, U35, U125) or the DUMP COUNTER (U15, U135A) to address a memory location. Normally GATE (U121 pin 1) is low and the LOAD COUNTER is selected. However, when a character is to be dumped from MEMORY to the Minibus, GATE goes high and selects the DUMP COUNTER to address the MEMORY.

The COMPARATOR (U21, U25, U141) output (U141 pin 5) goes low when the binary value of the DUMP COUNTER is greater than the LOAD COUNTER.

The borrow output U125 (pin 13) inhibits the LOAD COUNTER from passing zero. OVFL (U125 pin 6) goes active when the contents of the LOAD COUNTER pass 1023 and generate DCRL to decrement the LOAD COUNTER again.

STATUS REGISTER

Upon receipt of <ESC> = 3, $\overline{\text{DSTR}}$ (U351E pin 13) goes low. If the current mode is REFRESH, COND (U51D pin 13) is high and U51D (pin 11) will output a low $\overline{\text{SSTR}}$. $\overline{\text{SSTR}}$ presets STOR (U55A pin 6) low. At the end of a store cycle, RSST resets $\overline{\text{STOR}}$ high again.

After receipt of $\overline{\text{SCMP}}$ (U255B pin 5) and $\overline{\text{SBUF}}$ (U255B pin 4) setting COMPOSE and BUFFER mode respectively, LOAD (U155B pin 9) will be set high. The receipt of $\overline{\text{SCMP}}$ and $\overline{\text{SREF}}$ (U155A pin 3) setting COMPOSE and REFRESH mode respectively, will cause COND (U155A pin 5) to set high. CPUD (U55B pin 9) will be set high during COMP DUMP mode by SCPD (U55B pin 10) and set low after the computer dumping cycle by DGTL (U55B pin 11).

CONTROL LOGIC AND SUPPRESS LOGIC

The following signals may interrupt the buffer dumping cycles: $\overline{\text{DLCE}}$, LCAR, CBUSY, TBUSY, CPUNT, TIME, GIN and FPAUSE. All these signals are "ored" by U425, but only if CKIN (U475 pin 13) is high are they allowed to interrupt. U275A passes the interrupt to U421 pin 10 after synchronizing it with 614 KS. (See figure 10 for Interrupt Synchronization Timing.)

Upon receiving < ESC> = 0, $\overline{\text{NEUT}}$ (U151A pin 4) will pulse low and trigger, on its positive going edge, monostable U151B, thus, generating a 1 μsec positive RSET pulse at its output (U151 B pin 6).

During COMPOSE mode $\overline{\text{COMP}}$ (U235C pin 10) remains low. Only a $\overline{\text{CSTROBE}}$ will enable GSTB to be generated from U75F pin 12 and data from the computer accompanied by $\overline{\text{TSTROBE}}$ will not be accepted.

During BUFFER mode $\overline{\text{COMP}}$ remains high and only a TSTROBE will enable GSTB to be generated. Data from the keyboard accompanied by $\overline{\text{CSTROBE}}$ will not be accepted. An "echo" or "local" condition causes data from the keyboard to also be accompanied by a $\overline{\text{TSTROBE}}$.

During COMPOSE mode, $\overline{\text{COMP}}$ is low which activates $\overline{\text{CSUP}}$ (U465E pin 10). Inputs from the keyboard to be stored in the buffer are then inhibited from going to the computer. The first GATE (U365C pins 9 & 10) signal during COMP DUMP mode resets $\overline{\text{CSUP}}$.

$\overline{\text{CCHS}}$ (U321A pin 2) is activated after receipt of the following display formatting codes: < BS> , < HT> , < LF> , < VT> , < FF> , < CR> , < SO> and < SI> . $\overline{\text{CCHS}}$ activates CGZSUP which suppresses the Z axis to inhibit cursor generation while the cursor position is changing.

LED 1 or LED 2 can be strap selected to activate during the time KLOCK is active and the keyboard is locked. (See Strap Options section.)

When BKSP or OVFL are decoded, they cause $\overline{\text{DCRL}}$ (U81 A pin 3) to go low and decrement the LOAD COUNTER.

RELOCATOR

The RELOCATOR can only be activated if COND and $\overline{\text{GIN}}$ are high. Then either a low on keyboard switches (SW1 or SW 2 - Strap selected) can switch the RELOCATOR ON. When the RELOCATOR is switched OFF, Y ANALOG and X ANALOG pass the unity gain summing amplifiers (U291 & U391) unaltered to Y DEF and X DEF respectively. If the RELOCATOR is switched ON the output U375C (pin 8) is high, and the analog value of the keyboard thumbwheel Y POT and X POT is buffered by U395.

Now the value of the buffered Y POT and X POT are added to Y ANALOG and X ANALOG respectively and give an extra bias to the deflection system to offset the original refreshed information.

A filter consisting of R385 and C385 inhibits short pulses on the $\overline{\text{GIN}}$ line, caused by the ASCII code <GS > stored in the buffer, to switch the RELOCATOR OFF.

SIGNAL LINE DEFINITIONS

The following is a description of major internal signal lines on the Interactive Buffer. A description of Minibus Signal Lines is given in the 4014 and 4015 SERVICE MANUAL.

A signal's active state is indicated by the signal name; i.e. those with overlines indicate that the source must pull the signal line low to cause that function to occur.

ADDØ - ADD9	High active address bits from multiplexer to memory.
ARCH	High active pulse indicating receipt of arming character "=".
$\overline{\text{BIT 1}}$ - $\overline{\text{BIT 7}}$	Data to and from the Terminal/Computer.
BKSP	High active signal caused by < BS> control character.
$\overline{\text{BUFF}}$	This signal indicates that BUFFER mode is selected.
$\overline{\text{CCHS}}$	Indicates that this control character needs suppression of $\overline{\text{Z}}$ signal.
CKIN	High active signal allows the buffer dumping cycle to be interrupted.
CLOK	Squarewave clock signal of 614 KHz supplied to OUTPUT SEQUENCER.
$\overline{\text{COMP}}$	This signal indicates that COMPOSE mode is selected.
$\overline{\text{COND}}$	This signal activates the buffer dumping cycle sequence.
$\overline{\text{CPUD}}$	This signal means that data from the dumping cycles is also sent to the computer.
CRRT	High active signal caused by < CR> control character.
$\overline{\text{DCRL}}$	A pulse which causes the LOAD COUNTER to decrement.
DGTL	High active signal goes active when address of DUMP COUNTER is greater than the LOAD COUNTER address.
$\overline{\text{DCLE}}$	Arming signal caused by < ESC> control character.
$\overline{\text{DSTR}}$	This signal pulses active when STORE mode command is received.
ESCP	High active pulse indicating receipt of arming control character < ESC>.
$\overline{\text{GATE}}$	Used to place the data on the Minibus of the buffer location addressed by the DUMP COUNTER.
$\overline{\text{GSTB}}$	Strobes data into the Refresh Buffer.

$\overline{\text{INCD}}$	A pulse which causes the DUMP COUNTER to increment.
$\overline{\text{JMLT}}$	Goes active then the cursor jams to screen location X = 0, Y = 33.
KLOK	High active signal indicating that the keyboard is inhibited.
$\overline{\text{LCAR}}$	A running signal caused by "=" character.
$\overline{\text{LINT}}$	Suspends generation of "line-terminator" when computer (interface) is busy accepting a character.
$\overline{\text{LOAD}}$	This signal activates the storing of characters in the buffer.
$\overline{\text{NEUT}}$	This signal indicates that NEUTRAL mode is selected.
$\overline{\text{MDST}}$	Allows the last character of the 3-code arming sequence to be decoded.
OUTP	High active signal causes TSUP to be generated during COMPOSE mode.
OVFL	High active signal activated when LOAD COUNTER passes 1023.
$\overline{\text{RFON}}$	This signal indictes that REFRESH or NEUTRAL mode is selected.
RLON	High active signal indicates that RELOCATION mode is selected.
$\overline{\text{RSDS}}$	This signal clears the DUMP COUNTER after a buffer dumping cycle.
$\overline{\text{RSET}}$	Master reset for all logic.
$\overline{\text{RSJL}}$	This signal indicates the end of a cursor jam or "line-terminator" generation.
$\overline{\text{RSST}}$	This signal resets STORE mode to REFRESH mode.
RSTD	High Active signal which clears the DUMP COUNTER.
$\overline{\text{SBUF}}$	This signal pulses active when BUFFER mode command is received.
$\overline{\text{SCMP}}$	This signal pulses active when COMPOSE mode command is received.
$\overline{\text{SCPD}}$	This signal pulses active when COMPUTER DUMP mode is commanded.

$\overline{\text{SSTR}}$	This signal pulses active when STORE mode command is received.
$\overline{\text{STOR}}$	This signal indicates that STORE mode is selected.
STRB	High active signal used to strobe data out of the Interactive Buffer.
$\overline{\text{SREF}}$	This signal pulses active when REFRESH mode command is received.
$\overline{\text{TIME}}$	This signal goes active during cursor jam to suspend the next buffer dumping cycle.
$\overline{\text{TIM 1}}$	High Active signal which generates $\overline{\text{HIY}}$, $\overline{\text{LOY}}$ and $\overline{\text{BIT 1}}$ during cursor jam.
$\overline{\text{TIM 2}}$	High Active signal which generates: $\overline{\text{LOY}}$, $\overline{\text{HIX}}$, $\overline{\text{LOXE}}$, $\overline{\text{ENDCOUNT}}$, $\overline{\text{SPD 1}}$ and resets DUMP COUNTER during cursor jam.
TIM 3	High active signal which either generates a "line-terminator" or ends cursor jam.
$\overline{\text{TIM 4}}$	This signal ends cursor jam after generation of a "line-terminator".
$\overline{\text{TOUT}}$	Originated at the beginning of each buffer dumping cycle to inhibit each next cycle with in 50 msec.
$\overline{\text{WRIT}}$	This signal causes the data to be stored in the buffer.
XDEF	This is the analog deflection voltage controlling horizontal deflection.
XPOT	This is the analog deflection voltage controlling vertical deflection.
YDEF	This is the analog deflection voltage controlling vertical deflection.
YPOT	This is the analog voltage controlled by the keyboard vertical thumbwheel.
614KS	This clock signal is a 200 μsec delayed version of the 614 KHz system clock of the terminal.

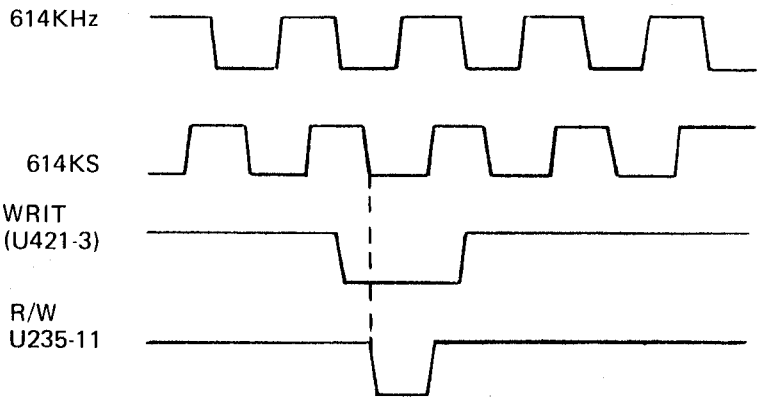


FIG. 6. WRITE TIMING

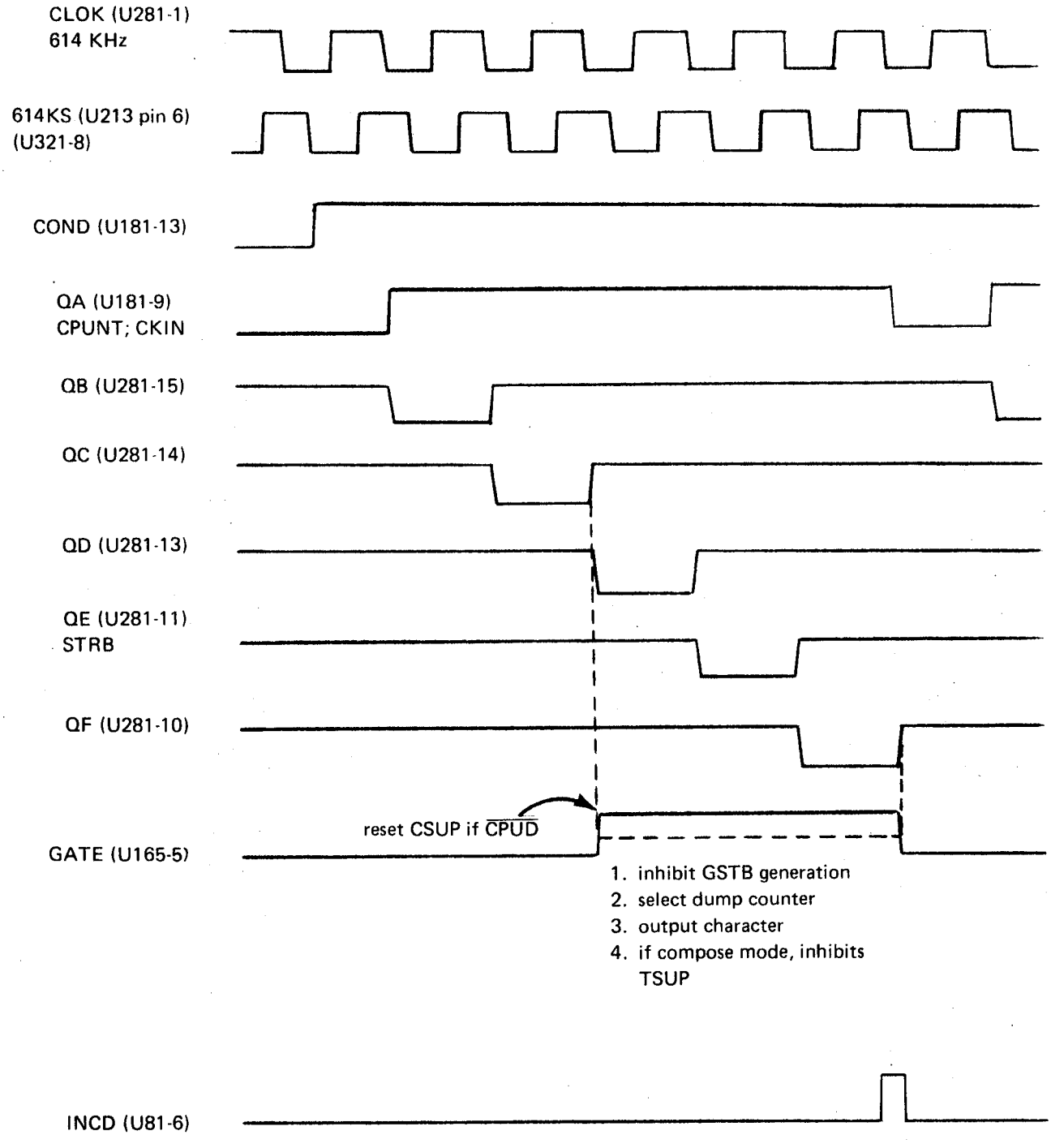


FIG 7. OUTPUT SEQUENCING TIMING

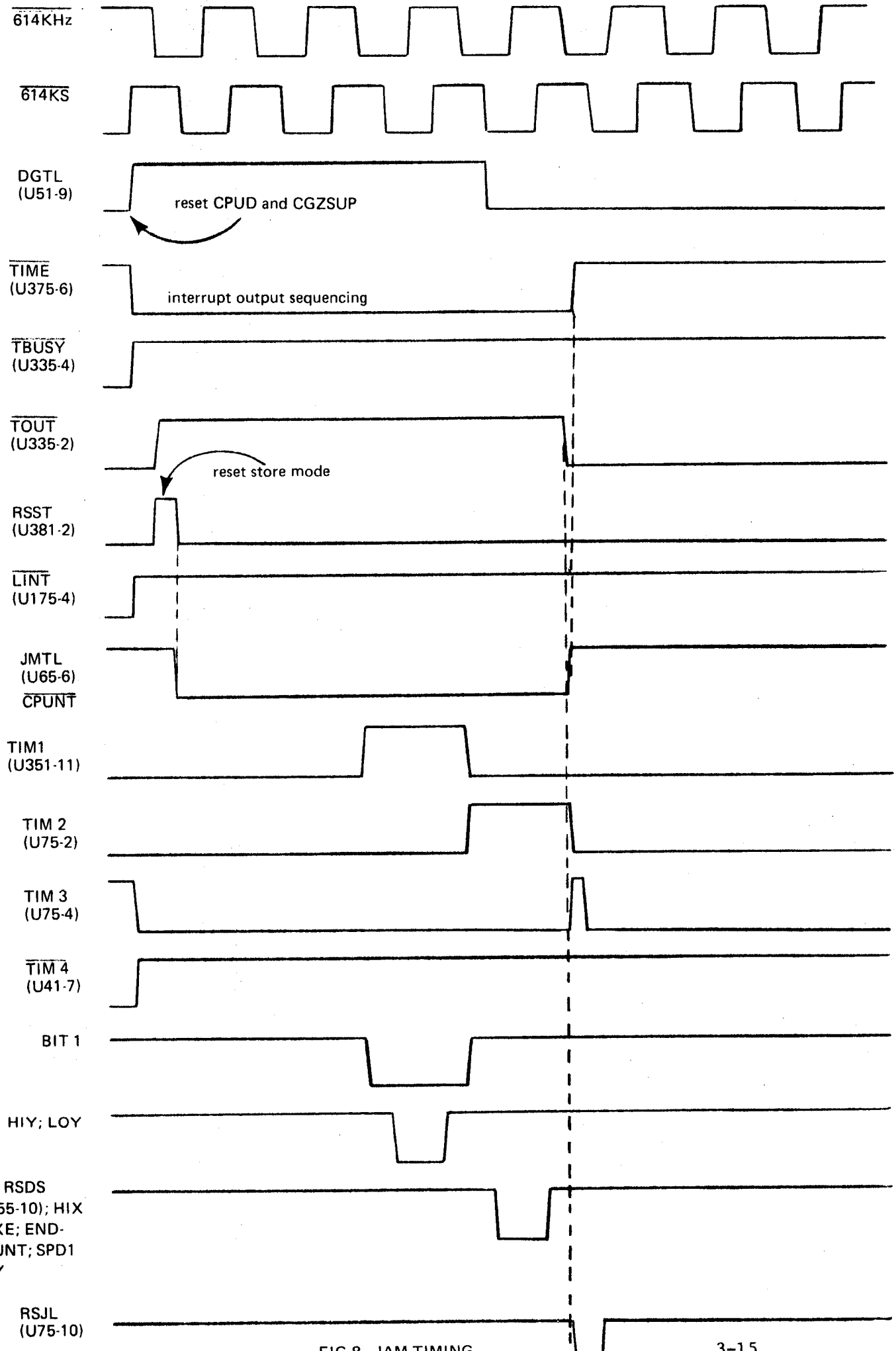


FIG 8. JAM TIMING

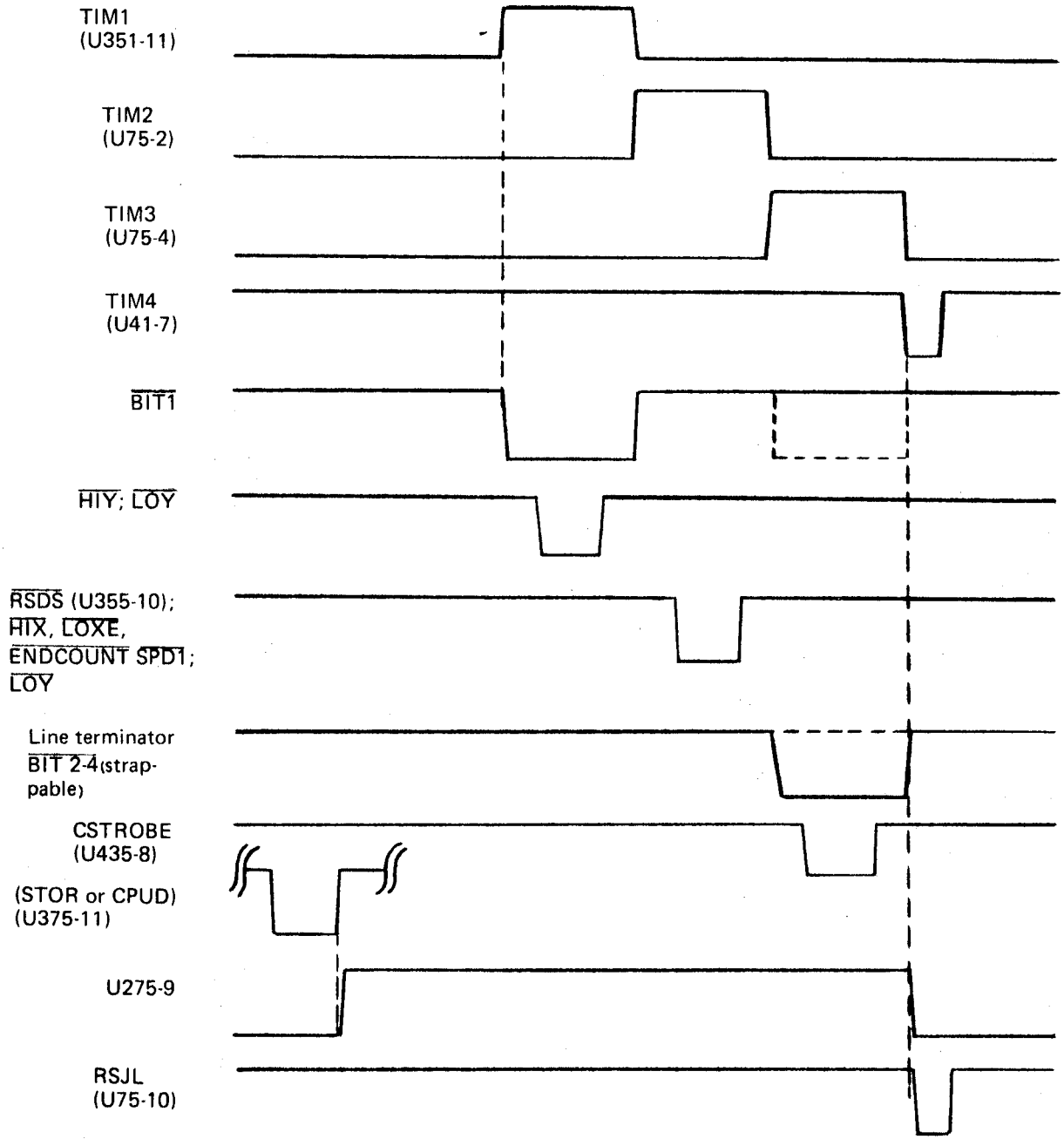


FIG. 9. LINE TERMINATOR TIMING.

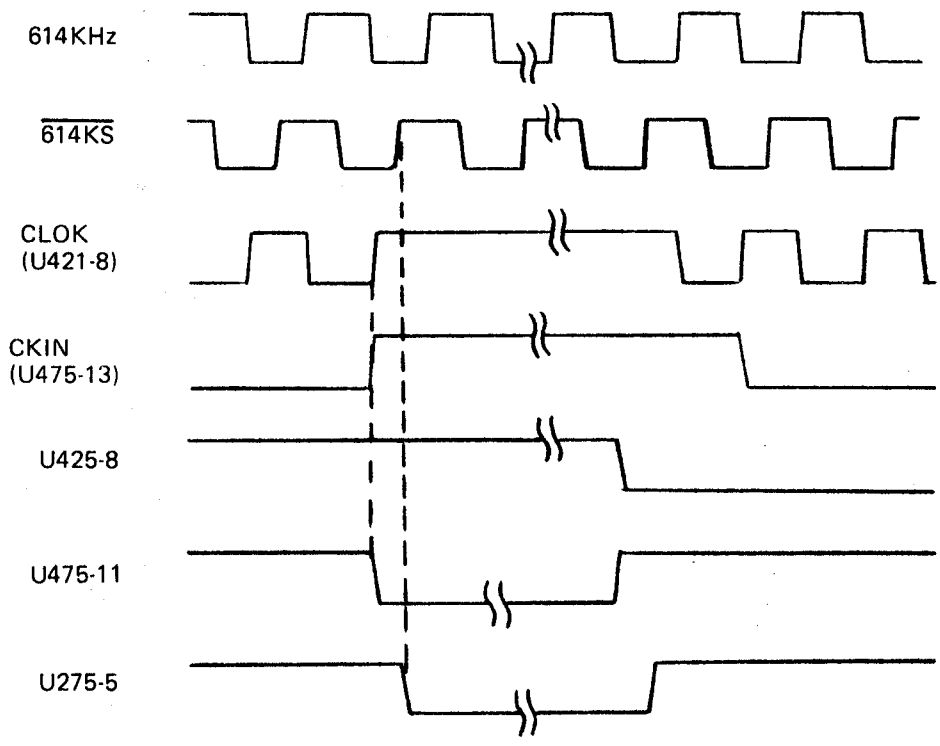
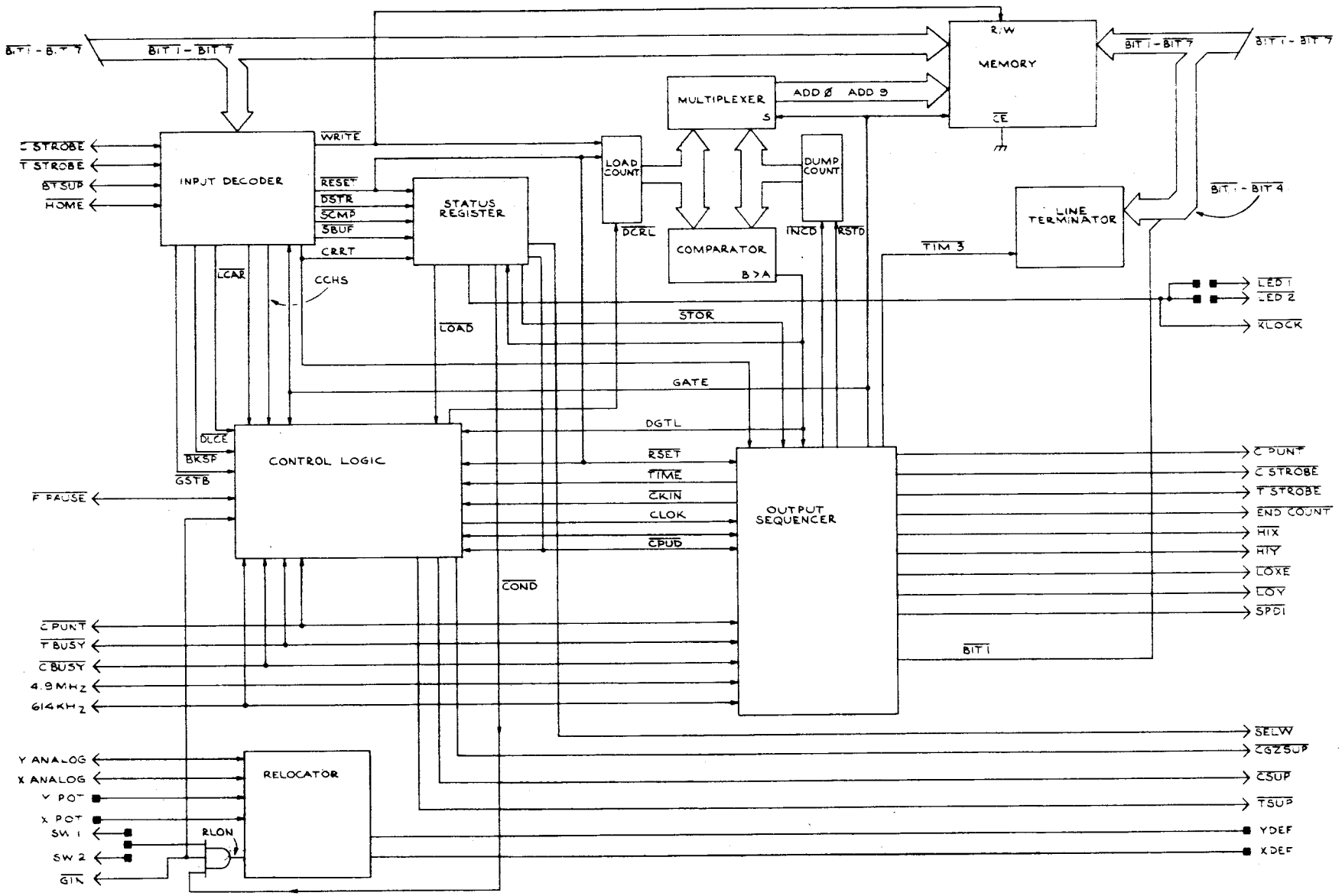


FIG. 10. INTERRUPT SYNCHRONIZATION TIMING.



CM018-0120-00

INTERACTIVE BUFFER BLOCK DIAGRAM

FIGURE 11

SECTION 4

PROGRAMMING NOTES

GENERAL

Primary uses of the Interactive Buffer are:

1. Message Buffering
2. Picture Element Relocation
3. Picture Editing

Each application involves transitions of the operating modes for the Interactive Buffer. It is important that the correct ASCII code sequences are supplied for this purpose by the utility software, and that it keeps track of the transitions made.

When the terminal is ON LINE, these command sequences can be entered from the terminal keyboard provided that an ECHO condition exists on the terminal minibus. Commands sent to the Interactive Buffer in this way are also received by the computer. The computer can therefore keep track of the operating modes of the Interactive Buffer when such are controlled from the terminal keyboard.

A software utility package is available for the CM 018-0120-00 Interactive Buffer. For users who wish to program their own utility package, the following notes provide an outline of programming procedures and typical usage.

NEUTRAL MODE TRANSITIONS

For example, any transition into BUFFER mode, or into COMPOSE mode, is usually made from Neutral mode. To be sure that NEUTRAL mode is established, the ASCII code sequence <ESC> = 0 should be entered before sending the code sequence to enter BUFFER mode or COMPOSE mode. An exception occurs when additions or modifications to the end of the buffer are to be made. Any transition to

NEUTRAL mode including from NEUTRAL mode to NEUTRAL mode, provides a general reset of the terminal electronics and installed peripheral interfaces.

PICTURE ELEMENT RELOCATION

Picture element relocation is an operator controlled function. If it is to be useful the computer must have a way of determining the "picture element relocation bias". It can do this by sending the ASCII code sequence <ESC><SUB> to set up the crosshair cursor. Then, after a delay of 15 ms, it should allow the crosshair cursor to locate its intersection point on the terminal screen, sending the ASCII code sequence <ESC><ENQ>. (Note that the 15 ms delay is only necessary if baud rate of communications link is greater than 1000.)

The "crosshair cursor bias" is not, however, the "picture element relocation bias". This is true only if zero relocation occurs when the crosshair cursor is centered on Point 0, 0 of the terminal screen. As stated before, zero relocation occurs when the crosshair cursor is at approximately center screen.

At the beginning of each user session with the Interactive Buffer, a procedure for reading the "zero relocation bias" should be followed. The computer can then use this to determine "picture element relocation bias" by the following formula:

PICTURE ELEMENT RELOCATION BIAS = (CROSSHAIR CURSOR BIAS - ZERO RELOCATION BIAS)

Using this bias, the computer can compute the relocated picture element,and keep track of the picture under construction.

Picture elements stored in the buffer for relocation should normally be centered on the terminal screen (as opposed to being based on point 0,0). This allows full screen relocation.

Then how is the "zero relocation bias" obtained?

The initial activity of a session using the relocator feature of the Interactive Buffer would normally be to send the "zero relocation bias" to the computer.

For the purposes of this example,

ZRB	instructs the computer to enter a routine which is used for obtaining the "zero relocation bias".
GET	instructs the computer to enter a routine which sets up the crosshair cursor, and subsequently inquires its position.

- The operator switches relocater ON
- The operator enters:

  ZRB <CR> Requests the computer to obtain "zero relocation bias"

- The computer sends:

  <ESC> = 0 Initializes Interactive Buffer

  <ESC> = 1

  <GS> F/@
  F1@
  <GS>-F0@
  + @ Enters CROSS centered on terminal screen into Interactive Buffer

  <CR> The CROSS appears on the terminal screen.

  <ESC> = 3 Stores CROSS at center of terminal screen (relocator switched out)

- The operator switches ON relocator and manipulates the refreshed CROSS so that it becomes superimposed with the stored cross. See Fig. .
- The operator enters:

  GET <CR>

- The computer sends:

  <ESC><SUB> Sets up crosshair cursor

  15 ms Delay Not necessary if <1000 baud

  <ESC><ENQ>

- The terminal automatically returns:

  Status

  Zero Relocation Bias Coordinates

  <CR> <EOT> Optionally strappable

- The computer sends:

  <ESC> = 0 Initializes Interactive Buffer

  <ESC> <FF> Erases terminal Screen

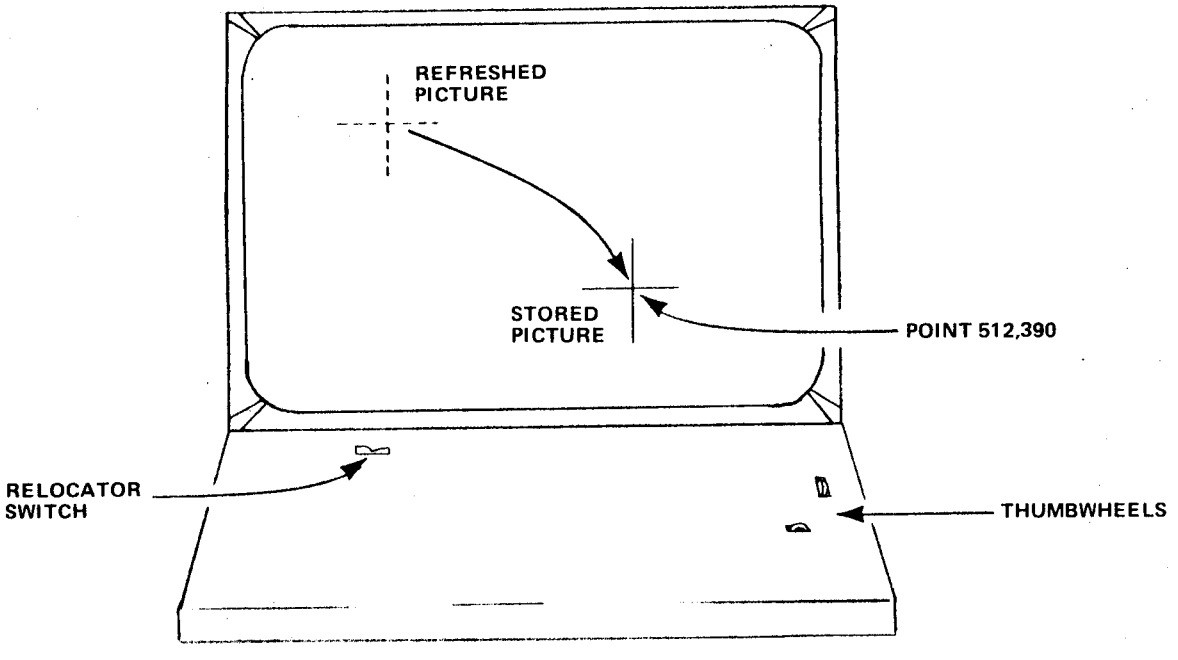


FIGURE 12. RELOCATION OF PICTURE ELEMENT.

A TYPICAL SESSION

A typical user session would progress according to the flow chart shown in Fig. 13.

The session begins (if relocation is to be used) with sending the "zero relocation bias" to the computer. The Interactive Buffer is then initialized by the computer and is put into its primary data entry mode - either BUFFER mode or COMPOSE mode. If COMPOSE mode is set, once the data has been entered into the buffer it is sent to the computer, and REFRESH mode is set. REFRESH mode is entered directly from BUFFER mode. The buffer contents are then refreshed on the terminal screen and may, if desired, be relocated around the terminal screen, by first switching the relocator ON, and then using the keyboard thumbwheel controls (or attached joystick...see INSTALLATION SECTION).

An action may be selected by the operator directly at the keyboard. More often, however, it is selected by a command to the computer. For example, the operator may type one of the following instructions, followed by a carriage return to invoke a response from the computer:

For the purposes of this example:

ST	instructs the computer to enter a routine which sets the Interactive Buffer to STORE mode, and then obtains the crosshair cursor bias.
BD	instructs the computer to enter a routine which sets the Interactive Buffer to BUFFER mode directly, without a transition through NEUTRAL mode. (Only possible from REFRESH mode, via HOLD mode).
CD	instructs the computer to enter a routine which sets the Interactive Buffer to COMPOSE mode directly, without a transition through NEUTRAL mode. (Only possible from REFRESH mode, via HOLD mode).

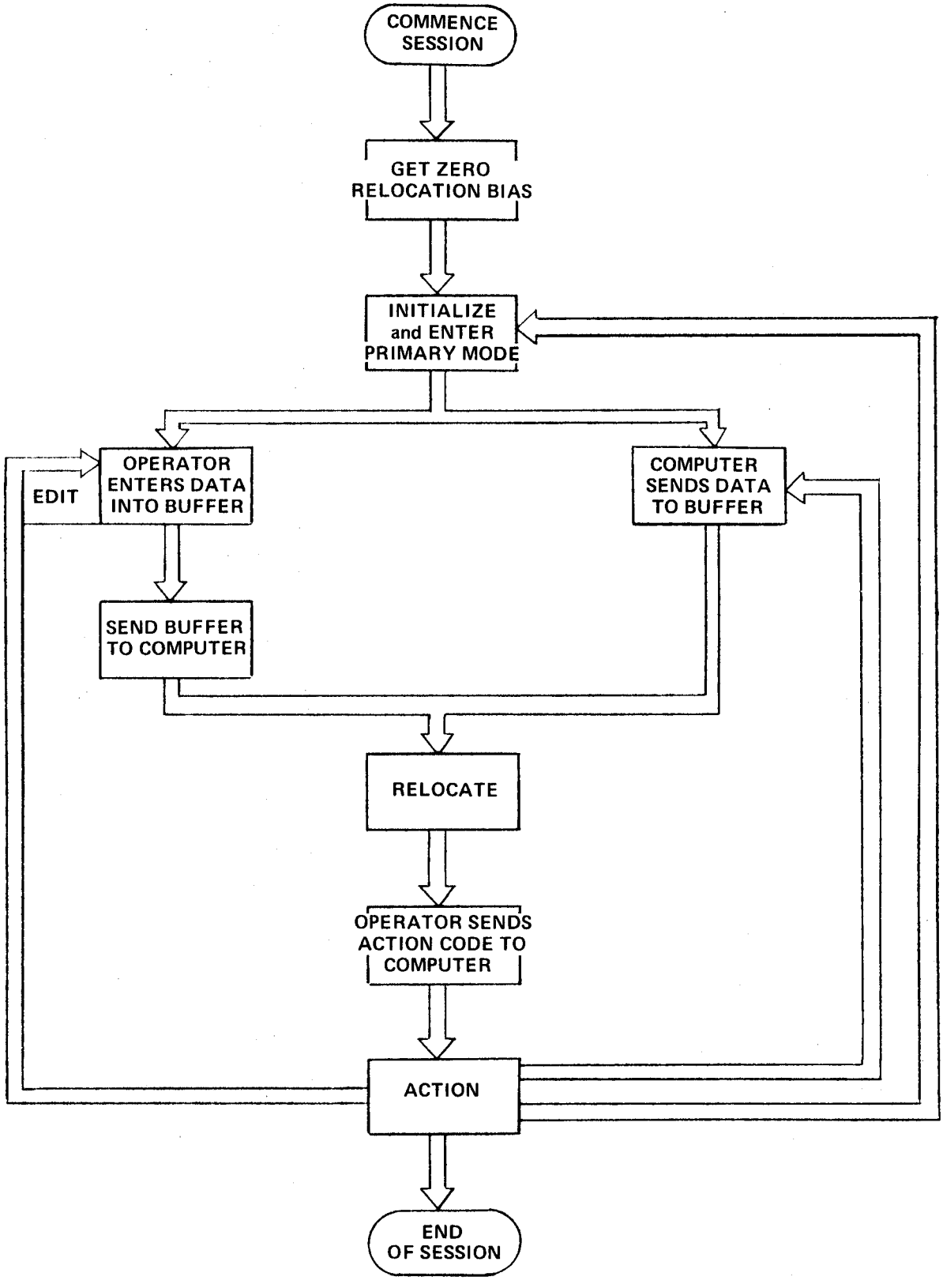


FIGURE 13. TYPICAL USER SESSION WITH THE INTERACTIVE BUFFER .

BI instructs the computer to enter a routine which sets the Interactive Buffer to COMPOSE mode via NEUTRAL mode.

CI instructs the computer to enter a routine which sets the Interactive Buffer to COMPOSE mode via NEUTRAL mode.

FI instructs the computer to enter a routine which sets the Interactive Buffer to NEUTRAL mode and finishes the session.

1. The operator enters:

   ST <CR> Store buffer contents on screen. Get "crosshair cursor bias".

- The computer sends:

  <ESC> = 3

  Waits for Line Terminator from Interactive Buffer

  <ESC><SUB>

  15 ms Delay

  <ESC><ENQ>

- The terminal automatically returns:

  Status

  Crosshair Cursor Bias

  <CR><EOT>

- The computer calculates:

  PICTURE ELEMENT RELOCATION BIAS = (CROSSHAIR CURSOR BIAS - ZERO RELOCATION BIAS)

  Picture element remains refreshed on screen awaiting a further action.

2. The operator enters:

   BD <CR> Return to buffer mode directly. The computer may add some data at the end of the buffer or by

preceding the data with <BS>'s, modify the end of the buffer.

- The computer sends:

  <ESC> = 1

3. The operator enters:

   CD <CR> Return to compose mode directly. The operator may add some data at the end of the buffer or by preceding the data with <BS>'s, modify the end of the buffer. Note that the entire buffer must be retransmitted to the computer when this mode is exited.

- The computer sends:

  <ESC> = 2

  Waits for buffer contents and Line Terminator from Interactive Buffer.

4. The operator enters:

   BI <CR> Initialize Interactive Buffer (clears buffer). Set primary data entry mode for computer.

- The computer sends:

  <ESC> = 0

  <ESC> = 1

5. The operator enters:

   CI <CR> Initialize Interactive Buffer (clears buffer). Set primary data entry mode for operator

- The computer sends:

  <ESC> = 0

  <ESC> = 2

  Waits for buffer contents and Line Terminator from Interactive Buffer.

6. The operator enters:

   FI <CR> Initializes Interactive Buffer. Ends session.

- The computer sends:

  <ESC> = 0

USE OF INTERACTIVE BUFFER WITH STORAGE PERIPHERALS

The Interactive Buffer may be used with data storage and graphic input peripherals. However, the possible combinations of operating modes are many and care should be taken when selecting these modes.

In the next few pages, operating instructions for the Interactive Buffer with 4 Tektronix peripherals are given: I. The 4921/22 Flexible Disc Memory Unit; II. The 4923 and 4923 Opt. 1 Digital Cartridge Tape Recorder; III. The 4952 Joystick; and IV. The 4953/54 Graphics Tablet. Each instrument is dealt with separately for convenient user reference.

NOTE

COMPOSE mode is used for preparing data for storage, and the data is sent to the disc or tape via COMP DUMP mode.

BUFFER mode is generally used when a storage peripheral sends data to the Interactive Buffer. However, COMPOSE mode is always used with graphic input peripherals.
(See Fig.

I. 4921/22 FLEXIBLE DISC MEMORY UNIT.

TO the DISC. One of the following sequences may be used for sending data to the disc. Tables for program control (ON LINE with LOCAL ECHO) and manual control (LOCAL) are given.

I. 4921/22 Flexible Disc Memory Unit (cont.)

To the Disc.

ON LINE with LOCAL ECHO			
Sequence of Operations	Performed by	Action Taken	See Notes
ARM DISC UNIT	Computer/ Operator	ENTER: <ESC> &	
		SELECT: WRITE Data Transfer is between Disc & Term. only.	1
		DEFINE: Track number and Sector	2
SET COMPOSE	Computer/ Operator	ENTER: <ESC> = 2	
CSUP IS ACTIVE	Operator	ENTER: Data <DC2><BS><CR>	3
SET COMP DUMP	Buffer	Data and Line Terminator are Sent to Disc.	
KEYBOARD LOCKED; LED LIT; SET REFRESH CLOSE	Computer/ Operator	ENTER: <DC4><ESC> = Ø <ESC> 7	

NOTES:

1. This is the Read/Write Command sequence as outlined in Section 2 of the 4921/22 Flexible Disc Memory Unit User's Manual (P.N. 070-1758-00).

2. When defining track numbers, the user should always use two digits (i.e. Ø1, Ø9, 21, etc.).

3. <DC2> sets Disc Unit to start receiving data. <BS> removes the <DC2> from the buffer. <CR> causes data to be sent to the Disc Unit. Neither <BS> nor <CR> are sent to the Disc Unit since terminal minibus signal CSUP is active when they are generated.

I. 4921/22 Flexible Disc Memory Unit (cont.)

To the Disc.

TERMINAL in LOCAL			
Sequence of Operations	Performed by	Action Taken	See Notes
ARM DISC UNIT	Operator	DEFINE: Track Number	
SET COMPOSE	Operator	ENTER: <ESC> = 2	
CSUP IS ACTIVE	Operator	DEPRESS: START	1
		ENTER: Data <CR>	
SET COMP DUMP; KEYBOARD LOCKED; LED LIT	Buffer	Data and Line Terminator are sent to Disc.	
SET REFRESH; CLOSE FILE	Operator	DEPRESS: CLOSE	1

NOTES:

1. Located on the front panel of the 4921 or 4922 Disc Unit.

I. 4921/22 Flexible Disc Memory Unit (cont.)

FROM THE DISC. Following are the sequences used for receiving data from the disc. Tables for program control (ON LINE with LOCAL ECHO) and manual control (LOCAL) are given.

ON LINE with LOCAL ECHO			
Sequence of Operations	Performed by	Action Taken	See Notes
ARM DISC UNIT	Computer/ Operator	ENTER: <ESC> &	1
		SELECT: Read Disc and Terminal Only	1
		DEFINE: Track Number and Sector	2
SET BUFFER	Computer/ Operator	ENTER: <ESC> = 1	
KEYBOARD LOCKED; LED LIT	Computer	ENTER: <DC1>	3
SET REFRESH	Disc	Data is set to Buffer	
		ENTER: <CR>	4

NOTES:

1. This is the Read/Write Command sequence as outlined in Section 2 of the 4921/22 Flexible Disc Memory Unit User's Manual (P.N. 070-1758-00).
2. When defining track numbers, the user should always use two digits (i.e. Ø1, Ø9, 21, etc.).
3. <DC1> must be supplied by the computer since the terminal keyboard is locked at this time.
4. <CR> must be present on the disc file, since the terminal keyboard is locked at this time.

I. 4921/22 Flexible Disc Memory Unit (cont.)

From the Disc.

TERMINAL in LOCAL			
Sequence of Operations	Performed By	Action Taken	See Notes
ARM DISC UNIT	Computer/ Operator	DEFINE: Track Number	1
SET BUFFER	Operator	ENTER: <ESC> = 1	
KEYBOARD LOCKED; LED LIT	Operator	DEPRESS: START	2
SET REFRESH	Disc	Data is sent to Buffer.	
		ENTER: <CR>	3

NOTES:

1. When defining Track numbers, the user should always use two digits (i.e. Ø1, Ø9, 21, etc.).
2. Located on the front panel of the 4921 or 4922 Disc Unit.
3. <CR> must be present on the disc file, since the terminal keyboard is locked at this time.

II. 4923 DIGITAL CARTRIDGE TAPE RECORDER (Standard)

TO THE TAPE. The following sequence of operations may be used for sending data to the tape. When sending to the tape, the terminal is operated in LOCAL mode only.

TERMINAL in LOCAL			
Sequence of Operations	Performed by	Action Taken	See Notes
SET COMPOSE	Computer/ Operator	ENTER <ESC> = 2	
CSUP IS ACTIVE	Operator	DEPRESS: WRITE and RUN	1
		ENTER: DATA <CR>	
SET COMP DUMP; KEYBOARD LOCKED; LED LIT	Buffer	Data and Line Terminator are sent to Tape.	
SET REFRESH; FILE WRITTEN	Operator	DEPRESS: STOP	1

NOTES:

1. Located on front panel of unit.

II. 4923 Digital Cartridge Tape Recorder (cont.)

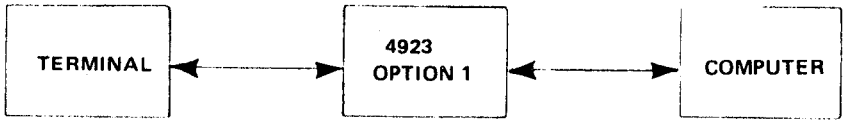
FROM the TAPE. With the terminal in LOCAL or ON LINE, and with LOCAL ECHO, the following sequence may be used.

TERMINAL IN LOCAL or ON LINE with LOCAL ECHO			
Sequence of Operations	Performed by	Action Taken	See Notes
SET BUFFER	Computer/ Operator	ENTER: <ESC> = 1	
KEYBOARD LOCKED; LED LIT	Operator	DEPRESS: RUN (twice)	1
	Tape	Sends Data to Buffer and to Computer	
SET REFRESH	Buffer	ENTER: <CR>	2

NOTES:

1. Located on front panel of unit.
2. <CR> must either be supplied by computer, or be present on the tape file, since the terminal keyboard is locked at this time.

II. 4923 DIGITAL CARTRIDGE TAPE RECORDER (Option 1).



NOTE

The 4923 Option 1 Digital Cartridge Tape Recorder is only ON LINE to the computer when the ON LINE button on the Tape Unit is depressed.

TO THE TAPE. The following sequence may be used when sending data to the tape. The Terminal must be placed ON LINE with LOCAL ECHO.

ON LINE with LOCAL ECHO			
Sequence of Operations	Performed by	Action Taken	See Notes
SET COMPOSE	Computer/ Operator	ENTER: <ESC> = 2	
CSUP IS ACTIVE	Operator	DEPRESS: WRITE and RUN	1
		ENTER: Data <CR>	
SET COMP DUMP; KEYBOARD LOCKED; LED LIT; SET REFRESH	Buffer	Data and Line Terminator are Sent to Tape and to Computer	
FILE WRITTEN	Operator	DEPRESS: STOP	1

NOTES:

1. Located on front panel of unit.

II. 4923 Digital Cartridge Tape Recorder, Option 1 (cont.)

FROM the TAPE. Placing the terminal ON LINE with LOCAL ECHO, the following sequence may be used to receive data from the tape.

ON LINE with LOCAL ECHO			
Sequence of Operations	Performed by	Action Taken	See Notes
SET BUFFER	Computer/ Operator	ENTER: <ESC> = 1	
KEYBOARD LOCKED; LET LIT	Operator Tape	DEPRESS: RUN (twice) Sends Data to Buffer and to Computer	1
SET REFRESH	Buffer	ENTER: <CR>	2

NOTES:

1. Located on front panel of unit.
2. <CR> must either be supplied by computer, or be present on tape file, since the terminal keyboard is locked at this time.

III. 4952 JOYSTICK

In normal operation, the 4952 Joystick replaces the keyboard thumbwheel in controlling the crosshair cursor. With the Interactive Buffer, however, the Joystick may also control relocation.

IV. 4953 and 4954 GRAPHICS TABLET

NOTE: If the Graphics Tablet communicates directly with the Terminal and the Interactive Buffer, without local storage, then no modification to the Control Card is required. The Control Card provides the necessary signals for local terminal display of graphic information. If a computer is processing Graphics Tablet data, it (the Computer) can supply the necessary control characters for proper Terminal display.

However, if the Graphics Tablet is storing information locally, (i.e., 4923/22 Flexible Disc, 4923 Digital Cartridge Tape Recorder) the Control Card needs to be modified. When the locally-stored data is sent back to the Terminal, the Control card no longer provides display control signals, and the Terminal cannot correctly interpret the data. The modification rectifies this situation by encoding additional display information in the two most significant bits of each byte sent from the Graphics Tablet Control card.

If this modification is needed, contact the nearest Tektronix field office for assistance.

IV 4953 and 4954 Graphics Tablet (cont.)

FROM the TABLET. The Graphics Tablet can be programmed to operate in a number of different modes (i.e. TRACKING mode, MULTI-POINT mode, SINGLE-POINT mode, LOCAL COPY mode, etc.). As an example, the following sequence may be used to enter TRACKING mode data into the Interactive Buffer. The terminal may be in LOCAL or ON LINE and with LOCAL ECHO.

Entering TRACKING mode data into the Buffer:

TERMINAL in LOCAL or ON LINE with LOCAL ECHO			
Sequence of Operations	Performed By	Action Taken	See Notes
ARM TABLET	Computer/ Operator	ENTER: <ESC> !	1
		SELECT: 10-bit, Tracking, No Local Copy, and Disable on Leaving Presence	
SET COMPOSE	Computer/ Operator	ENTER: <ESC> = 2	
CSUP IS ACTIVE	Tablet	Data is Sent to the Buffer	2
	Operator	ENTER: <CR>	
SET COMP DUMP; KEYBOARD LOCKED; LED LIT; SET REFRESH	Buffer	Data and Line Terminator are Sent to the Computer.	

NOTES:

1. This is the ASCII Tablet Arming Character. See Graphics Tablet Instruction Manual, Section 2 (P.N. 070-1791-00).
2. Care must be taken not to overfill the buffer; data past 1023 characters will be lost.

LIST OF PARTS

Following is a list of the parts which make up Custom Modification 018-0120-00. These parts are available through Tektronix, Inc.

Quantity or Circ. No.	Description	Part Number
1	Interactive Buffer board	CM 670-4986-00
5	Jumper Strap	131-0993-00
K491, K495	Relay, Reed	148-0086-00
2	Diode, IN4152	152-0141-02
U165	Integrated Circuit (I.C.) SN7474N	156-0041-00
U75	I.C. SN7404N	156-0058-00
U281	I.C. SN7496N	156-0073-00
U355, U455, U465	I.C. SN7416N	156-0093-00
U21, U25, U141	I.C. SN7485N	156-0123-00
U225	I.C. SN7408N	156-0129-00
U341,435,445,451	I.C. SN7438N	156-0145-00
U395	I.C. MC 1458	156-0158-00
U205,215,221,305, 315,405,415	I.C. Intel 2102	156-0291-00
U51,265,421,475,481	I.C. SN74LS00N	156-0382-00
U325,351,381,441	I.C. SN74LS04N	156-0385-00
U175,345,365	I.C. SN74LS10N	156-0386-00
U45,55,65,155 181,275,321	I.C. SN74LS74N	156-0388-00
U5,35,125,	I.C. SN74LS193N	156-0412-00
U335	I.C. SN74LS20N	156-0464-00
U425	I.C. SN74LS30N	156-0465-00
U235	I.C. SN74LS32N	156-0479-00
U81,255,375	I.C. SN74LS08N	156-0480-00
U251	I.C. SN74LS11N	156-0481-00
U151	I.C. 96L02	156-0487-00
U291,391	I.C. NE531V	156-0511-00

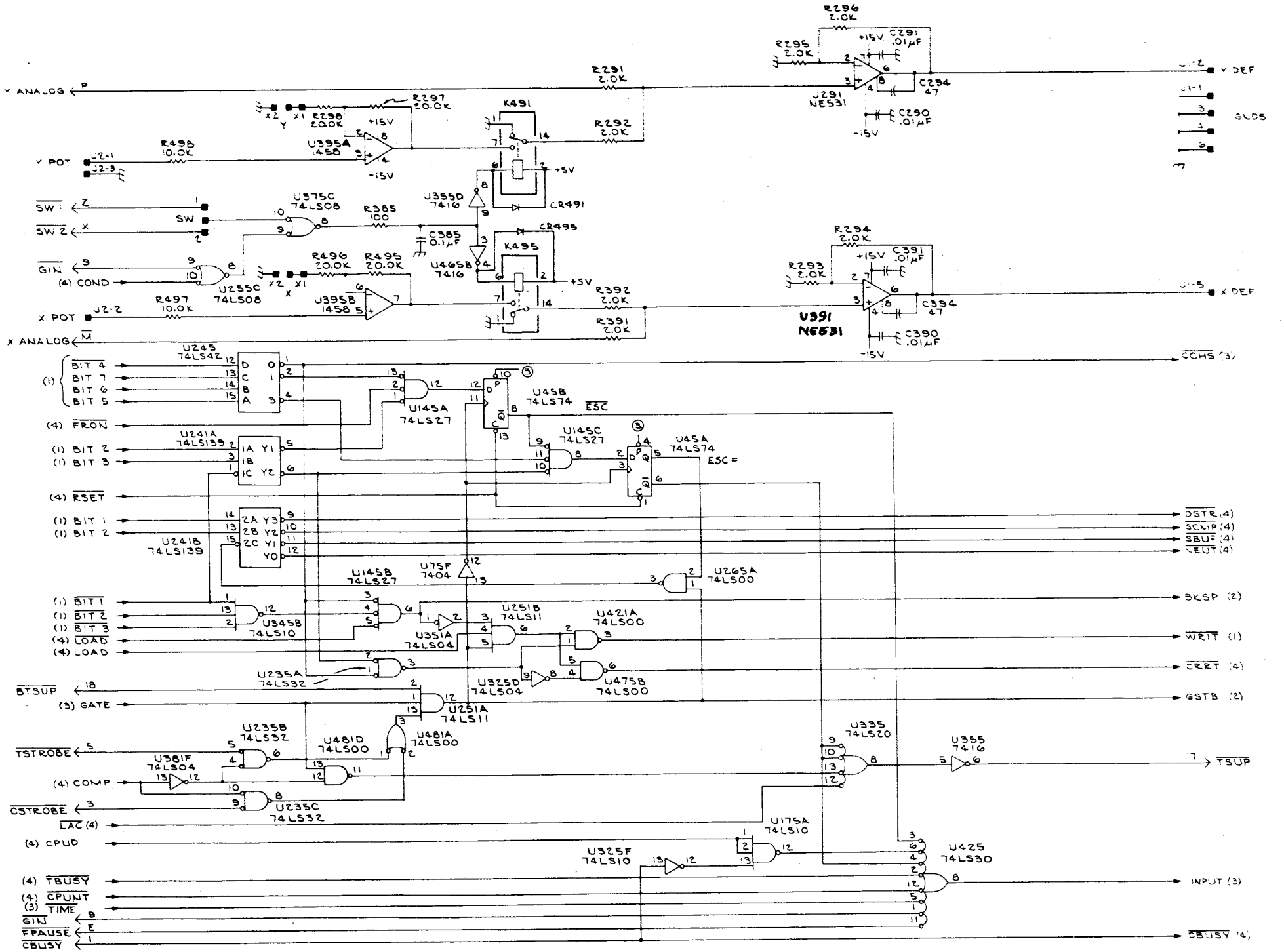
CM 018-0120-00
Interactive Buffer

PARTS LIST (cont.)

Quantity or Circ. No.	Description	Part Number
	Interactive Buffer board (cont)	
U105,U115,U121	I.C. SN74LS157N	156-0530-00
U241	I.C. SN74LS139N	156-0541-00
U15,135	I.C. SN74393N	156-0617-00
U145	I.C. SN74LS27N	156-0718-00
U41,245	I.C. SN74LS42N	156-0736-00
C294,394	Capacitor 47pf 500V	281-0518-00
C145	Capacitor 100pf 500V	281-0523-00
C385	Capacitor .1µf 50V	283-0111-00
C15,35,55,81,121, 155,215,235,245,281, 325,355,415,435,451, 475	Capacitor .47µf 50V	283-0203-00
C151	Capacitor 2µf 50V	283-0212-00
C290,291,390,391	Capacitor .01µf 50V	283-0238-00
C454,455	Capacitor 1µf 35V	290-0522-00
R451,452	Resistor ¼w 5% 2.7Ω	307-0103-00
R385	Resistor ¼w 5% 100Ω	315-0101-00
R145	Resistor ¼w 5% 20K	315-0203-00
R301,303,401,403	Resistor ¼w 5% 4.7K	315-0472-00
R51	Resistor ¼w 5% 51K	315-0513-00
R291,292,293,294, 295,296,391,392	Resistor 1/8w .1% 2K	321-0222-07
R497,498	Resistor 1/8w 1% 10K	321-0289-00
R297,298,496,495	Resistor 1/8w 1% 20K	321-0318-00
1	Data Delay board	CM 670-5049-00
C1,C2	Capacitor .01µf 50V	283-0238-00
U1	I.C. SN74121N	156-0072-00

PARTS LIST (cont.)

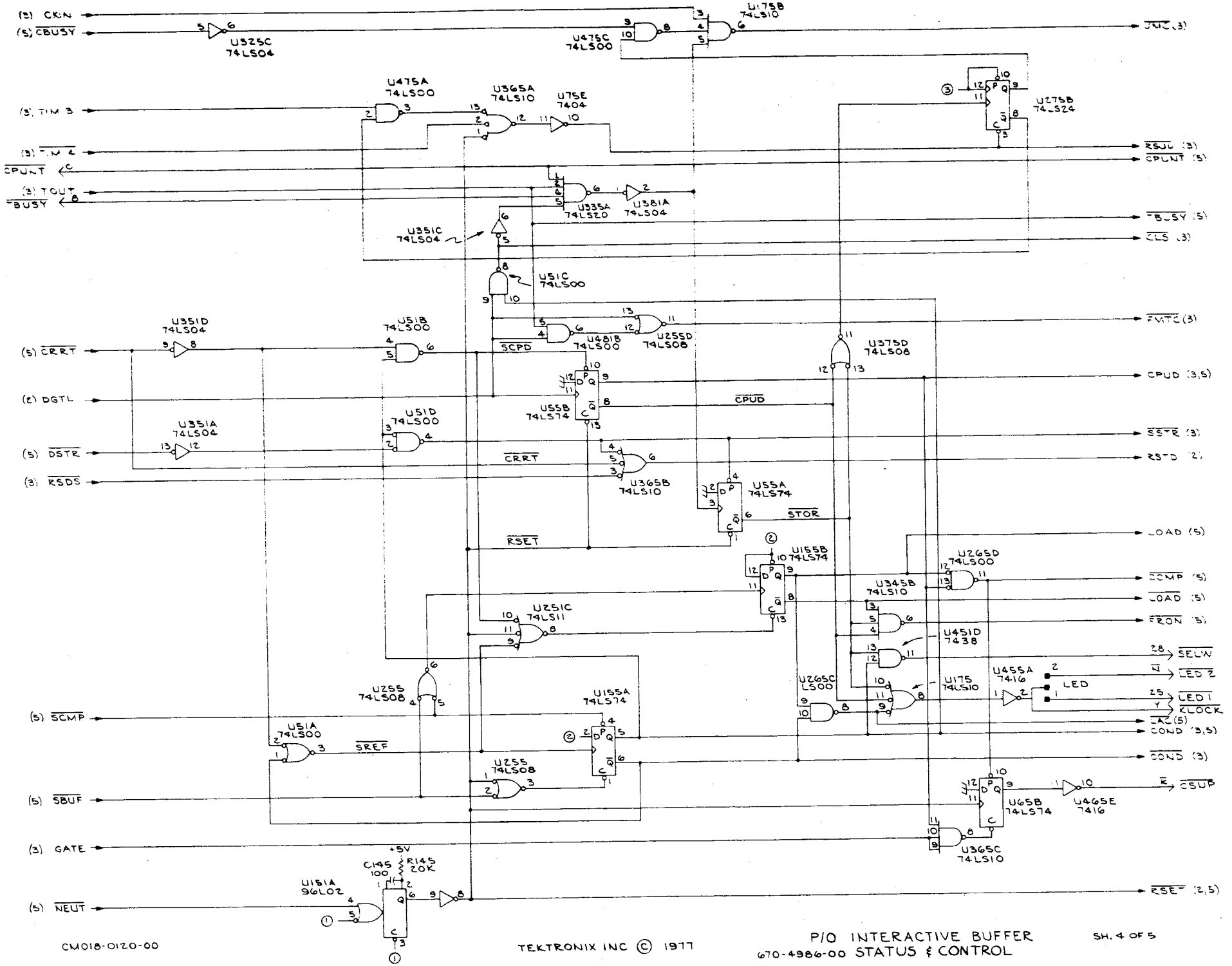
Quantity or Circ. No.	Description	Part Number
	Miscellaneous Parts	
1	Nylon Spacer	129-0222-00
1	Tubing, approximately 2"	162-0025-00
1	Wire Kit	198-3608-00
2	Capacitor .01µf 50V	283-0220-00
1	Resistor ¼w 5% 1K	315-0102-00
1	Operational Amplifier, H2-2655-5	156-0977-00



CM018-0120-00

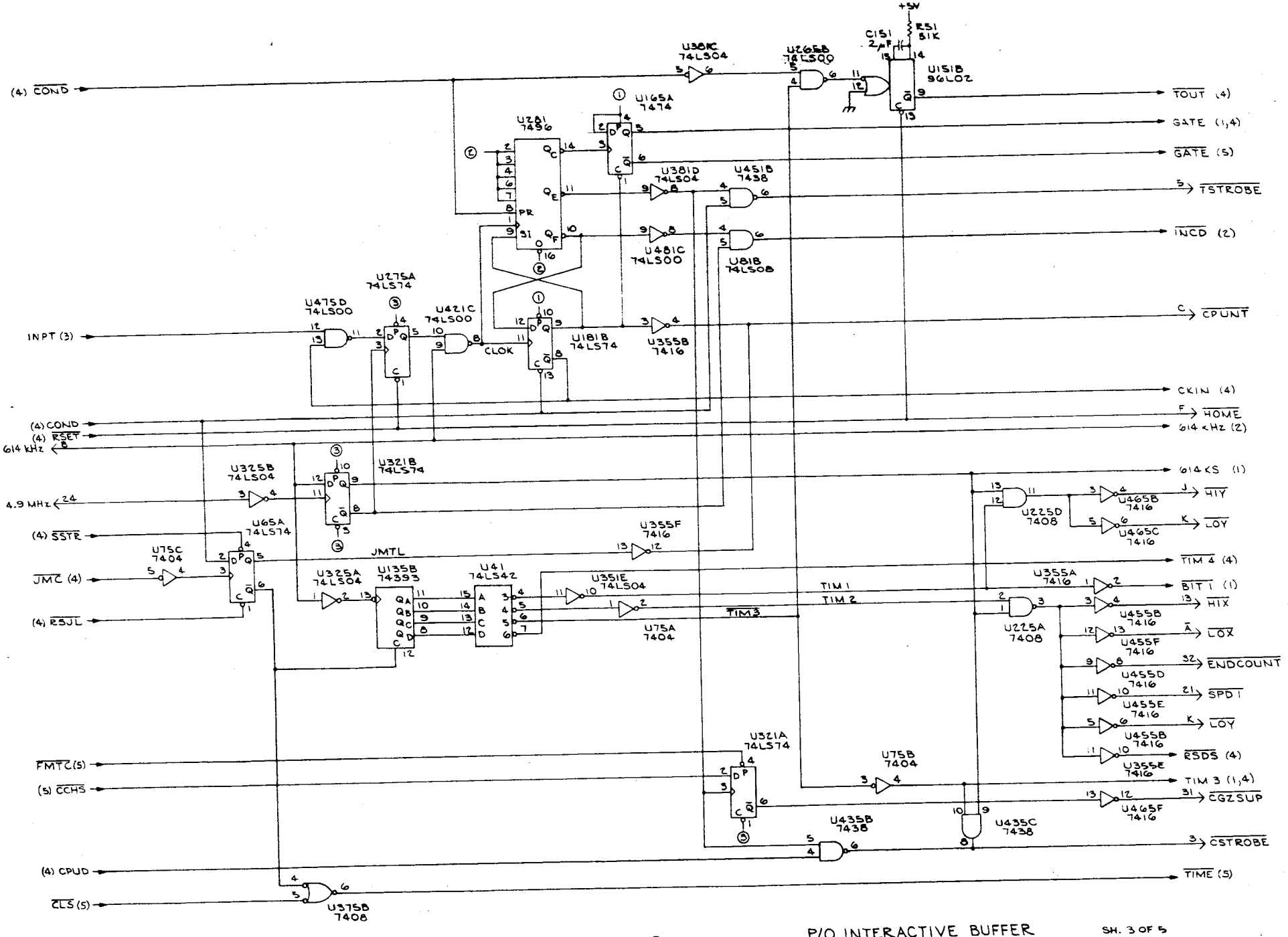
670-4986-00

P/O INTERACTIVE BUFFER
RELOCATOR & INPUT DECODE



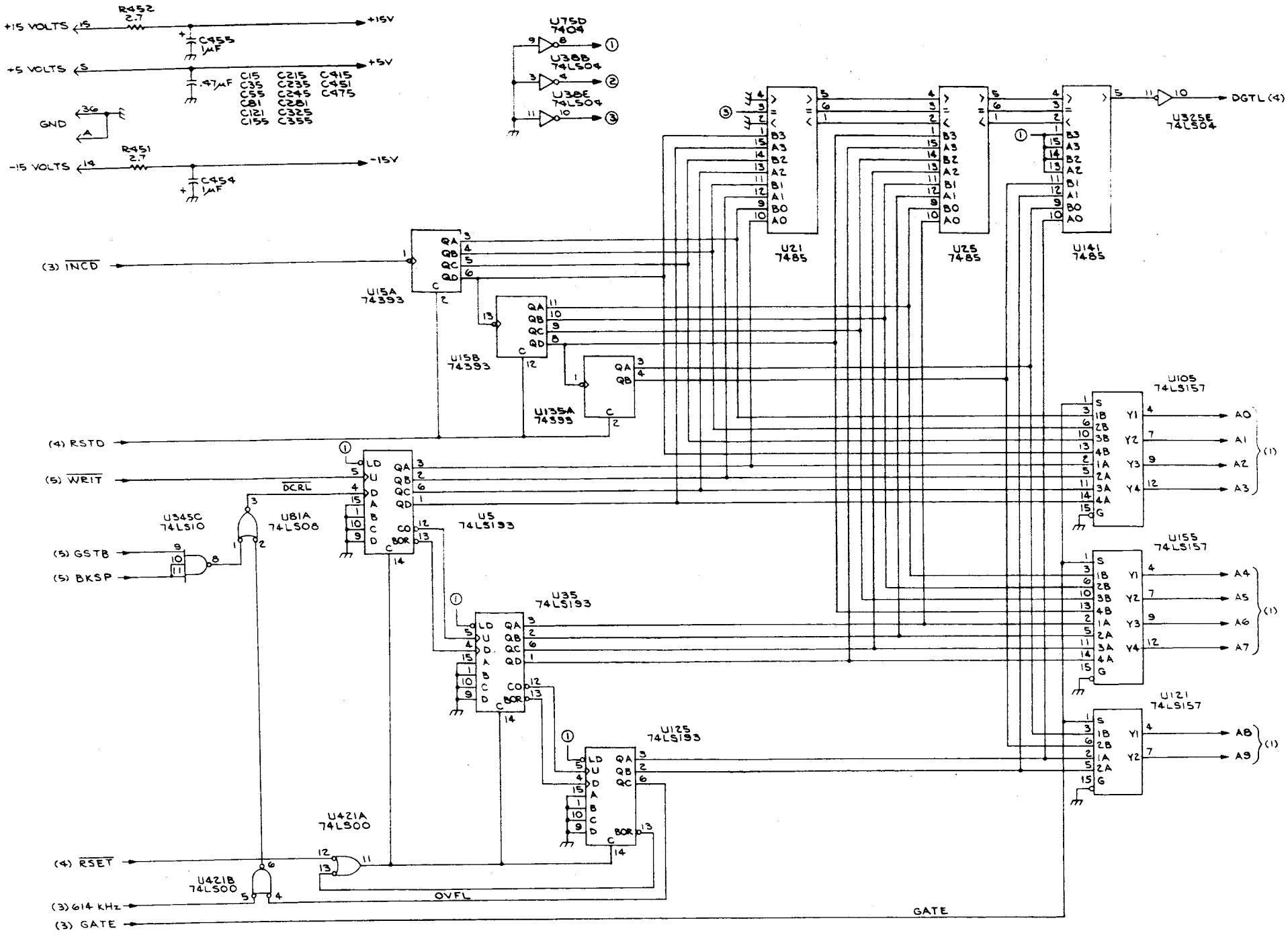
CM018-0120-00

P/O INTERACTIVE BUFFER
670-4986-00 STATUS & CONTROL



CM018-0120-00

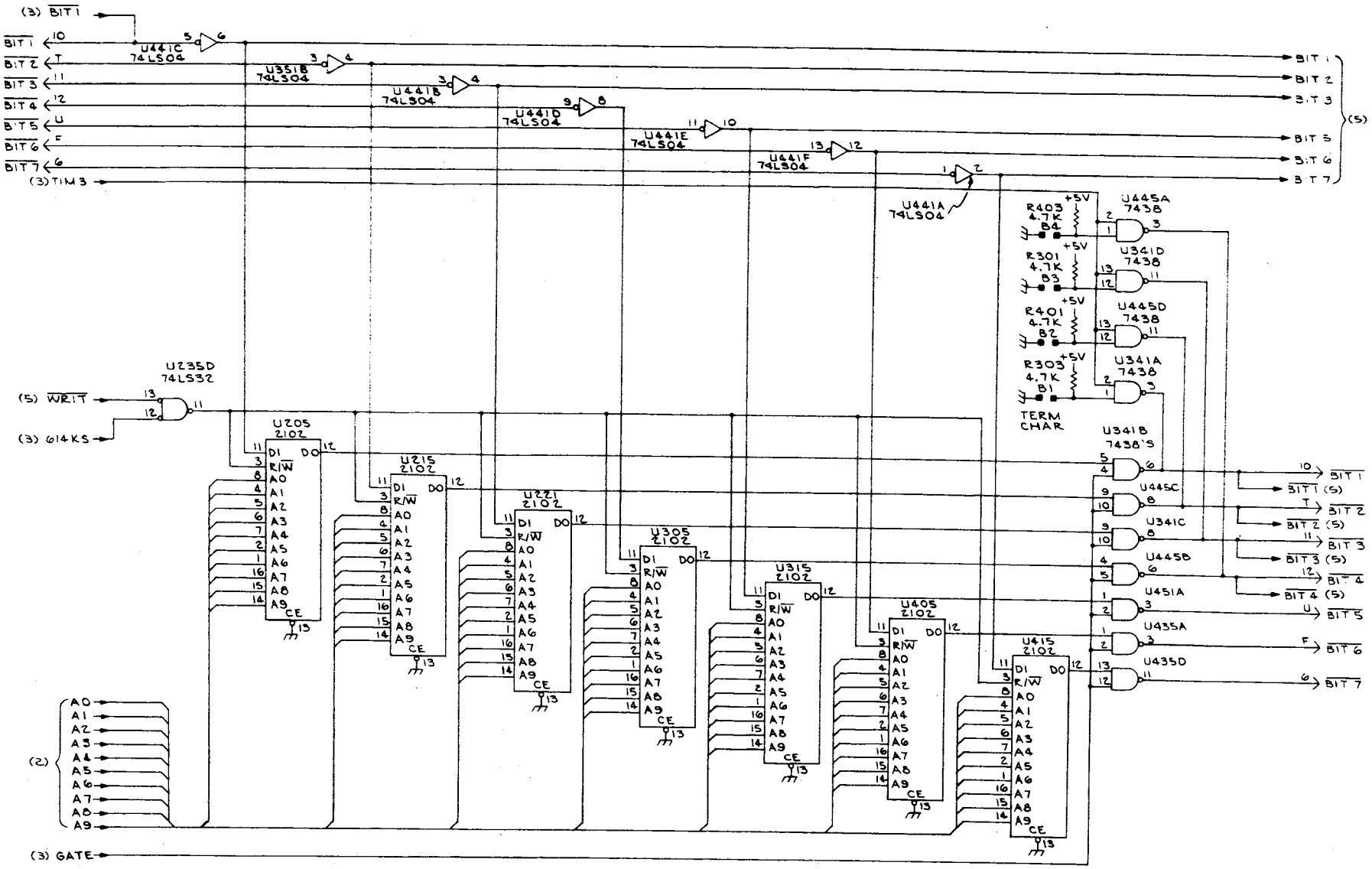
P/O INTERACTIVE BUFFER
670-4986-00 SUPPRESS & OUTPUT SEQUENCE



CM018-0120-00

670-4986-00

P/O INTERACTIVE BUFFER ADDRESS CONTROL



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P/O INTERACTIVE BUFFER MEMORY
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