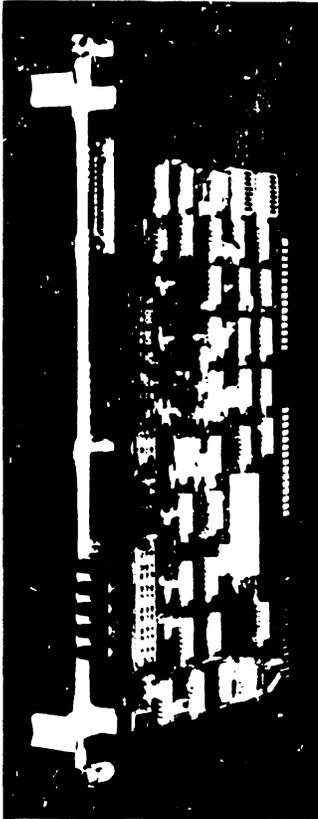


EDITED BY CUSTOMER ENGINEERING DIVISION

## MODEL 2207A & 2227 CONTROLLERS



**MODEL 2207A  
TELETYPE  
CONTROLLER**



**MODEL 2227  
TELECOMMUNICATIONS  
CONTROLLER**

The 2207 controller has been made obsolete by the 2207A. However, the only added feature on a 2207A controller is the selectable baud rate switch bank. Therefore, all 2207A information contained herein also applies to 2207 controllers (except where reference is made to selectable baud rates).

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Printed in U.S.A.  
13-210A

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## 1. DESCRIPTION - 2207A

### 1.1 GENERAL

The Model 2207A I/O Interface Controller provides the capability to interface a WANG 2200B CPU with a Teletype<sup>®</sup> or Teletype compatible peripheral, terminal, or laboratory instrument, provided that the Teletype/Teletype compatible equipment is also compatible to the Electronics Industries Association standard RS-232-C<sup>1</sup>. Signal rates up to 1200 baud are possible to and from the CPU and external device via the 2207A controller.

This option is available with the 2200A CPU; however, neither paper tape punch nor paper tape reader is operable with the limited command structure of the 2200A. The 2207A controller can operate with *full* I/O capabilities when used with a 2200B CPU. Commands are provided in the 2200B language specifications which allow paper tape punch/read operations.

The 2207A operates at selectable signal rates of 110, 150, 300, 600 and 1200 baud (asynchronous) with either of the following code formats:  
a) 1 start bit, 8 data bits, 2 stop bits (BINARY); or b) 1 start bit, 7 data bits plus an even parity bit, and 2 stop bits (ASCII).

In addition, a break signal from the Teletype produces a HALT/STEP command in the 2200; an ESC (Escape) character from the Teletype produces a RESET command in the 2200. Thus, the Teletype unit may perform complete keyboard operations with the 2200.

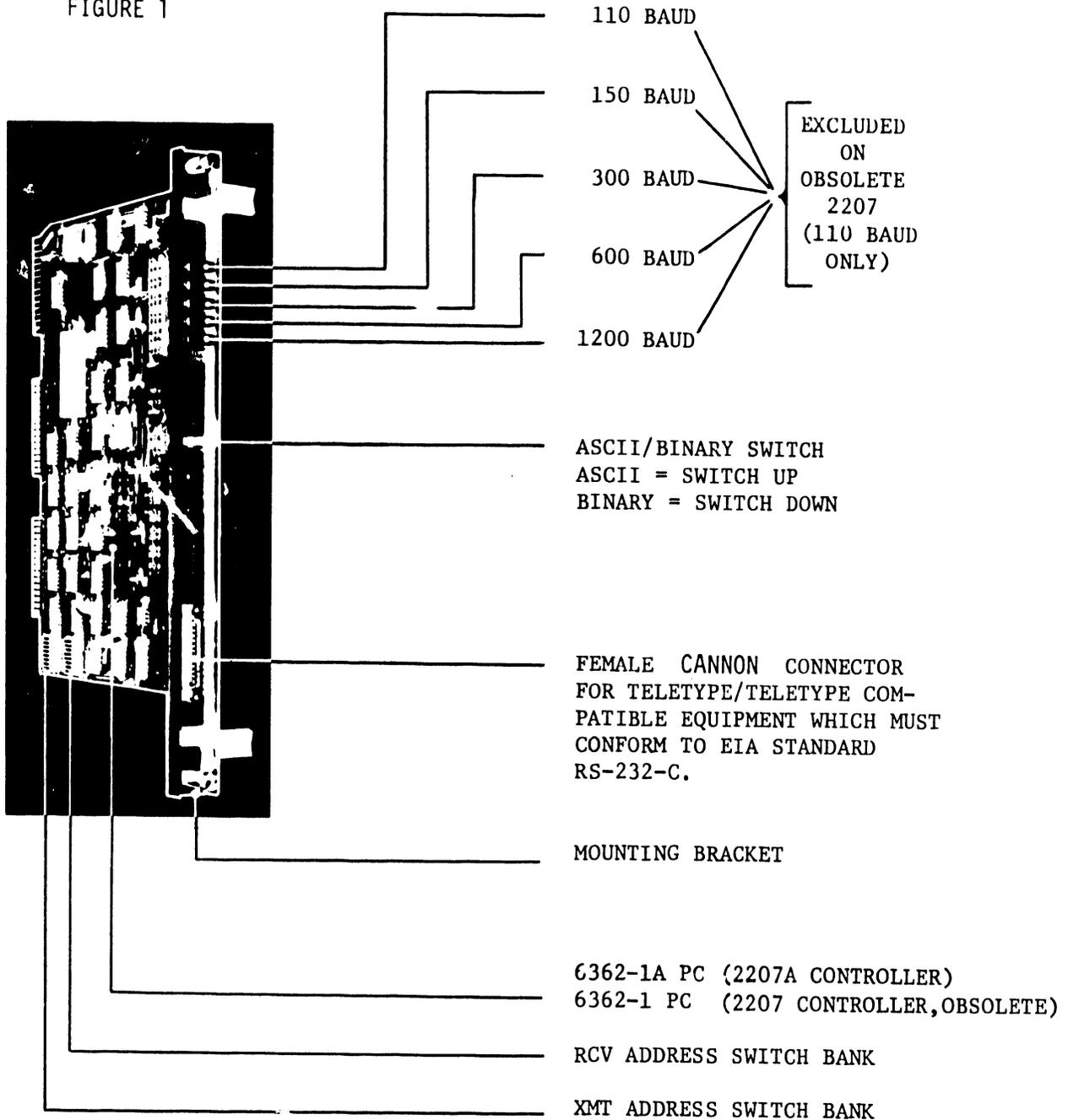
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<sup>1</sup> See *Product Service Teleprocessing Guide*, page 76.

<sup>®</sup> Registered Trademark; Teletype Corporation.

1.2 IDENTIFICATION DIAGRAM - 2207A

FIGURE 1



1.3 CONNECTOR J1 PIN ASSIGNMENTS FOR 2207A

J1 PIN NUMBERS	CIRCUIT	DESCRIPTION	TO TTY	FROM TTY	GROUND
1	AA	Protective Ground			X
2	BA	Transmitted Data		X	
3	BB	Received Data	X		
4	-				
5	CB	Clear To Send	X		
6	CC	Data Set Ready	X		
7	AB	Signal Ground (Common Return)			X
8	CF	Received Line Signal Detector	X		
9	-				
10	-				
11	-				
12	-				
13	-				
14	-				
15	-				
16	-				
17	-				
18	-				
19	-				
20	CD	Data Terminal Ready		X	
21	-				
22	-				
23	-				
24	-				
25	-				

## 1.4 SPECIFICATIONS

### Electrical Connector:

Receives Cannon 25 pin male connector, #DB-25P. (Not supplied by Wang Laboratories.)

### Maximum Cable Length:

50 feet (15.2 meters)

### Code Format (Selectable):

- (a) 1 start bit, 8 data bits, 2 stop bits
- (b) 1 start bit, 7 data bits, even parity bit and 2 stop bits.

### Transmission Rate:

Selectable baud rates of 110, 150, 300, 600 and 1200, all asynchronous.

### Special Features:

Decodes Teletype BREAK signal into a HALT/STEP command in the System 2200;  
Decodes Teletype ESCAPE (ESC) character into a RESET command in the System 2200.

**NOTE:**

Conversion of Teletype equipment to EIA standard RS-232-C is accomplished by customer. Contact parts and service division of Teletype Corp., Skokie, Illinois. Tel: 312-982-2206.

## 2. DESCRIPTION - 2227

### 2.1 GENERAL

The Model 2227 Telecommunications Controller for the WANG System 2200 consists of a controller board which plugs directly into an I/O slot in the CPU (Central Processing Unit) chassis and a 12 foot connector cable (3.6 meters). See Figure 1.

With the Model 2227 controller card, connector cable, and a compatible modem or acoustic coupler, the System 2200 can be used as a telecommunications terminal for data transmission over voice-grade telephone lines. If the System 2200 is connected to a Bell 103A, a Bell 103A3 (if auto-answer is required), or an equivalent modem, data transmission rates up to 300 baud are feasible. Using a Bell 202C or equivalent modem, data transmission rates up to 1200 baud are feasible.

Transmission rate is one of the switch selectable features of the Model 2227. Rates of 110, 150, 300, 600, or 1200 baud can be selected.

Over direct-connection lines (using a WANG Model 2227-N null modem or equivalent) data transmission rates up to 1200 baud are feasible for communications between two System 2200 Central Processing Units or between one System 2200 and a compatible computer.

Character formatting is another switch selectable feature on the Model 2227 controller board. Control over the following elements of character formats is provided: the number of data bits, parity checking, odd or even parity, and the number of stop bits.

The Model 2227 Telecommunications Controller is designed to be compatible with the widely used EIA (Electronics Industry Association) standard RS-232-C (See *Product Service Telecommunications Guide*, page 76).

The controller card can receive a 25-pin RS-232-C male plug. Each end of the connector cable provided with the board, contains one RS-232-C male plug. One end of the cable plugs into the Model 2227 board. The other end plugs into a Bell 103A modem or into any 103A/RS-232-C compatible data set or acoustic coupler.

The current method of program control limits data transmission to the half duplex mode. However, when using the Model 2227 and a modem equipped with a full/half duplex switch, the modem switch must be set to the full duplex position. The Bell 103A is a full duplex design.

The Model 2227 controller board is designed to handle asynchronous transmissions only.

The telecommunications controller card contains five "baud rate" buttons which provide switch selectable control of the data transmission rate. Available transmission rates are 110, 150, 300, 600, and 1200 baud.

Feasible transmission rates are:

- (a) 110, 150, or 300 baud over a voice-grade telephone line when the System 2200/2227 is connected to a Bell 103A compatible data set or equivalent.
- (b) 110, 150, 300, 600, or 1200 baud over a voice-grade telephone line when the System 2200/2227 is connected to a Bell 202C data set or equivalent.
- (c) 110, 150, 300, 600, or 1200 baud over a direct-connection line between two System 2200 Central Processing Units or between the System 2200 CPU and a compatible computer, if the connection is made via the WANG Model 2227-N null modem or equivalent.

Data transmission rates at the transmitting and receiving terminals must agree. Furthermore, if a Bell 100 Series modem (or equivalent) is used at the transmitting terminal, a Bell 100 Series modem (or equivalent) must be used at the receiving terminal.

The red BREAK key on the Model 2227 controller board, if depressed, sends a 200 millisecond space signal to the host CPU. The key is effective when the System 2200/2227 and the host CPU are connected via Bell 103A modems or equivalent. The break key will not function via 202C modems. The host CPU interprets the break-signal; transmission and reception are interrupted.

The Remote Break jack on the face plate of the Model 2227 controller board can be used to plug in a Break key mounted on the keyboard for greater operator convenience. This key is not standard equipment for the System 2200.

2.2 IDENTIFICATION DIAGRAM - 2227

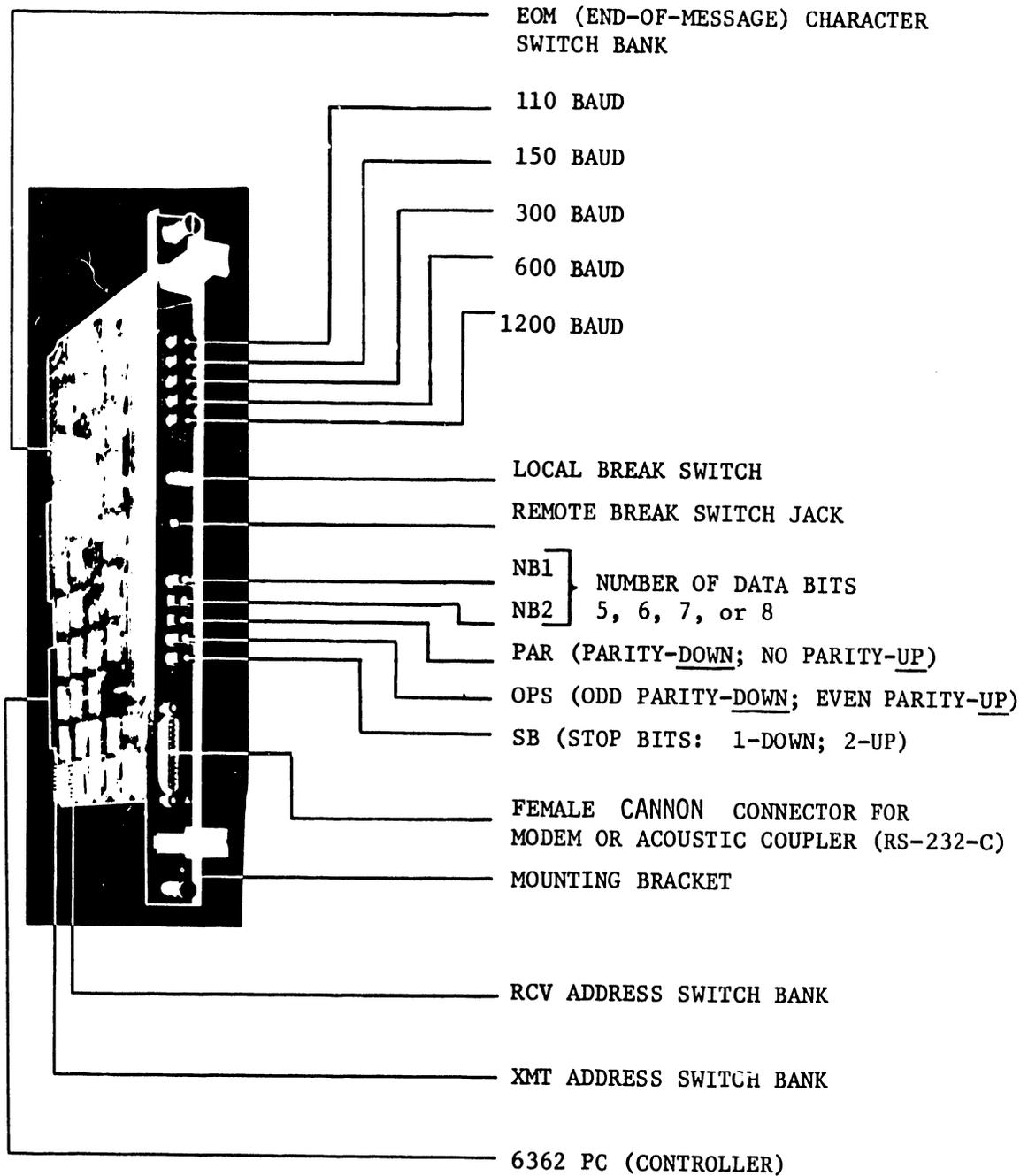


FIGURE 2

2.3 CONNECTOR CABLE PIN ASSIGNMENTS FOR 2227

PIN	CIRCUIT	FUNCTION	TO MODEM	FROM MODEM	GROUND
1	AA	Protective Ground			X
2	BA	Transmitted Data	X		
3	BB	Received Data		X	
* 4	CA	Request To Send	X		
5	CB	Clear To Send		X	
6	CC	Data Set Ready		X	
7	AB	Signal Ground			X
8	CF	Carrier Detector		X	
9	--	-			
10	--	-			
11	--	-			
12	--	-			
13	--	-			
14	--	-			
15	--	-			
16	--	-			
17	--	-			
18	--	-			
19	--	-			
20	CD	Data Terminal Ready	X		
21	--	-			
22	--	-			
23	--	-			
24	--	-			
25	--	-			

\* Not used by 103A modem.

Used only by 202C modem.

## 2.4 SPECIFICATIONS - 2227

### Electrical Connection: RS-232-C Compatible

A 25-pin RS-232-C female plug is mounted on the controller board.

A 12-foot (3.6m) cable, equipped with 25-pin RS-232-C male connectors on each end, is supplied as an accessory.

### Communication Mode:

Electronically, the Model 2227 is capable of full duplex transmission; however, current methods of program control in the System 2200 limit data transmission to the half duplex mode (alternate one-way-at-a-time independent transmission between a pair of terminals). The Bell 103A data set is full duplex. If an acoustic coupler equivalent to the Bell 103A data set is used, the acoustic coupler should be set in the full duplex mode.

### Transmission Mode: Asynchronous

#### Character Format Features:

- 1 Start Bit - Automatically Selected.
- 5, 6, 7, or 8 Data Bits - Switch Selectable.
- Odd, Even, or No Parity - Switch Selectable.
- 1 or 2 Stop Bits - Switch Selectable.

Transmission Rates (Switch Selectable): 110, 150, 300, 600, and 1200 baud.

### Break Key

A break key on the face plate of the controller, if depressed, sends a 200 millisecond spacing signal to the host CPU. The signal is effective when the System 2200/2227 and the host CPU are connected to Bell 103A modems or equivalent. The host CPU interprets the break signal as an interrupt and returns control to the receiving terminal. (The break key is not effective when Bell 202C modems or equivalent are used.)

## 2.5 PUSH-BUTTON SELECTABLE CHARACTER FORMAT

Five push-button switches on the telecommunications board control the character format of data transmissions. The labels on these buttons are NB1, NB2, PAR, OPS, and LSB; their functions are explained in Tables 1 and 2.

In asynchronous transmission, each character is represented by a unique train of binary bits. A start bit marks the beginning of each character train. The format of the train is defined by specifying the following information: the number of data bits; whether or not a parity check bit is included; if so, whether parity is odd or even; and the number of stop bits.

NOTE:  
Character formats at the transmitting and receiving terminals must agree.

Table gives the range of character format information in general use for asynchronous data transmission and identifies the Model 2227 switches which facilitate character formatting.

TABLE 1

CHARACTER FORMATS IN ASYNCHRONOUS TRANSMISSION			
INFORMATION	QUANTITY OR TYPE	MODEL 2227 CAPABILITY	MODEL 2227 SWITCHES
Start Bit	1	Automatic	
Data Bits	5, 6, 7, or 8	Switch Selectable	NB1, NB2
Parity	Odd, Even or No	Switch Selectable	PAR, OPS
Stop Bits	1 or 2	Switch Selectable	LSB

Table 2 contains Model 2227 push-button setting for control of character formats. In the table, the symbol D denotes the DOWN (i.e., depressed) position of a button. Similarly, U denotes the UP (i.e., released) position of a button.

The button configuration in the left column of Table corresponds to the actual configuration of the character-format-buttons on the Model 2227 controller card. The positions for buttons NB1 and NB2 are printed on the controller board just below the NB1 button as an aid when setting these buttons for 5, 6, 7, or 8 data bits (See Figure 2).

T  
A  
B  
L  
E  
  
2

Buttons	Push-Button Options*	Function
1SB	D U 1 2	Number of Stop Bits
OPS	D U Odd Even	Odd Parity Selection
PAR	D U Parity No Parity	Parity Selection
NB2 NB1	D D U U D U D U 5 6 7 8	Number of Data Bits

\* D = Down U = Up

## 2.6 MODEL 2227-N NULL MODEM

The WANG Model 2227-N Null Modem is a double connector module which reverses input/output pin assignments in the RS-232-C connector mounted on the Model 2227 Telecommunications Controller.

The standard 12-foot (3.6 meter) cable supplied with the Model 2227 Telecommunications Controller board is equipped with two RS-232-C male connectors, one on each end of the cable, wired pin one to pin one, two-to-two, etc. For data transfer to or from a System 2200/2227 via tele-

phone lines, one end of the standard cable is plugged into the female connector on the Model 2227 board; the other end of the cable is plugged into the connector on either a Bell 100 Series or a Bell 200 Series modem or a modem equivalent to one of these modems. On the other hand, for data transfer to or from a System 2200/2227 via direct connection lines, one end of the standard 12-foot cable is plugged into the Model 2227 board; the other end of the standard cable is plugged into a Model 2227-N Null Modem (or equivalent) or into a Model 2227 extension cable.

Model 2227 extension cables are available in two lengths; a 25-foot (7.6 meter) cable or a 50-foot (15.2 meter) cable. The extension cables are equipped with an RS-232-C female connector on one end and a male connector on the other end. The distance from the System 2200/2227 to the Model 2227-N Null Modem can be extended by using extension cables as shown in Figures. However, for proper transmission of data, total cabling distances should not exceed the maximum values shown. The maximum cabling distance for direct hookup of one System 2200/2227 to another System 2200/2227 via a null modem is 124 feet (37.8 meters). The maximum cabling distance for direct hookup of a System 2200/2227 to other equipment conforming to EIA standards is 50 feet (15.2 meters).

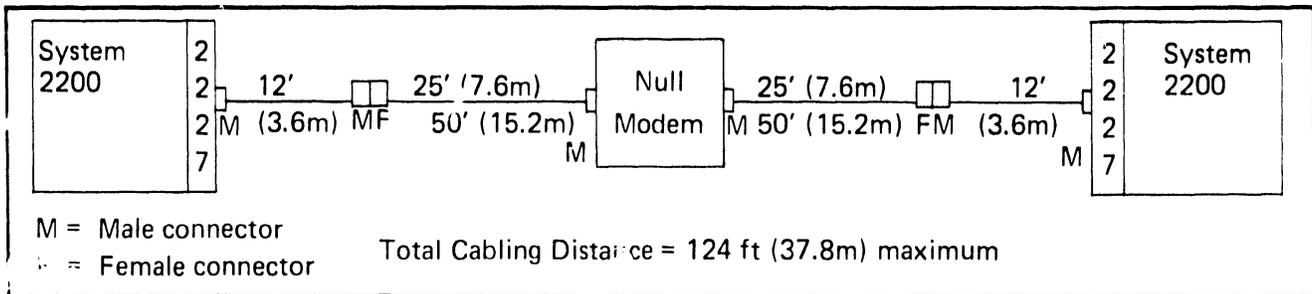


FIGURE 3 Extension Cable Configuration for System 2200/2227 to System 2200/2227 Hookup

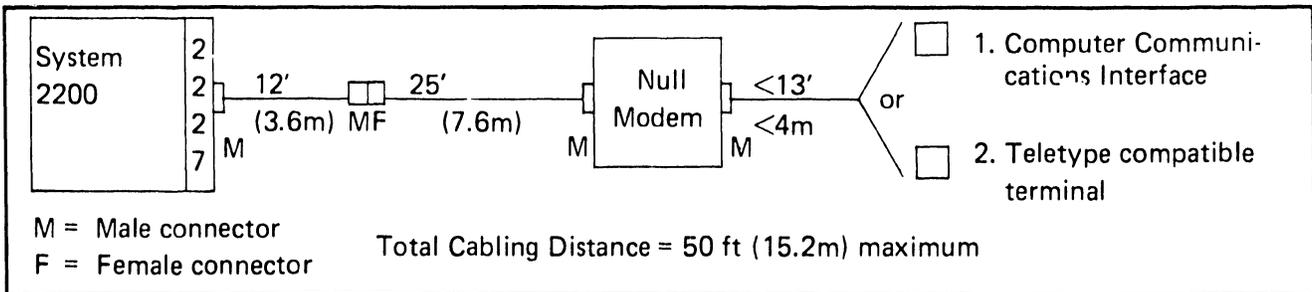


FIGURE 4 Extension Cable Configuration for System 2200/2227 Hookup to Other Equipment Conforming to EIA Standards

With the Null Modem, the following configurations are possible for the System 2200/2227:

- 1) Direct connection of two System 2200/2227's up to 124 feet (27.8 m) apart.
- 2) Direct connection to a computer which already has a cable and an RS-232-C connector capable of plugging into a Bell 103A or 202C data set.
- 3) Direct connection to a Teletype compatible terminal. The System 2200/2227/2227-N configuration can be used if there is no requirement for entering HALT/STEP or RESET from the terminal.

### 3. TRANSMISSION TIMING - 2207A/2227

Knowing the data transfer rate in baud and the total bits-per-character in the format, the transmission timing is expressable in either characters-per-second (See Table 3) or milliseconds-per-character (See Table 4)

TABLE 3 TRANSMISSION TIMING IN CHARACTERS PER SECOND

TOTAL BITS PER CHARACTER DATA RATE IN BAUD	7	8	9	10	11	12
	110	15.71	13.75	12.22	11.00	10.00
150	21.42	18.75	16.66	15.00	13.63	12.50
300	42.85	37.50	33.33	30.00	27.27	25.00
600	85.71	75.00	66.66	60.00	54.54	50.00
1200	171.42	150.00	133.33	120.00	109.09	100.00

TABLE 4 TRANSMISSION TIMING IN MILLISECONDS PER CHARACTER

TOTAL BITS PER CHARACTER DATA RATE IN BAUD	7	8	9	10	11	12
	110	63.63	72.72	81.81	90.90	100.00
150	46.66	53.33	59.99	66.66	73.33	80.00
300	23.33	26.66	30.00	33.33	36.66	40.00
600	11.66	13.33	15.00	16.66	18.33	20.00
1200	5.83	6.66	7.50	8.33	9.16	10.00

#### 4. DEVICE ADDRESS CODES - 2207A/2227

A three character device address code of the form "XYZ" is assigned to each peripheral connected to the System 2200 CPU. The first character, "X", is the device type, the next two characters, "YZ", are the device address.

A System 2200 with one Model 2207A has the following primary addresses:

INPUT/OUTPUT PROGRAM STATEMENT	PRIMARY ADDRESS (HEX XYZ) USED IN PROGRAM	RECEIVE OR TRANSMIT	RCV SWITCH SETTING (YZ)	XMT SWITCH SETTING (YZ)
DATALOAD	41D	Receive	19	1D
DATALOAD BT	41D	Receive	19	1D
LOAD	41D	Receive	19	1D
DATASAVE	41D	Transmit	n/a	1D
DATASAVE BT	41D	Transmit	n/a	1D
SAVE	41D	Transmit	n/a	1D
INPUT	019 or 219	Receive	19	n/a
KEYIN	019 or 219	Receive	19	n/a
PRINT	* 01D, 21D or 41D	Transmit	n/a	1D
HEXPRINT	01D, 21D or 41D	Transmit	n/a	1D
PRINTUSING	01D, 21D or 41D	Transmit	n/a	1D

TABLE 5

\*See explanation of *end-of-line* processing in PRINT, HEXPRINT, and PRINTUSING statements, pages 29 and 30.

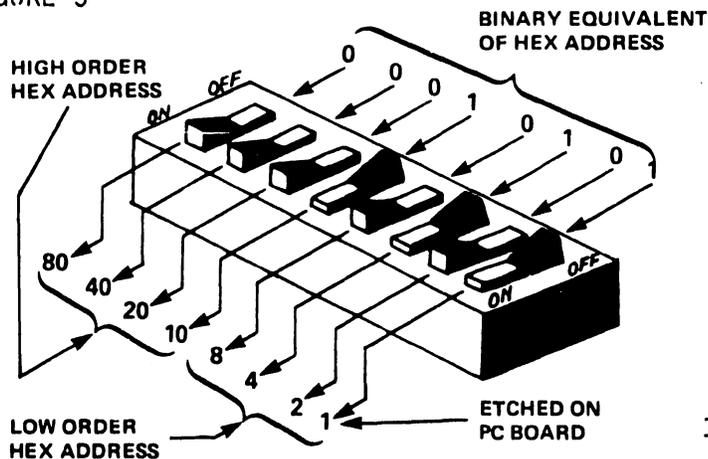
An explanation for setting device address follows:

#### MICROSWITCH SETTINGS

On the Model 2227 controller board, three component side, 8-bank rocker switches (labeled XMT, RCV, and EOM) are factory preset, or are set by a WANG Laboratories representative at the time of installation.

Only two switches (XMT and RCV) are located on the Model 2207 controller board. Figure 5 illustrates a typical 8-bank rocker switch:

FIGURE 5



**NOTE:**

- ① Only the HEX "YZ" portion of the Device Address is set into the switch bank. The "ON" side of the switch bank is noted either by a dot on one side of each rocker switch, or the word "ON" scribed on the switch casing. (See left)
- ② BINARY 0 = "OFF" side DOWN  
"ON" side UP
- ③ BINARY 1 = "OFF" side UP  
"ON" side DOWN

The EOM (End-of-Message) switch setting (Model 2227) depends on customer application. For reception of messages terminating with a HEX 11, the microswitches should correspond to the binary equivalent, shown in Table 6 (below). Any HEX 11 received, with the EOM switch set to HEX 11, will generate a carriage return code (required by the System 2200) to complete processing of INPUT statements.

If the Telecommunications planned for a Model 2227 requires no special End-of-Message character, an alternate setting for the EOM switch is HEX 0D, the carriage return code.

Failure of EOM circuitry can prematurely terminate data transfers, since recognition of an incorrect EOM character would generate a carriage return in the System 2200.

TABLE 6  
TYPICAL SETTINGS FOR EOM SWITCH

SPECIAL END-OF-MESSAGE CHARACTER	HEXADECIMAL CODE	8-BIT BINARY EQUIVALENT
X-ON	HEX (11)	00010001
CR (only carriage return)	HEX (0D)	00001101

5. 2207A,2227 INSTALLATIONS

- 1) Inspect controller pc board for damage.
- 2) Run OFF-LINE diagnostics.
- 3) If controller verifies good by off-line diagnostics, connect RS-232-C cable as follows:
  - (a) From 2207A to Teletype/ Teletype compatible equipment.
  - (b) From 2227 to modem (Bell 103A, 202C, or compatible type equipment).
- 4) Run ON-LINE diagnostics.
- 5) Turn System 2200 power off.
- 6) Set RCV and XMT switches to appropriate address, per customer requirement. (See Table 5 and Figure 5 on page 16).
- 7) Set EOM switch per customer requirement, or set to HEX 0D if customer has no special EOM character to use. (2227)
- 8) Set customer Baud rate, number of bits per character, even or odd parity, or no parity (2227).
- 9) Insert controller board in one of the I/O slots in the CPU.
- 10) Record all pertinent data (switch settings, etc.) on paper for future service calls. See typical checklist, page 71.

NOTE:

- 1) A Model 2207A controller in a system without CRT or keyboard must be set to the following address:  
RCV=HEX 001; XMT=HEX 005.
- 2) Teletype punch/reader address is HEX 405.

## 6. PROGRAMMING

### 6.1 GENERAL - 2207A/2227

The Model 2207A Teletype Interface can be used to interface a Teletype to the System 2200. In this configuration, the Teletype keyboard and printer are used in a similar manner to the System 2200 keyboard or CRT, providing the appropriate device address is selected for console input, console output, and print operations. Therefore, most console, input, and print operations which apply to a System 2200 keyboard and CRT also apply to the Teletype keyboard and printer. CRT cursor and screen control operations (cursor up, down, etc.) are not valid on a Teletype; for editing, the backarrow (+) key acts as a backspace key to delete the last character entered and the backslash (\) key acts as a line erase key. With the 2207 controller selected for ASCII, HALT/STEP and RESET are produced by the Teletype BREAK and ESC keys, respectively.

The 2207A Teletype Interface has two device addresses associated with it: one for input and one for output. For paper tape read or punch operations, the output address with device type 4 is always used. The following device addresses are used to select the Teletype.

019 (or 01A, 01B)	-	Teletype Keyboard Input
01D (or 01E, 01F)	-	Teletype Printer Output
41D (or 41E, 41F)	-	Teletype Paper Tape Read or Punch Operations

The following BASIC commands are valid for 2207A operations:

- 1) DATALOAD - Reads formatted paper tape data from Teletype in ASCII.
- 2) DATALOAD BT - Reads any format paper tape data from Teletype.
- 3) LOAD - Reads paper tape program text from Teletype.
- 4) DATASAVE - Punches paper tape data on Teletype.
- 5) DATASAVE BT - Punches paper tape on Teletype.
- 6) SAVE - Punches paper tape program text on Teletype.
- 7) INPUT - Input data from Teletype keyboard to CPU.
- 8) KEYIN - Input data from Teletype keyboard to CPU.
- 9) PRINT - Output writing on Teletype.
- 10) HEXPRINT - Output writing on Teletype.
- 11) PRINTUSING - Output writing on Teletype.

The Model 2227 Telecommunications Controller and a 103A compatible modem (or acoustic coupler) will interface a 2200 CPU for data transmission and reception via voice-grade telephone lines.

The 2227 has two address switches and one EOM (End-of-Message) switch. As explained previously, the EOM switch selects a termination character for input to the 2227/2200.

The following BASIC commands are valid for 2227 operations:

- 1) INPUT - Input: Receive ASCII character string.
- 2) KEYIN - Input: Receive individual characters
- 3) PRINT - Output: Transmit ASCII characters
- 4) HEXPRINT - Output: Transmit HEX equivalent of ASCII characters
- 5) PRINTUSING - Output: Transmit ASCII characters in specified format.

See TABLE 5 for valid Transmit/Receive addresses.

#### DATALOAD - 2207A (ASCII/Binary Switch In ASCII)

This statement reads values from the Teletype paper tape and sequentially assigns those values to the variables in the argument list. Numeric values can be assigned to alphanumeric variables; values assigned to numeric variables must be legitimate BASIC numbers. Arrays are filled row by row.

Values are successively read from the tape until all variables in the list are satisfied or until the end-of-file is encountered (i.e., an X-OFF character is read). When an end-of-file is encountered, the remaining variables in the list are left with their current values; an IF END THEN statement then causes a transfer to the specified line number.

The System 2200 will automatically transmit an X-ON character to the Teletype to start the tape reader, and an X-OFF character to stop it when reading is completed.

To be read, the paper tape must conform to the following format:

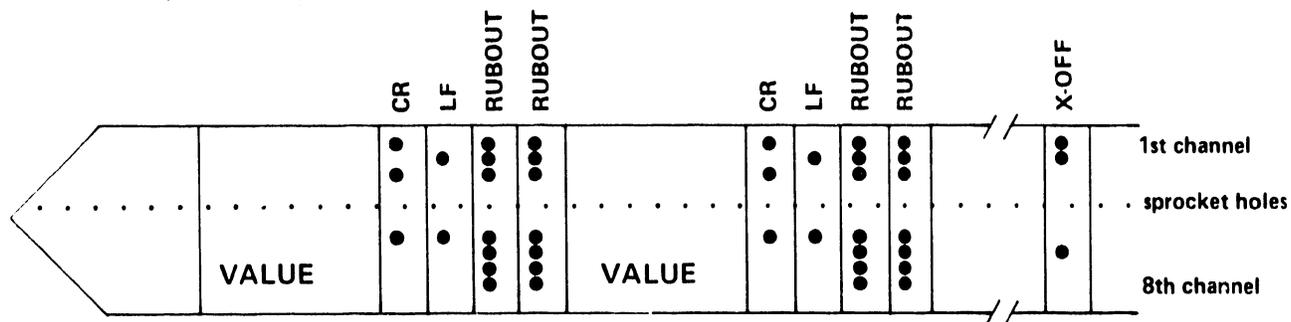


FIGURE 6

Values are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. All other RUBOUTS and nonpunched frames on the tape are ignored when the tape is read. DATALOAD reads only the first seven channels of the tape; the 8th bit is always read as 0.

Paper tapes punched on a Teletype via DATASAVE statements conform to this format. To read tape not in this format, use the DATALOAD BT statement.

EXAMPLE:

```

DATALOAD X, Y, A$, B$
DATALOAD #3, N(), A$
DATALOAD /41D, A1$(), X, Y
DATALOAD STR (A$, I, J)

```

DATALOAD BT - 2207A (ASCII/Binary Switch In Binary)

This statement reads a paper tape and stores characters read in the alpha variable or alpha array designator specified. The tape is read until the stop character is encountered, the alpha variable or array is full, or the number of characters specified by N are read, whichever occurs first. All eight channels of the paper tape are read.

The System 2200 automatically sends out an X-ON character to start the Teletype tape reader and an X-OFF character to stop it. Because two additional characters are read after the X-OFF is sent, the following considerations should be observed. For termination by count (N parameter), the system normally sends out the X-OFF character after N-2 characters have been read. Therefore, if the number of characters to be read is specified by N, N should be  $\geq 3$ . If N = 1 (or 2), the next 2 or (1) characters may be lost. Similarly, if reading is terminated by filling the variable or array, the number of characters in the variable or array should be  $\geq 3$ . If a stop character (S parameter) is encountered, the stop character and the next 2 characters are read; the tape then stops.

The "L" parameter specifies the leader code on the paper tape. When a tape is read (starting with the leader code) all leader codes are ignored until a character not equal to the leader code is recognized.

DATALOAD BT permits paper tapes in any format to be read by the System 2200. The data read then can be converted into a form usable by the System 2200 using System 2200 data manipulation statements.

EXAMPLE:

```
DATALOAD BT /41D, A$  
DATALOAD BT (L=FF, S=0D) #1, A$()  
DATALOAD BT (N=100) A$()  
DATALOAD BT (N=20, L=00, S=A$) A1$()
```

## LOAD - 2207A (ASCII/Binary Switch In ASCII)

When the LOAD command is entered, the program punched on the paper tape is loaded and appended to the current program in memory. This command permits additions to a current program, or if entered after a CLEAR command, entry of a new program.

To be read, the paper tape must conform to the following format.

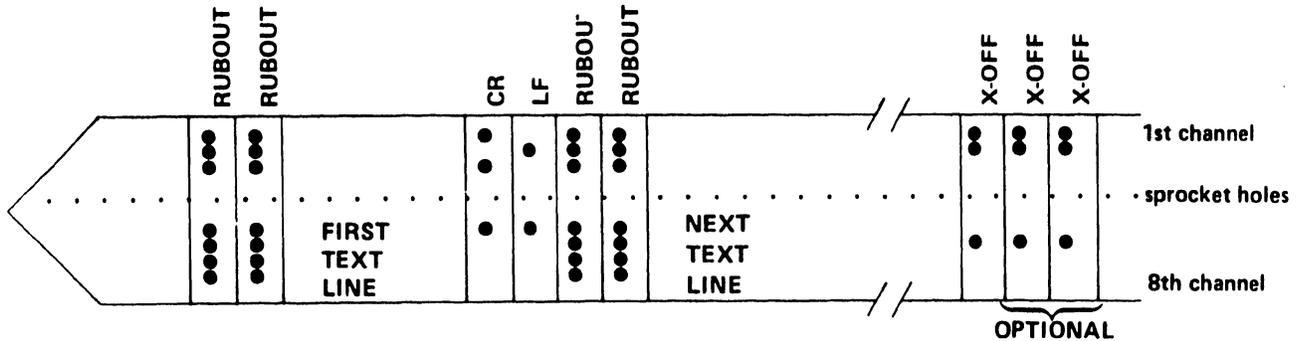


FIGURE 7

Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by 3 X-OFF characters. LOAD reads only the first seven channels of the paper tape; the 8th bit is always read as 0. Nonpunched frames and RUBOUTS are ignored when reading the tape. LOAD also can be used as a program statement, as described below.

### EXAMPLE:

```
LOAD
LOAD #1
LOAD /41D
```

This is a BASIC program statement which, in effect, produces an automatic combination of the following:

```
STOP      (stop current program execution)
CLEAR P   (line number 1 [line number 2] remove program text)
CLEAR N   (remove noncommon variables only)
LOAD      (load new program)
RUN       (line number 1) (run new program)
```

If only line number 1 is specified, the remainder of the current program is deleted starting with that line number. If no line numbers are specified, the entire current program is deleted, and the newly loaded program is executed from the lowest line number.

The LOAD statement must not be within a FOR/NEXT loop or subroutine; an error results when the NEXT or RETURN statement is encountered.

Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by three X-OFF characters. LOAD reads only the first seven channels of the paper tape; the eighth bit is always read as 0. Nonpunched frames and RUBOUTS are ignored when reading the tape.

EXAMPLE:

```
100 LOAD
100 LOAD #2
100 LOAD /41D
100 LOAD #2, 400, 1000
100 LOAD /41D, 100
```

DATASAVE - 2207A (ASCII/Binary Switch In ASCII)

This statement causes the values specified in the argument list to be punched on paper tape. Numeric values are written in a form identical to that resulting from a PRINT statement.

Alphanumeric values are written identically to the character string data they contain; trailing spaces in values of alphanumeric variables are not written. Alphanumeric values must not contain any of the following characters: CR, RUBOUT, X-OFF, null. The OPEN parameter writes leader code (50 null characters). The END parameter terminates the data file by punching an X-OFF character and trailer code (50 null characters).

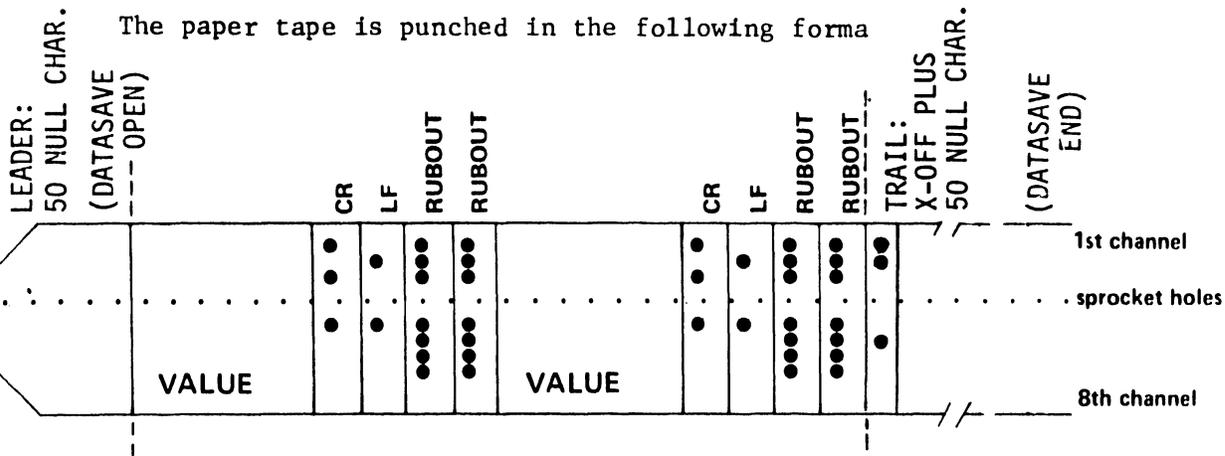


FIGURE 8

Values are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT.

EXAMPLE:

```
DATASAVE X, Y, A$
DATASAVE OPEN "TTY"
DATASAVE END
DATASAVE #1, A$()
DATASAVE /41D, N(), A$, X, Y, Z
DATASAVE STR(A$, I, J), HEX(FAFB)
```

DATASAVE BT - 2207A (ASCII/Binary Switch In Binary)

This statement punches the values of an alpha variable or alpha array onto a paper tape with no control information (i.e., no CR LF RUBOUT RUBOUT separating values). Trailing spaces in alpha values are punched.

DATASAVE BT permits paper tapes to be punched in any format. Any 8-bit codes may be punched.

EXAMPLE:

```
DATASAVE BT #2, A$()
DATASAVE BT /41D, B1$
DATASAVE BT Q$()
```

SAVE - 2207A (ASCII/Binary In ASCII)

The SAVE command causes BASIC program (or portions of BASIC programs) to be punched on paper tape.

If no line numbers are specified, the entire user program text is saved. SAVE with one line number causes all user program lines from the indicated line through the highest numbered program line to be punched on tape. If two line numbers are entered, all text from the first through the second line number, inclusive, is punched.

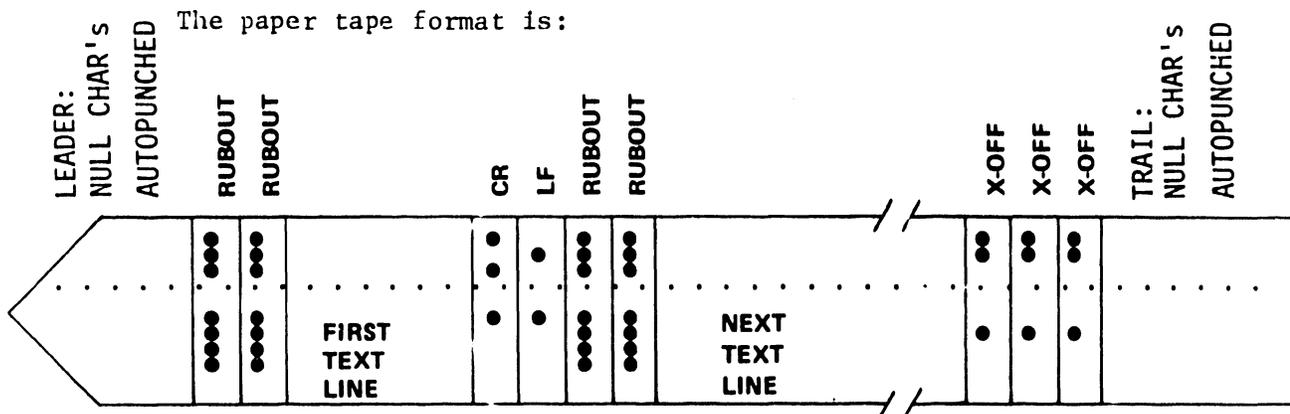


FIGURE 9

Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by 3 X-OFFs.

EXAMPLES:

- SAVE
- SAVE #3
- SAVE /41D
- SAVE /41D, 100, 200
- SAVE #5, 400

INPUT - 2207A/2227

Logic for data reception can be programmed using INPUT statements with numeric variables or alphanumeric string variables as arguments. BASIC language restrictions on legal names for variables and the maximum number of characters assignable to each type of variable are the same for telecommunications applications as for other applications of the System 2200. The INPUT verb produces an echo on the CRT ( or the last device selected for CO class operations ).

EXAMPLE:

```
10 SELECT INPUT 019-----(219 for 2227)
```

```
20 INPUT A$
```

(where A\$ is alphanumeric variable receiving data)

KEYIN - 2207A/2227

The KEYIN verb, available only in the System 2200B, can be used for data reception; but inherent limitations restrict its use. The KEYIN verb differs in several ways from the INPUT verb, available in the System 2200 A and B. The KEYIN verb can be used only in the Program Mode.

When a KEYIN statement is processed during program execution, the system checks the buffer of the device last selected for INPUT-class operations. System action depends upon the input condition existing in the device. One of three conditions is possible:

- 1) Device not ready - execution advances to the next statement in the program.
- 2) Device ready with character - the character is transferred from the buffer to memory and stored in the specified alphanumeric variable; then execution branches to the first line number specified in the KEYIN statement.

- 3) Device ready with a special function code - the special function code is stored in the specified alphanumeric variable; then execution branches to the second line number specified in the KEYIN statement. If the keyboard is the current input-device, the special function code is one of the codes HEX(00) through HEX(1F) corresponding to the 32 possible special function keys available for input. If the input channel of a TC board is the current input device, the special function code is HEX(4D). The code HEX(4D) is supplied by the TC board when a parity error is detected in data being received.

KEYIN statements are well suited for reception of the single-character-messages (ENQ, ACK, or NAK) used for overall control of data transfer between terminals. With the logic of a simple loop, KEYIN statements can be used to test input devices (i.e., the keyboard and each TC unit in a multi-unit telecommunications configuration) one at a time. If no control character is waiting in the buffer of the last selected INPUT class device, another device is tested. If a control character is waiting, execution branches to the program line whose number matches the first specified line number in the KEYIN statement.

EXAMPLE:

```
10 SELECT INPUT 019 _____(219 for 2227)
20 KEYIN A$, 40, 40
30 GO TO 20
40
```

PRINT, HEXPRINT - 2207A/2227

The PRINT and HEXPRINT verbs are used for the transmission of data. PRINT statement output is in ASCII format; HEXPRINT statement output is in HEXADECIMAL format.

EXAMPLE:

```

                                (21D for 2227)
10 SELECT PRINT 01D
20 PRINT "ABCD"

                                (21D for 2227)
10 SELECT PRINT 01D
20 HEXPRINT A$
    
```

A BASIC statement line can contain any number of HEX codes. If more than one HEX code is included in sequence, the line can be written two different ways. Statement (b) below is an alternative to the format of statement (a):

- (a) PRINT HEX (YY0D00)
- (b) PRINT HEX (YY); HEX (0D); HEX (00)

IMPORTANT:

The following information explains PRINT, HEXPRINT, and PRINTUSING end-of-line processing:

- (a) ADDRESS:

The 2200 micro-code allows the user to exercise print line control on various devices through use of special codes on SELECT PRINT, SELECT LIST, or SELECT CO instructions. The leftmost, first digit of the device code denotes to the 2200 CPU how to handle the end of line processing. Automatic end of line processing occurs when a carriage return character is detected or when the line character count reaches the line length specified for the device.

TABLE 7

<u>DEVICE ADDRESS</u>	<u>END-OF-LINE CHARACTERS</u>	<u>LENGTH CODE SPECIFIED</u>	<u>EXPLANATION</u>
0xx	CR, LF	1 - 256 or DEFAULT LENGTH 64	The end-of-line processing issues a carriage return and a line feed.
2xx	CR, 00	Same As Above	The end-of-line processing issues a carriage return and a HEX 00 (NUL).
4xx	None	None	The line character count is suppressed in determining end-of-line processing.

(b) *CHARACTERS:*

Furthermore, HEX characters 00 - 0F will not increment the line character count when being transmitted. the 2200 issues an automatic carriage return only when there is some line character count.

(c) *SEPARATORS:*

A semicolon in the output statement will suppress any end-of-line processing character, such as HEX 0D (carriage return).

TABLE 8  
(Examples of above items a,b,and c)

ASSUME: A\$ = HEX(05)

<u>COMMAND</u>	<u>SELECTED ADDRESS</u>		
	<u>01D</u>	<u>21D</u>	<u>41D</u>
PRINT HEX(FF); PRINT A\$	FF050DOA	FF050D00	FF05
PRINT HEX(FF); PRINT A\$;	FF05	FF05	FF05
PRINT HEX(FF); HEX(05)	FF050DOA	FF050D00	FF05
PRINT HEX(FF); HEX(05);	FF05	FF05	FF05
PRINT HEX(FF); HEX(050D)	FF050D	FF050D	FF050D
PRINT HEX(FF); HEX(050D);	FF050D	FF050D	FF050D
PRINT HEX(FF); HEX(05); HEX(0D); HEX(FF)	FF050DFF0DOA	FF050DFF0D00	FF050DFF
PRINT HEX(00); PRINT A\$	0005	0005	0005
PRINT HEX(00); PRINT A\$;	0005	0005	0005
PRINT HEX(00); HEX(05)	0005	0005	0005
PRINT HEX(00); HEX(05);	0005	0005	0005
PRINT HEX(00); HEX(050D)	00050D	00050D	00050D
PRINT HEX(00); HEX(050D);	00050D	00050D	00050D
PRINT HEX(00); HEX(05); HEX(0D); HEX(FF)	00050DFF0DOA	00050DFF0D00	00050DFF

RESULTANT HEX OUTPUT  
TO EXTERNAL DEVICE

PRINTUSING - 2207A/2227

The PRINTUSING verb is used for multivariable data transmissions requiring data-separator commas in the output data stream.

EXAMPLE:

```
70 SELECT PRINT 01D _____ (21D for 2227)
80 PRINTUSING 90, A$, B, C, D$
90 %#####, #####, #####, ###
```

6.2 OVERALL DATA TRANSMISSION CONTROL

The characters (ENQ, ACK, and NAK) provide overall control of data transfer between terminals. The ENQ code is issued when a terminal wishes to send a message. ACK is issued to acknowledge successful reception. NAK is issued to acknowledge unsuccessful reception.

Table contains the two-digit hexadecimal notation and equivalent seven-bit binary notation for these control characters.

TABLE 9 ASCII CHARACTERS FOR OVERALL TRANSMISSION CONTROL

CONTROL CHARACTERS	HEXADECIMAL NOTATION	7-BIT BINARY NOTATION
ENQ	05	0000101
ACK	06	0000110
NAK	15	0010101

Therefore, to transmit one of these characters using a System 2200/2227, the following statements seem appropriate:

- (a) SELECT PRINT XYZ (length)
- (b) PRINT HEX (YY)

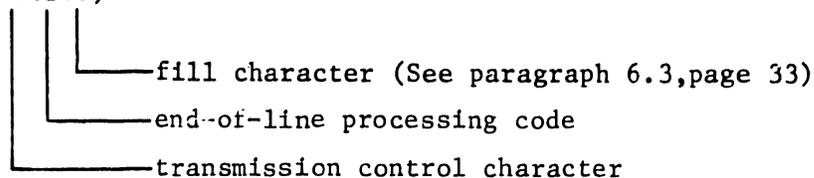
where XYZ is the Model 2227 Telecommunications output device address and YY is the two-digit hexadecimal code for a control character from Table. The length, if given, is an integer (less than 256) specifying the desired carriage width; if omitted, the default length (64) is used.

Output character codes with zero as the first hexadecimal digit do not increment the character count made by the system for its end-of-line processing procedure; therefore, a PRINT statement with only an ENQ or ACK character produces a character count of zero for the line being processed. In such cases, no special end-of-line characters (i.e., Carriage Return, Line Feed, or Null) are added by the transmitting System 2200.

For example, in a 2200 to 2200 system, if the receiving System 2200 is using the INPUT verb to request data, the requested data stream (even a single character message) must terminate with one or more special end-of-line characters in order for the system to complete the processing procedure for the input statement. This requirement places a constraint on the PRINT statement when used to transmit an ENQ or ACK message. The statement must produce a Carriage Return and a Null character in addition to the ENQ or ACK character.

Accordingly, transmission control characters would be sent in the following format:

- (c) PRINT HEX (YYOD00)



where YY, as before, is the two-digit hexadecimal code from Table; OD is the hexadecimal code for the Carriage Return character; and 00 is the code for the Null character.

### 5.3 TRANSMISSION WITH FILL CHARACTERS

*2207A Only:* Since no busy signal is provided by the external device, output via 2207A must be programmed to allow time for completion of mechanical print functions such as carriage return, line feed, and backspace. These pauses are provided by inserting *fill* characters in the output format. These fill characters are non-printing functions, such as HEX 00 (ASCII NULL character).

The *example* table below illustrates the minimum number of fill characters for a particular print function and baud rate, when interfaced with a TermiNet 300 printer via 2207A. When interfaced with a standard Teletype, (at 110 baud) no fill characters are necessary.

TABLE 10 TIME DELAY AND "FILL" CHARACTER TABLE FOR THE TermiNet 300 PRINTER

PRINTER OPERATION	INTERVAL BETWEEN	APPROXIMATE INTERVAL IN MILLISECONDS	NON-PRINTING FILL CHAR.			PLACEMENT OF FILL CHAR.
			300 BAUD	150 BAUD	110 BAUD	
Normal Single Linefeed**	Last char. on old line and first char. on new line.	300	6	2	0	After line feed code.
Repeated line feeds	(a) Last char. on old line & second LF code.	350	8	3	1	After first line feed code.
	(b) Subsequent LF codes.	67	2	1	0	After the second & subsequent line feed codes.
Backspace***	Printing and then reprinting in same position.	230	6	3	2	After the backspace code.
Startup****	Commanding motor on and printing.	430	12	6	4	After "Motor On" code.
Shutdown*****	Last data char.	300	9	4	3	Between last data character and "Motor Off" code.
Vertical Tab & Form Feed	VT or FF command and first character.	$300 + (25 \times \text{No. of Lines}) = \text{Required Time Delay in Milliseconds}$ $300 + (25 \times \text{No. of Lines}) = \text{Number of Fill Characters}$ Characters per Second				

\*\*If there is no C/R, on "fill" character should be added to that shown.

\*\*\*If BACKSPACE code is used more than once, it may take the place of "fill" characters; e.g., at 30 cps, to type and underscore "AND", send A N D BS BS BS fill fill fill - - -. The delay is required to insure hammers have recovered from the previous actuation.

\*\*\*\*The TermiNet 300 Printer will go from a motor off state to a printing or "ON LINE" state in response to the two code sequence ESC h or H, or also in the case of automatic motor on from the Dataset. The delay is required to allow the motor to come up to speed.

\*\*\*\*\*The TermiNet 300 Printer will go from a printing "ON LINE" state to a motor off state in response to the two code sequence ESC j or J, by the EOT code (when strapped), or also in the case of automatic motor off from the Dataset. The delay that precedes the motor off command is required to allow time to print any characters that are in memory waiting for the proper registration of the hammers and belt.

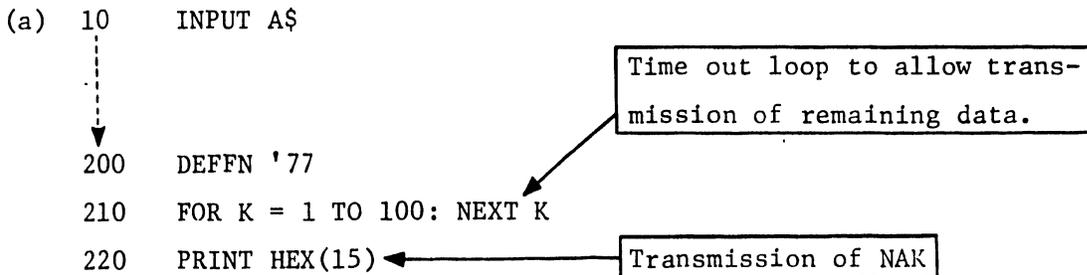
## 6.4 DATA VERIFICATION

Parity formatting of transmitted data and parity checking of received data are push-button selectable features of the Model 2227 controller.

Once the parity feature is activated, the parity of each character is verified as it is received. When a parity error or framing is detected, the System 2200 special function indicator ( $\overline{IB9}$ ) is set.

If an INPUT statement is being processed, a branch is made to the special function subroutine DEFFN '77; i.e., HEX(4D) plus  $\overline{IB9}$ . However, if a KEYIN statement is being processed when the parity error is detected, the character received by the System 2200 is again HEX(4D) plus  $\overline{IB9}$ , and program execution automatically branches to the second line number specified in the KEYIN statement.

The DEFFN '77 (INPUT) or second line branch (KEYIN) error subroutine is programmed by the user. If this subroutine is not programmed, an ERROR 48 will be produced at the console output (normally the CRT). Examples of the above follow:



```
(b) 10 INPUT A$  
  
200 DEFFN '77  
210 SELECT PRINT 005  
220 PRINT "PARITY/FRAMING ERROR"
```

Notification of error at receiving end.

```
(c) 10 KEYIN A$, 40, 50  
  
50 REM "ERROR SUBROUTINE"  
60 SELECT PRINT 005  
70 PRINT "PARITY/FRAMING ERROR"
```

Similar to example (b)

## 7. CIRCUIT OPERATIONS - 2207A/2227

Since 2207A and 2227 controller circuits are nearly identical, the text for circuit descriptions has been combined, except where special subtitles indicate a portion of text pertaining to one controller only (i.e., "2207A only" or "2227 only").

### 7.1 CLOCK CIRCUITRY

Timing for the selectable baud rates is derived from the 4 mhz clock at coordinates 7,K. L21 and L10 divide the base frequency from this clock. The outputs from the dividers (L21 and L10) are gated at two locations:

- (a) L11-8: Time base for 150, 300, 600, and 1200 baud rates.
- (b) L9-12: Time base for 110 baud rate.

When any of the baud rates in (a) are selected, the output of L11 (pin 8) is connected to the inputs to L22 (pin 14). When 110 baud rate is selected, L9-12 is connected to L22-14.

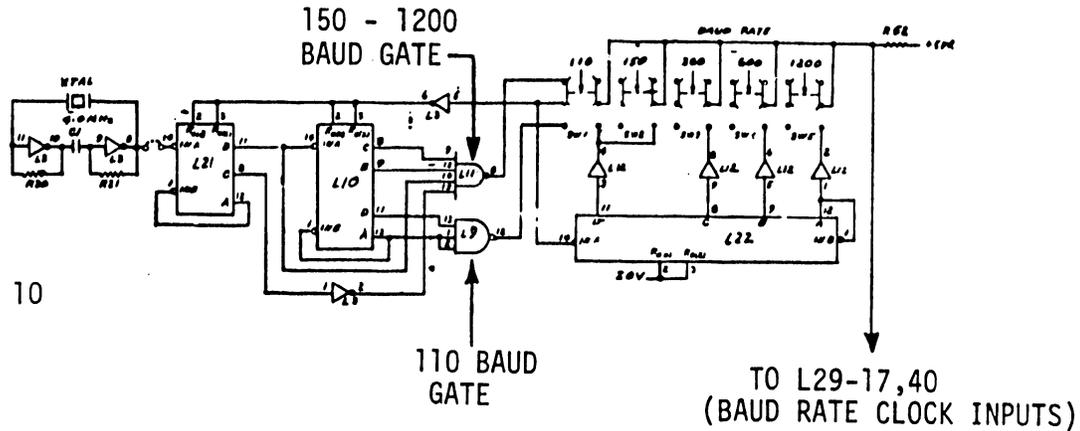
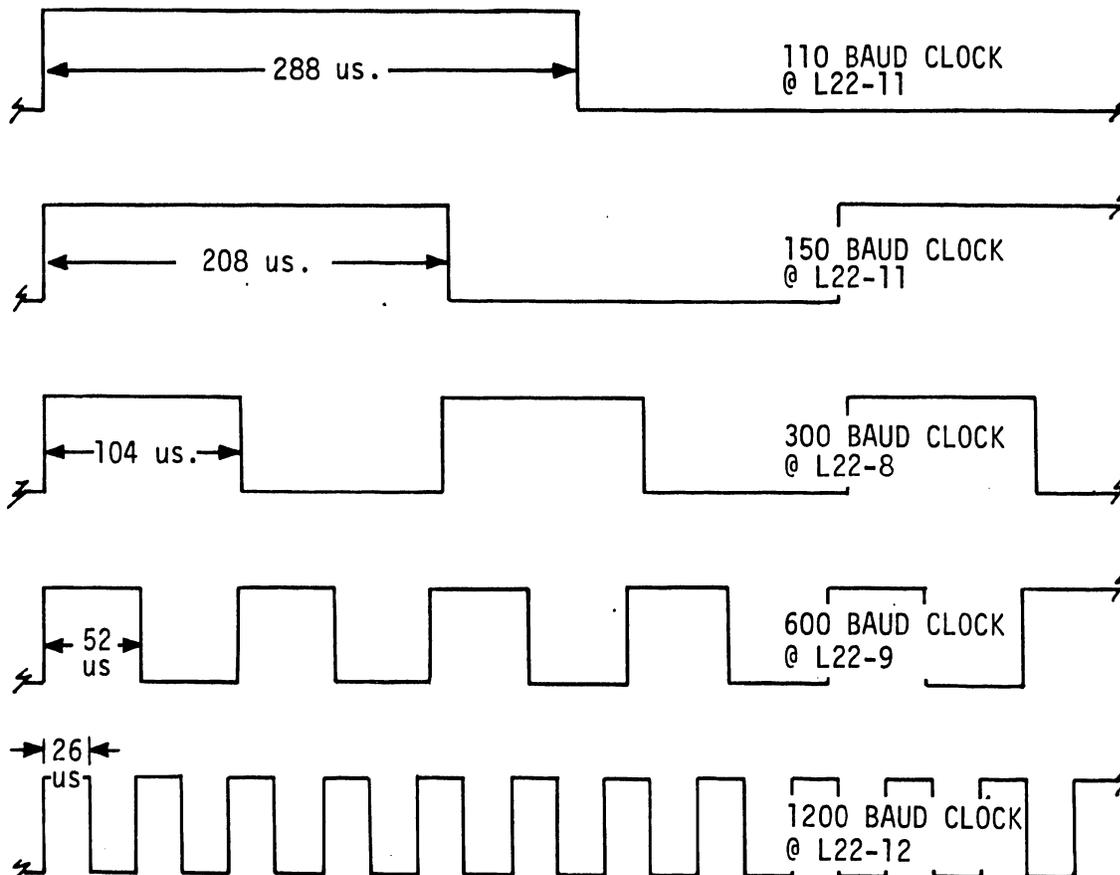


FIGURE 10

Since the transceiver IC (L29) requires a clock which is sixteen times the desired baud rate, the following timing is available at L22 (coordinates 3/4,J):

FIGURE 11





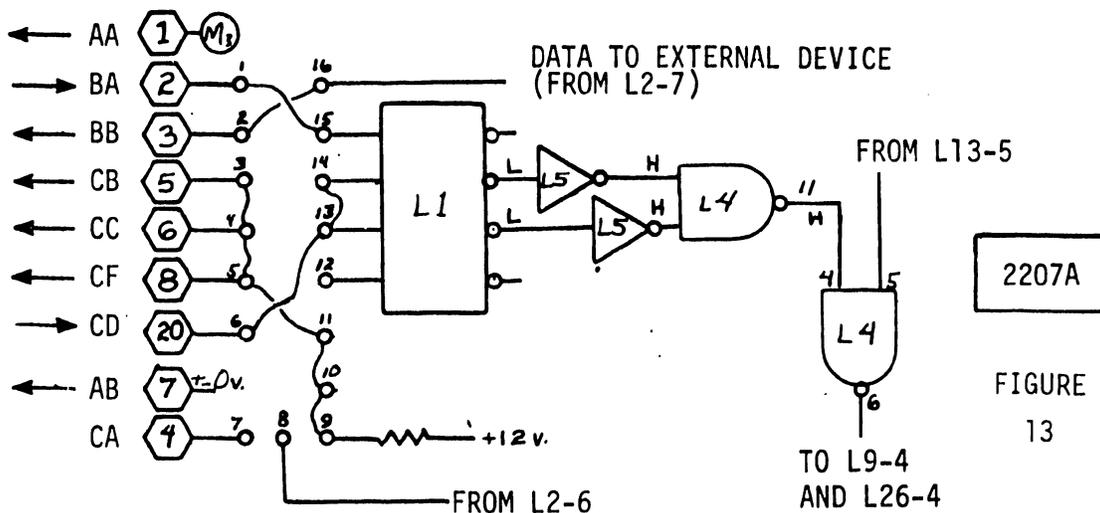


FIGURE  
13

2227 only: Pin 6 of L13 presets L5A via pin 6 (low). The low from L5A-6 is inverted at L2-6 (coordinates 8,K) and causes the CA (Request to Send) signal to be active (+10 volts, approximately). The inactive level of CA is approximately -10 volts. With a communications line established, the modem supplies active levels (+10 volts) on circuits CC (Data Set Ready) and CF (Carrier Detect). The active status of circuits CC and CF are ANDed at L4-11, thus causing L4-6 to be enabled high (coordinates 12,J).

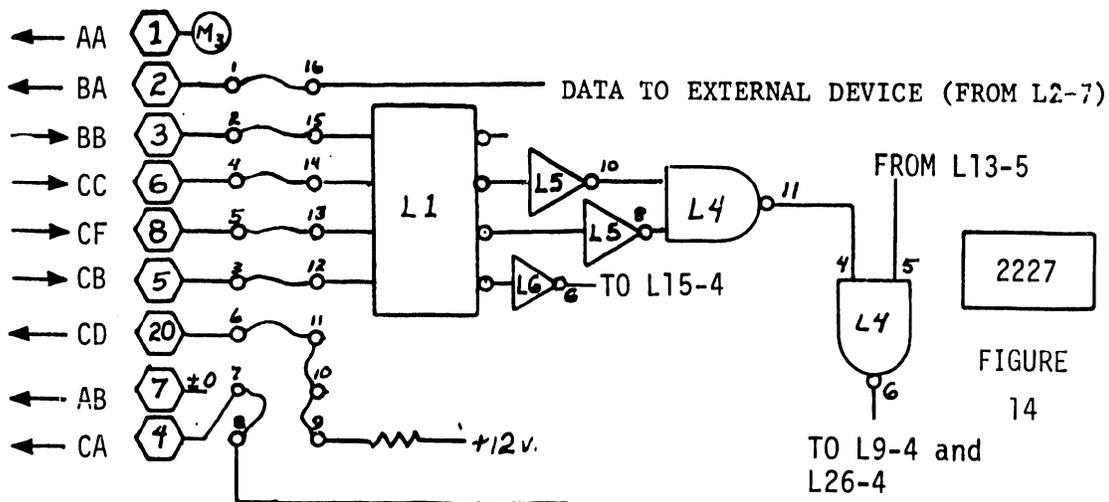


FIGURE  
14

The high from L4-6 is felt at L9-4 and L26-4. An active level (+10V) representing circuit CB (Clear to Send) is supplied at J1 pin 5; and is inverted twice (L1-10, L6-6) to enable L15 at pin 4 (coordinates 9/10,D).

Since no data has been sent from the CPU yet, the TBMT signal (Transmitter holding register empty) at pin 22 of transceiver IC L29 will be high. This high is felt at L15-3. L15-5 is also high at this time. With L15-3, 4, and 5 high, L5-2 sends a high to L26-5 and L9-5.

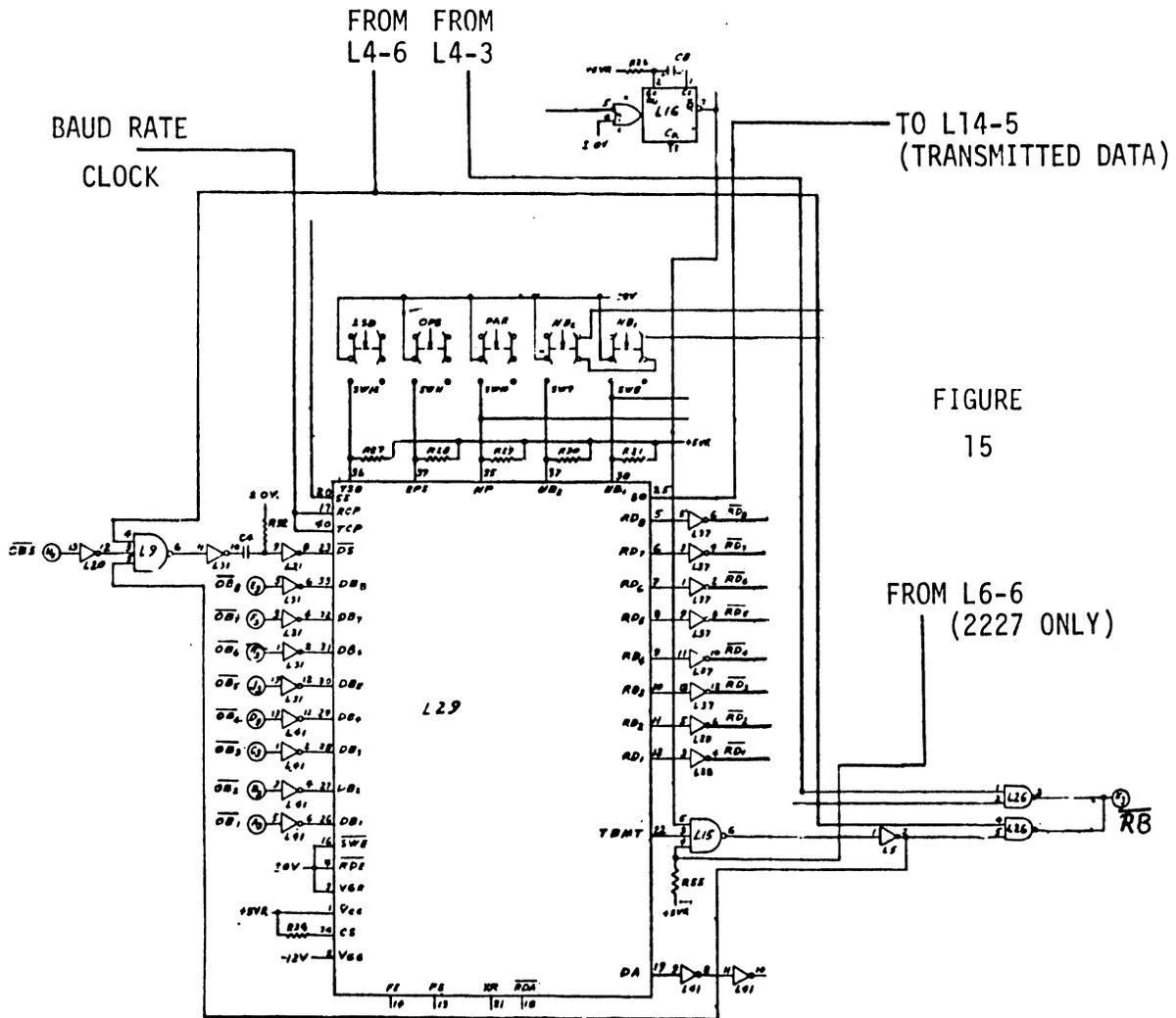


FIGURE 15

The high at L26-5 causes  $\overline{R/B}$  to be low, indicating to the CPU that the -07A/-27 controller is ready to receive data from the CPU. The high on L9-5 enables the transceiver IC to receive an  $\overline{OBS}$  strobe from the CPU. Accompanying the  $\overline{OBS}$  strobe one byte ( $\overline{OB1-8}$ ) is strobed into the transmitter holding register of L29 via L31 pins 8 and 10. At this time TBMT (L29-22) goes low.

With TBMT low,  $\overline{R/B}$  to the CPU goes high (via L15-6, L5-2, and L26-6) informing the CPU not to send any further output data until the transmitter holding register of L29 is empty (TBMT returns high).

The contents of L29's transmitter holding register is transferred to L29's transmit register, and is then sent out serially (at L29-25), accompanied by the start, stop, and parity bits selected by switches on the controller. This serial output data is routed to the RS-232-C connector via jumper wires, as follows: (See coordinates 11,J/K).

2207A only: Serial output data leaves the 2207A controller on circuit BB, "Received Data" to the Teletype.

2227 only: Serial output data leaves the 2227 controller on circuit BA, "Transmitted Data" to the modem.

When one byte is transmitted, TBMT again goes high, causing  $\overline{R/B}$  to flag the CPU for the next byte output via  $\overline{OBI-8}$  and  $\overline{OBS}$ .

The preceding circuit actions repeat each time  $\overline{R/B}$  goes low, until all data has been transmitted to the external device (Teletype or Modem).

### 7.3 RECEIVE CIRCUITRY

#### 7.3.1 INPUT, KEYIN

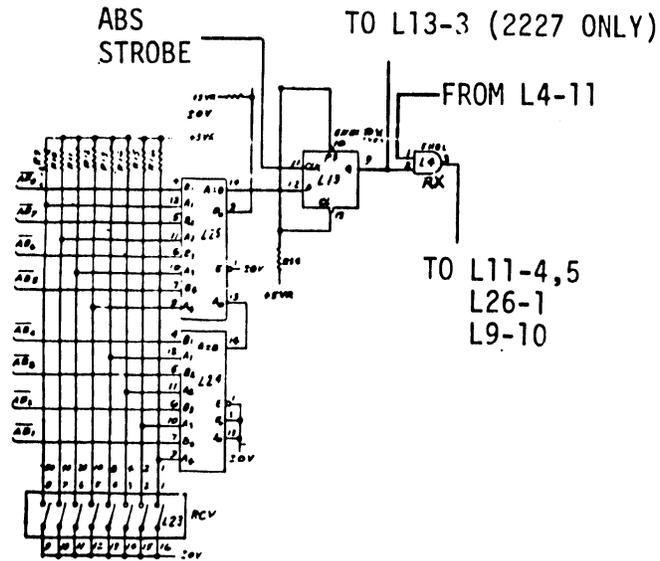
On execution of an INPUT or KEYIN statement for reception of data from an external device via 2207A or 2227, the following events occur:

One of three addresses are strobed from the CPU at  $\overline{ABS}$  time:

HEX 19,1A,1B (2207A, 2227) } — Receive  
Addresses

The address sent from the CPU via AB1-8 is compared to the RCV address switch setting via L24 and L25 (coordinates 13,G/H). If the address strobed matches the RCV switch setting, the A = B condition at L25-14 causes the RCV address latch (L13-9) to be set high when clocked by ABS. This high is felt at L4-2 (coordinates 12,H).

FIGURE  
16



2207A only: The Teletype unit supplies a ready level (= +10 volts, approximately) on circuit CD (Data Terminal Ready), which ultimately enables L4 at pin 1. Thus, L4-3 sends a high with 2207A selected for input, AND with Teletype (Data Terminal) ready.

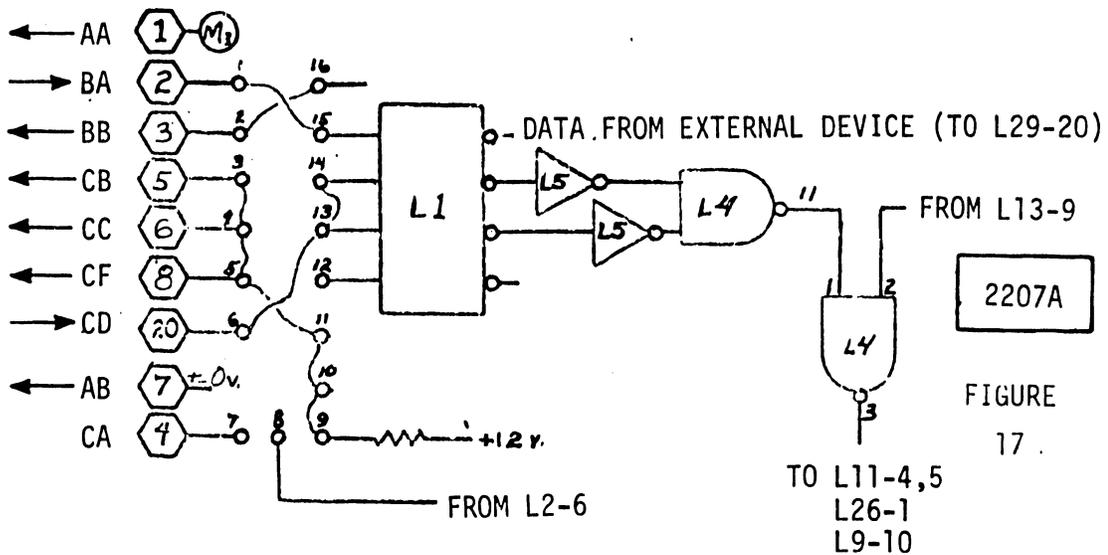
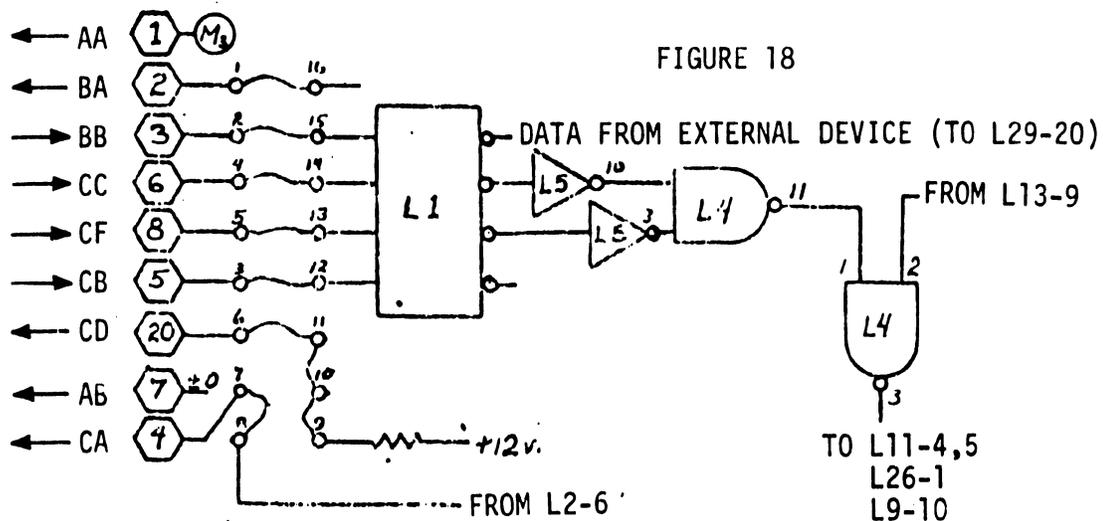


FIGURE  
17

2227 only: The high from L13-9 clocks L5A-6 high (coordinates 12,I), which results in a -10 volt (non-active) condition on circuit CA (Request to Send) via line driver L2-6. With a communications line already established the modem supplies active levels (+10 volts, approximately) on circuits CC (Data Set Ready) and CF (Carrier Detect) which ultimately enables L4 at pin 1.



The high from L4-3 is felt at L11-4/5, L26-1, and L9-10. One serial byte of incoming data is received by the -07A/-27 controller at the SI (Serial Input) port of L29 (pin 20) via L1-13. This byte of data is transferred to L29's receiver register, and then to L29's receiver holding register, where the data awaits input to the CPU. With an entire character transferred into L29's receiver holding register, DA (L29-19; "Data Available") becomes active (high).

For KEYIN: (2207A or 2227)

$\overline{R/B}$  then goes low (via L41-8,10 and L26-3) indicating to the CPU that data in the receiver holding register (L29) is awaiting input to the CPU. On receipt of  $\overline{R/B}$  = low from the 07A/27 controller, the CPU becomes ready ( $\overline{CPB}$  = high), thus causing L8-6 to be triggered (5  $\mu$ s) via L9-8. This 5  $\mu$ s pulse becomes  $\overline{IBS}$  to the CPU. L8 pin 7 send a low to L29 pin 18 ( $\overline{RDA}$ ) via L15-12 and L28 pin 2, in order to clear L29's receiver holding register prior to arrival of next byte input.

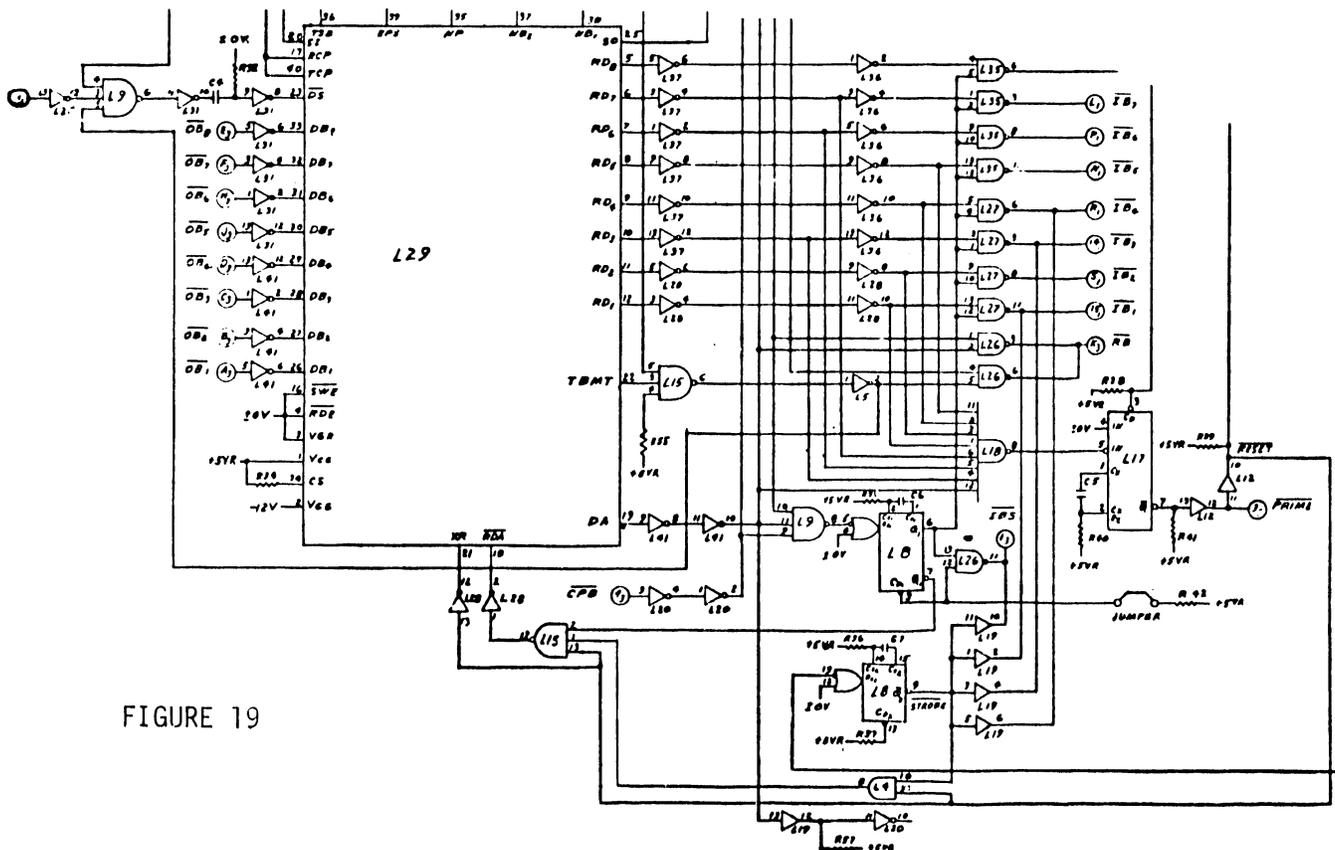


FIGURE 19

For INPUT: (2207A or 2227)

$\overline{CPB}$  is already high (CPU awaiting data) when  $\overline{RB}$  goes low, thus, DA triggers  $\overline{IBS}$ .

The same 5  $\mu$ s pulse is used to enable L27, 27, and 35, in order to make the input data from L29 pin 5-12 available to the CPU via  $\overline{IB1-8}$ .  $\overline{IBS}$  strobes this byte of data into the CPU.  $\overline{CPB}$  goes busy (low) until ready to accept a new character from the 07A/27 controller.

During the input strobe to the CPU, L29's receiver holding register is cleared at L29 pin 18 ( $\overline{RDA}$ ) via L8-7, L15-12, and L28-2 (coordinates 8-11,C) and DA at L29-19 is reset low. Subsequently, a new byte of serial input data is received at L29-20 via L1-13 (coordinates 10/11,K), and the  $\overline{IBS}$  sequence repeats when  $\overline{CPB}$  again goes high (CPU ready for input).

2207A only: When a HEX 1B (ESCAPE) is entered from a teletype unit, the 2207A detects this at L18-8 (coordinates 8,C/D) and decodes a RESET instruction. Thus, L29 halts further input (all registers in L29 are cleared). This is exactly the same circuit action that would occur if RESET were manually keyed on a 2215/2222 keyboard. The 2207A is still selected for input after this RESET occurs.

### 7.3.2 LOAD, DATALOAD, DATALOAD BT (INPUT)

One pair of the following addresses are set on the XMT and RCV switches:

	XMT SWITCH SETTING	RCV SWITCH SETTING
Primary -07	1D	19
2nd 2207A	1E	1A
3rd 2207A	1F	1B

On execution of a LOAD, DATALOAD, or DATALOAD BT statement, or LOAD command for the reading of data from a Teletype mechanical tape reader, the following occurs:

Initially, one of three addresses (i.e., the one specified in the input statement) is strobed from the CPU at  $\overline{\text{ABS}}$  time:

HEX 1D, 1E, or 1F (2207A, 2227) } XMT addresses  
used for data  
input

The address sent from the CPU is compared to the XMT address switch setting via L33 and L34 (coordinates 13/14, I/J/K). If the address strobed matches the XMT switch setting, an A = B condition at L34-14 causes the XMT address latch to be set (L13-5,6). L13 is clocked by the ABS signal. Pin 5 of L13 sends a high to L4-5 (coordinates 12, J).

*2207 only:* The Teletype unit supplies a ready level (= +10 volts) on circuit CD (Data Terminal Ready), which ultimately enables L4 at pin 4. Thus, L4-6 sends a high with the 2207 selected with an XMT address AND with the Teletype (Data Terminal) ready.

*2227 only:* Pin 6 of L13 presets L5A pin 6 (low). The low from L5A-6 is inverted at L2-6 (coordinates 8, K) and causes the CA (Request to Send) signal to be active (+10 volts). (The inactive level of CA is approximately -10 volts.)

With a communications line already established, the modem supplies active levels (+10V) on circuits CC (Data Set Ready) and CF (Carrier Detect). The active states of circuits CC and CF are ANDed at L4 pin 14, thus causing L4-6 to be enabled high (coordinates 12,J).

The high from L4-6 is felt at L9-4 and L26-4. An active level (+10V) representing circuit CB (Clear to Send) is supplied at jumper pin 8, and is inverted twice (L1-10, L6-6) to enable L15 at pin 4 (coordinates 9/10,D). Since no data has been sent from the CPU yet, the TBMT (Transmitter Holding Register Empty) signal from the transceiver IC (L29) is high, which is felt at L15-3. L15 pin 5 is also high at this time. With L15-3, 4, and 5 high, L5-2 sends a high to L26-5 and L9-5.

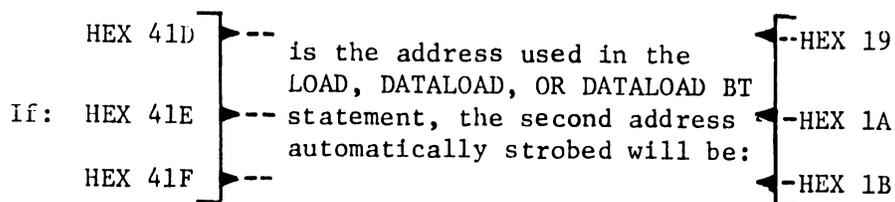
The high at L26-5 causes  $\overline{RB}$  to be low, indicating to the CPU that the 07A/27 controller is ready to receive data from the CPU. The high on L9-5 enables the transceiver IC (L29) to receive an  $\overline{OBS}$  strobe. When  $\overline{OBS}$  arrives from the CPU, a HEX 11 (X-ON) is strobed into the transmitter holding register of L29 via  $\overline{OB1-8}$ , L31, and L41 (coordinates 12,D/E/F). At this time, TBMT (L29-22) goes low. With TBMT low,  $\overline{RB}$  to the CPU goes high (via L15-6, L5-2, and L26-6) informing the CPU not to send another strobe and output data.

The contents of L29's transmitter holding register is transferred to L29's transmit register, and is then sent out serially, accompanied by the start, stop, and parity bits selected by push button(s). This serial data becomes circuit BA (Transmitted Data 2227) or circuit BB (Received Data 2207A) to the external device (Teletype -07A, or Modem -27) via line driver L2.

When one byte (HEX 11) X-ON is transmitted, the paper tape reader will be on, and the first byte of data is read and sent serially from Teletype to 2207A.

One serial byte of incoming data is received by the 07A/27 controller at the S1 (Serial Input) port of L29 (pin 20) via L1-13. This byte of data is transferred to L29's receiver register, and then to L29's receiver holding register, where the data awaits input to the CPU. With a character transferred into L29's receiver holding register, DA (L29-19, "Data Available") becomes active (high).

Prior to the reception of the first byte of serial input data, the microprogrammed signal sequence for the LOAD, DATALOAD, or DATALOAD BT statements will strobe a new address (RCV address) on  $\overline{AB1-8}$ .



(Second address is low order HEX 04 less than the HEX address specified in the LOAD, DATALOAD, or DATALOAD BT statement.)

If the secondary address strobed matches the RCV address switch setting, latch L13-9 and AND gate L4-3 are set high. The high from L4-3 enables L26-2. Since DA is high, L26-1 will be high; thus,  $\overline{R/B}$  goes low, indicating to the CPU that one byte of data is available for input (via  $\overline{IB1-8}$ ).

At this time, the CPU will become ready ( $\overline{CPB} = \text{high}$ ) and NAND gate L9-8 will trigger  $\overline{IBS}$  to the CPU, and will make data available to the CPU from L29's receiver holding register (L29 pins 5-12).

The CPU goes busy ( $\overline{CPB} = \text{low}$ ) to accept the first byte of data from the Teletype. A new character is input each time the CPU ( $\overline{CPB}$ ) becomes ready.

The primary (XMT) address specified in the LOAD, DATALOAD, or DATALOAD BT statement will be strobed when the last character has been read from the Teletype reader. The CPU automatically sends an ASCII X-OFF to shut o-f the Teletype reader mechanism.

2227 only: When an EOM (End-of-Message) character is read, L38 and L39 cause L30-9 to be set. L11-6 (coordinates 3,E) is already enabled with an RCV address and CPU ready. The high from L30-9 causes L11-6 to go low, triggering L8-9. L8-9 causes a 5  $\mu\text{s}$   $\overline{IBS}$ , plus a HEX 0D to be strobed into the CPU (L30-8 simultaneously disables L8-6, L26, L27, and L35). L8-9 also resets L29's Receiver holding register at L29-18, via L4-8, L15-12 and L28-2. This terminates the loading of data into the CPU via 2227 (See Figures A and B).

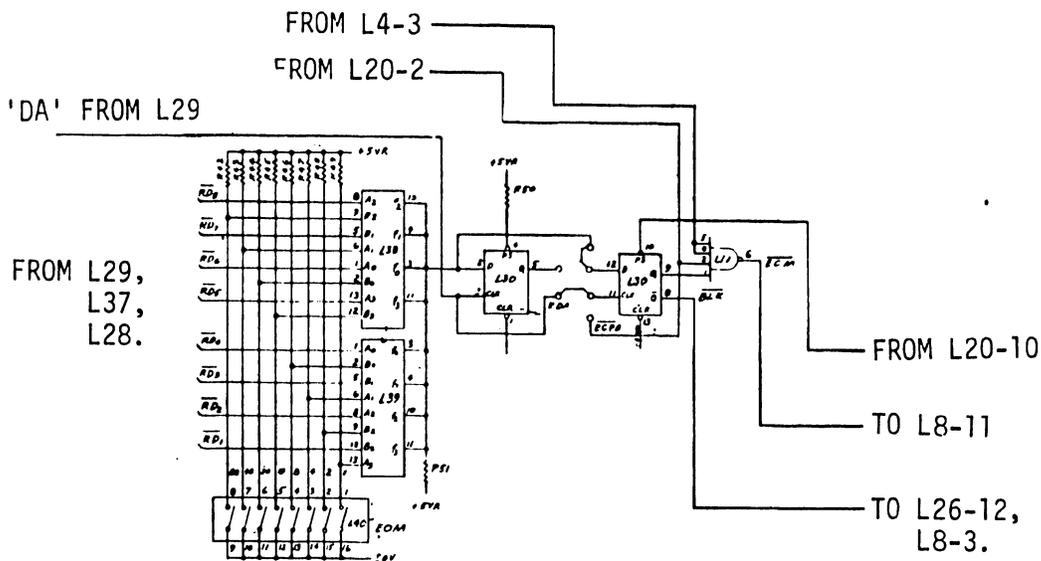
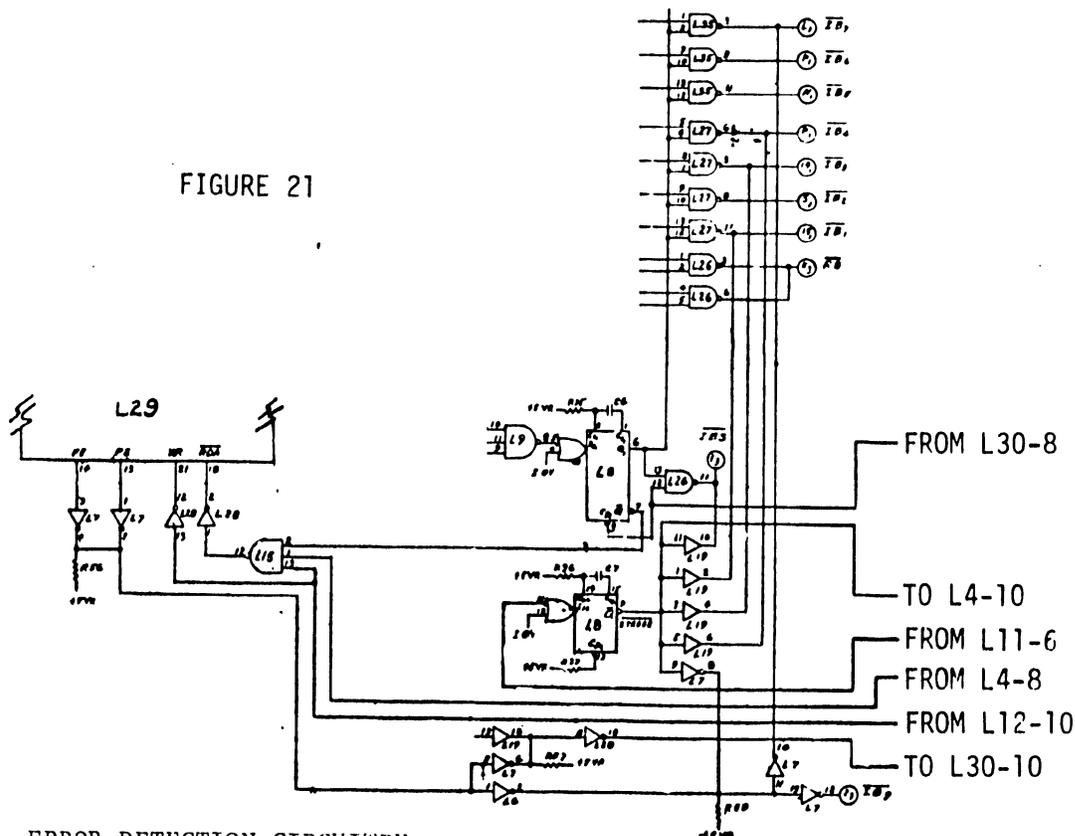


FIGURE 20

FIGURE 21



#### 7.4 ERROR DETECTION CIRCUITRY

When line distortion or noise is received at L29 pin 20 (Serial data output to transceiver IC, L29) generates a Framing/Parity error at L29-13/14. The resulting low at L7-4/2 causes the following:

- (a) L20-9 goes low via L7-4/2, to preset L30-9 high, and generates  $\overline{EOM}$  (low).
- (b) The low from L30-8 (preset low) disables  $\overline{IBS}$  at L26-12.
- (c) The low from L30-8 clears L8-6 low, disabling L26, 27, and 35.
- (d)  $\overline{EOM}$  triggers L8-9 (5  $\mu$ s, low).
- (e) This 5  $\mu$ s low from L8-9 issues a HEX 4D via  $\overline{IB}_{1-8}$ , an  $\overline{IB}_9$  bit (special function indicator) via L7-12/13, and an input strobe ( $\overline{IBS}$ ) via L19-10/11.
- (f) The HEX 4D plus special function indicator  $\overline{IB}_9$  executes a DEFFN '77 subroutine. If no DEFFN '77 routine has been programmed, an ERROR 48 will be produced in the CRT of the receiving 2200. The DEFFN '77 subroutine usually is programmed to PRINT "FRAMING/PARITY ERROR".

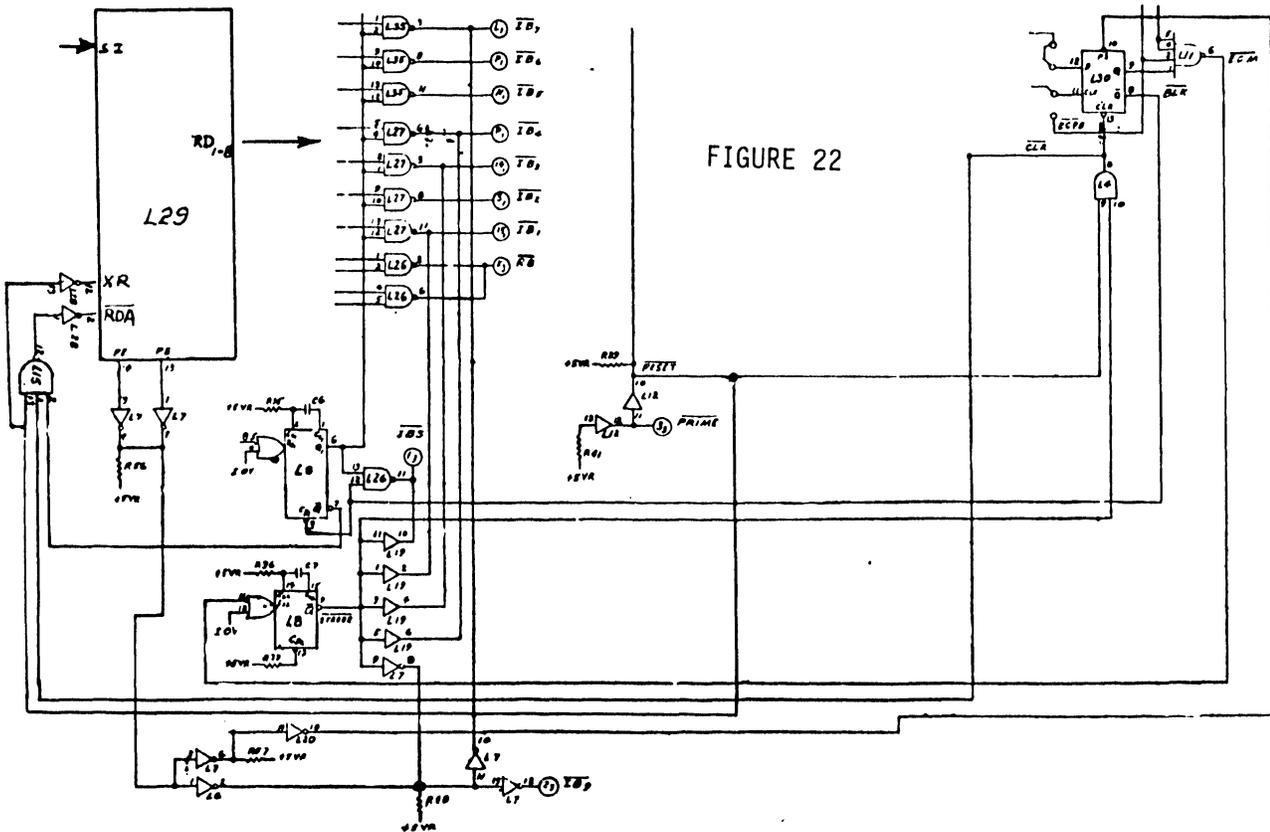


FIGURE 22

(g) This branch to DEFFN '77 also terminates further input to the 2200 CPU from the remote terminal via 2227. Control is returned to the 2200 for execution of the DEFFN '77 special function subroutine.

### 7.5 BREAK/HALT/STEP CIRCUITRY

2207A Only: If a BREAK signal (> 125 ms space) is received by the 2207A controller, the following events result in a 5 μs HALT pulse to the CPU. This will interrupt output to the Teletype/Teletype compatible device via 2207A. A BREAK (space) signal less than 125 ms in duration will not halt output.

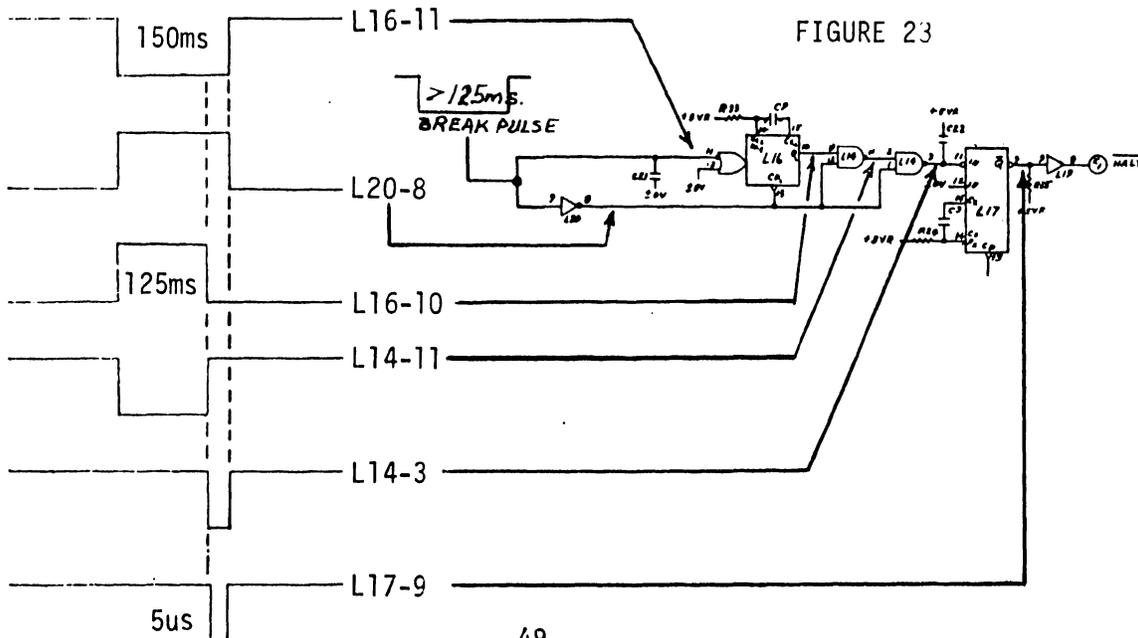


FIGURE 23

2227 Only: Originating a BREAK signal while receiving data from a remote terminal:

Depressing the red BREAK button on the 2227 controller (or at the external BREAK button) will trigger L16-7 via L15-8 and L5-6/5. The pulse from L16-7 (270 ms, low) causes a 270 ms space to be sent to the transmitting terminal via 103 Modem, L2-2/7, L5-12/13, and L14-4/6.

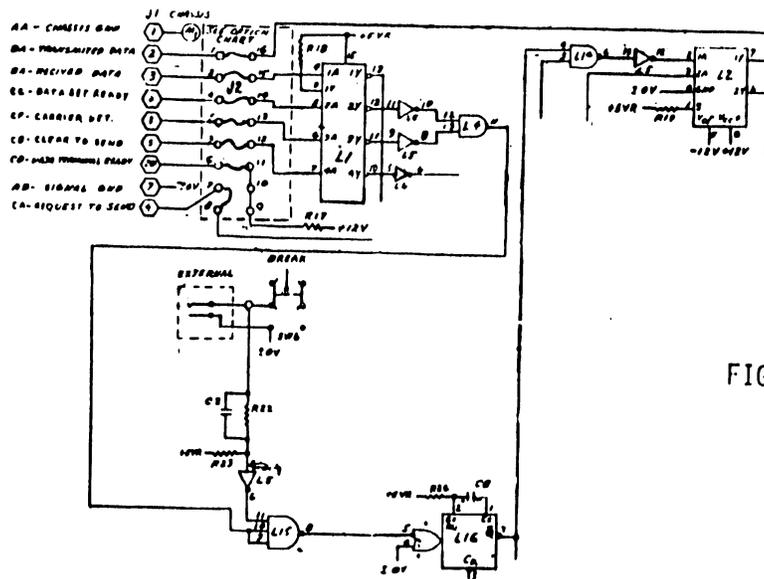


FIGURE 24

2227 Only: Receiving a BREAK signal while receiving data from a remote terminal:

A 270 ms BREAK (space) signal received (overriding any data currently being received) at L29 pin 20 (Serial data output to transceiver IC, L29) generates a Framing/Parity error at L29-13/14. The resulting low at L7-4/2 causes the same events listed under ERROR DETECTION CIRCUITRY (items (a) through (g)).

2227 Only: Originating a BREAK signal while transmitting data to a remote terminal:

Depressing the red BREAK button on the 2227 controller (or at the external BREAK button) will trigger L16-7 via L15-8 and L5-6/5. The resulting 270 ms low pulse causes L15-6 to go high, thus disabling any further  $\overline{\text{OBS}}$  (output) pulses from the CPU. Simultaneously,  $\overline{\text{RB}}$  goes high, informing the CPU to cease output data for the 270 ms break duration. Transmission continues until RESET or end of transmission occurs. (It is assumed that if one originates a Break, transmission will cease.)

DIAGNOSTIC TESTS - 2207A/2227

A test procedure has been set up for the Customer Engineering Division to communicate with WYLBUR, PHI's IBM series 360 computer. The test procedure will be used to assure the customer that 2200 TC units are functioning properly.

IMPORTANT

THESE TESTS WILL NOT BE USED FOR DEMO OR TRAINING PURPOSES.

The WYLBUR test procedure describes how to sign on to WYLBUR, and how to playback a test in WYLBUR's memory.

In order to use these test procedures you must obtain the "keyword" from a Home Office Field Engineer. Since the keyword is frequently changed, access to WYLBUR would be impossible without first obtaining the latest keyword.

Before contacting WYLBUR for a 2200/2227 telecommunication test, run the *off line* 2227 diagnostic (with test connector), described below:

DIAGNOSTICS

This diagnostic cassette has five -07A/27 telecommunications tests. The first block is a general 2207A/2227 OFF-LINE test for 2200 A or B; the second block is a Model 2227 ON-LINE test (System 2200-to-System 2200 via modems); the third block is a 2207A/2227 OFF-LINE test for 2200B CPUs *only*; the fourth block is a Model 2207A ON-LINE Teletype test; the fifth block is the WYLBUR diagnostic.

To load any diagnostic on this cassette, rewind, key CLEAR, EXECUTE, LOAD, EXECUTE, RUN, EXECUTE and follow the instructions listed in this section, along with those listed on the CRT.

BLOCK #1 (MODEL 2207/2227 OFF-LINE)

- (a) Plug RS-232-C Cannon test connector\* into Model 2207/2227 controller PC.
- (b) Set RCV switch to HEX 19 (Model 2207/2227)  
Set XMT switch to HEX 1D (Model 2207/2227)  
Set EOM switch to HEX 0D (Model 2227 only)
- (c) Plug controller board into CPU and turn System 2200 power ON.
- (d) For Model 2207, set the red ASCII/BINARY switch to the BINARY position (DOWN). This will select 8 bits per character with no parity.
- (e) For Model 2227, set switches NB1 and NB2 to the UP position (8 bits per character).
- (f) For Model 2227, set OPS switch to either UP or DOWN position (not critical).
- (g) For Model 2227, set PAR switch to the UP position (no parity).
- (h) For Model 2227, set SB to the UP position (2 stop bits).
- (i) RUN, EXECUTE
- (j) Enter 64 characters on Model 2215/2222 keyboard:

:ABCDEFGHIJKLMNPOQRSTUVWXYZ0123456789; < = > ? ! " # \$ % & ' ( ) \* + , - . / [ ] ↑ ← ABC

- (k) Enter "YES" for continuous test loop or "NO" for one test run.
- (l) If characters are received into display exactly as sent, OFF-LINE test verifies good. Turn System 2200 power OFF. Remove RS-232-C test connector from controller board.

\*RS-232 Cannon Test Connector: #DB-25P; WL #350-1030 (Male) or #DB-25S; WL #350-1031 (Female).

Pins 2 and 3 are wired together; pins 4 and 5 are wired together; and pins 6, 8 and 20 are wired together.

BLOCK #2 (MODEL 2227 ON-LINE)

- (a) This test may be used in the event of a WYLBUR test failure.  
Connect RS-232-C cable from Model 2227 controller board to modem.  
Both Home Office and remote terminal must use the same or compatible modem type.
- (b) Call 617-851-4111, extensions 2124, 2125, or 2126 between 9 a.m. and 4:30 p.m. EDT, Monday through Friday.
- (c) Home Office: key special function 01 (System 2200) to RECEIVE DATA.
- (d) Remote Office: key special function 00 (System 2200) to TRANSMIT DATA.
- (e) Enter data shown in OFF-LINE test.
- (f) The Home Office should display data received from remote Model 2227.
- (g) Reverse procedure; that is, Home Office keys 00, remote office keys 01. Send data.
- (h) Remote office should display data received from Home Office Model 2227.

BLOCK #3 - 2207A/2227 OFF-LINE Test For 2200B Only

The instructions for this test are listed on the CRT.

BLOCK #4 - MODEL 2207A (Teletype ON-LINE Test)

Since the mechanical paper tape reading mechanism of TELETYPE units may also be used with the System 2200, the following test will verify TELETYPE punch/reader operation.

- (a) With System 2200 power OFF, connect RS-232-C cable from Model 2207 controller to TELETYPE unit. (ASCII/BINARY SWITCH DOWN)
- (b) Turn System 2200 power ON.
- (c) Clear System 2200 RAM (CLEAR, EXECUTE).
- (d) Reset System 2200.
- (e) LOAD 2200 Output Writer System Tape. (The 2207,27,50,52 tape has the same test. See Service Newsletter #3-5, General section, item #2.)
- (f) RUN, EXECUTE
- (g) Follow instructions on CRT.

(h) All operating instructions for this diagnostic are printed on the CRT.

This diagnostic performs two tests:

- 1) DATALOAD/DATASAVE (Indicates "OK" or "ERROR")
- 2) DATALOAD BT/DATASAVE BT (Indicates "OK" or "ERROR")

NOTE:

When DATALOAD BT/DATASAVE BT test is being run, hold Teletype punch ON button down.

BLOCK #5 - WYLBUR TEST

If Block #1 verifies good for 2227, proceed with the following:

Set address switches to:

RCV = HEX 19, XMT = HEX 1D, EOM = HEX 11

BAUD RATE: Set baud rate switch to 300 baud.

NUMBER OF BITS: Set NB1 switch DOWN and NB2 switch UP for 7 data bit structure.

PARITY: Set PAR switch DOWN and OPS switch UP for even parity.

STOP BITS: Set stop bit switch UP for two stop bits.

Resultant switch settings should appear as follows:

UP - 110	} ——— BAUD RATE
UP 150	
DOWN - 300	
UP - 600	
UP - 1200	

DOWN - NB1  
UP - NB2 ] ——— NUMBER OF BITS  
DOWN - PAR  
UP - OPS ODD/EVEN PARITY  
UP - STOP BIT ——— 2 STOP BITS

TEST:

- 1) Dial WYLBUR at 617-646-9600.
- 2a) If using a model 103 modem (or 103 equivalent), wait for carrier tone and then press "data" button.
- b) If using acoustic coupler wait for high pitch sound from telephone and place receiver down into cups located on coupler. A light will illuminate on coupler when carrier tone is established. If not, redial WYLBUR.

NOTE: .

The coupler should be set for full duplex operation.  
EXAMPLE: On OMNITECH coupler, both switches  
located at rear of coupler must be out.

- 3) Key special function 00 for 2200A; 01 for 2200B.
- 4) Enter the word "GTWX" from keyboard and EXECUTE.
- 5) The computer will respond with "Wang Computer Service". If this does not occur, repeat step three (3).
- 6) The computer will again respond with "TERMINAL?" ENTER "W33" then C/R.
- 7) The computer will respond with "INITIALS?" ENTER "FES" then C/R.
- 8) The computer will respond with "ACCOUNT?" ENTER "FS" then C/R.
- 9) The computer will respond with "KEYWORD?" Enter keyword obtained from Home Office) then C/R.
- 10) The computer will respond with "COMMAND?".

You are signed on to the computer system. If you want to play out the program which is already in the computer, follow procedure in Section I.

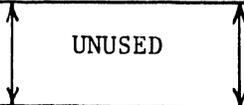
## SECTION I

The steps below follow step 10 of sign-on procedures.

- 1) ENTER "USE 2200 ON W33002" the C/R.
  - 2) The computer response "COMMAND?" ENTER "LIST UNN", the C/R.
  - 3) The computer will then send the test and it will be displayed on CRT.
- 1) This is a 2200 T.C. test.
  - 2) The 2200 can operate at 110, 150, 300, 600, and 1200 baud rate depending on modem.
  - 3) The bell 103A or compatible can operate at up to 300 baud/while bell 202C up to 1200 baud.
  - 4) The 2200 system can be selected for 5 to 8 data bits per character.
  - 5) The even or odd or not parity is switch selectable. Also 1 or 2 stop bits are switch selected.
  - 6) The 2200 T.C. uses half duplex mode which means it cannot receive and transmit at the same time.
  - 7) You must have received seven lines and this is the end of transmission.
- 4) When the test is completed the computer will respond with "COMMAND?" ENTER "CLR ACT" C/R.
  - 5) The computer will respond with "COMMAND?"
  - 6) ENTER "SIGNOFF", then C/R.
  - 7) The computer will respond with "OK TO CLEAR?" (Optional)
  - 8) ENTER "CLEAR", then C/R.
  - 9) The computer will give statistics on how long the terminal has been signed on, etc.
  - 10) The computer will send "END OF SESSION"; this concludes the test.

APPENDIX A - RS-232-C INTERFACE CONNECTOR CHECKS FOR 2227

The following table can be used to verify correct levels at the RS-232-C connector on the 2227.

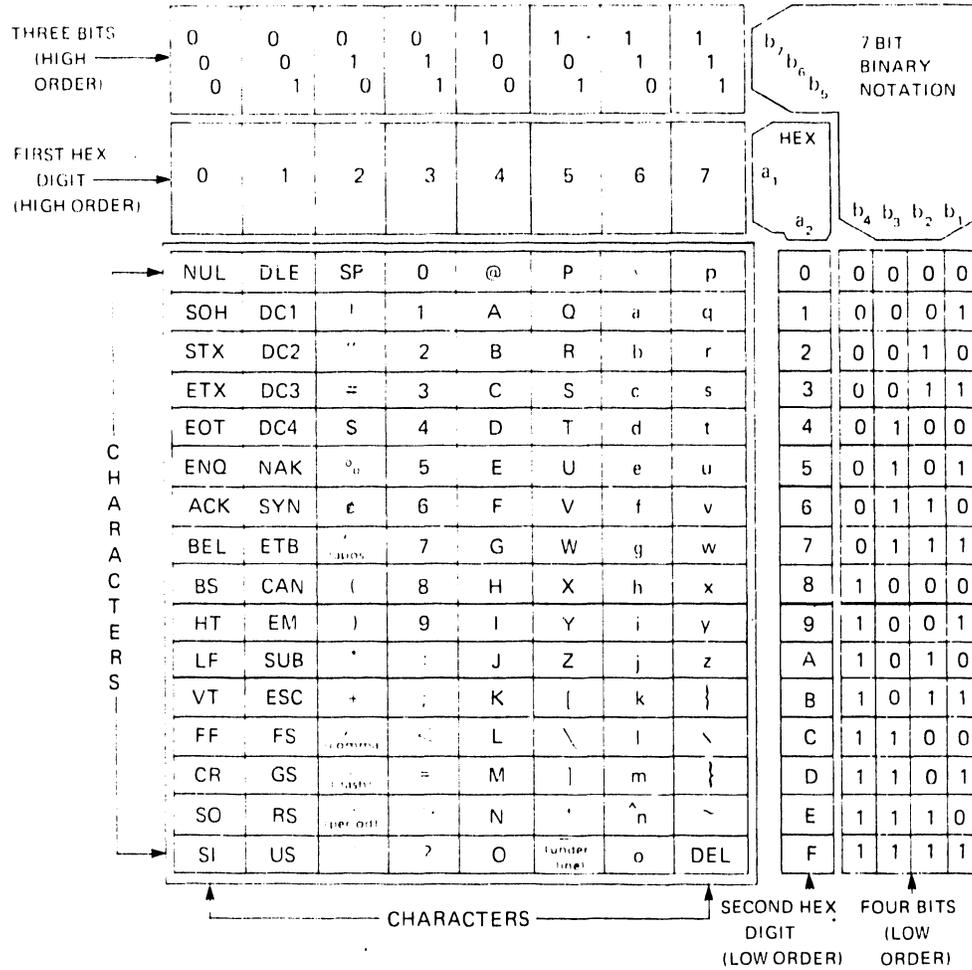
PIN #	EIA CIRCUIT	FUNCTION	LEVELS (No Line Established)	LEVELS (Line Established)
1	AA	Protective Ground	+0V	+0V
2	BA	Transmitted Data	-10V	+10V (data)
3	BB	Received Data	-10V	+10V (data)
*4	CA	Request To Send	-10V	+10V
5	CB	Clear To Send	-10V	+10V
6	CC	Data Set Ready	-10V	+10V
7	AB	Signal Ground	+0V	+0V
8	CF	Carrier Detector	-10	+10
<hr/> <div style="display: flex; justify-content: center; align-items: center; gap: 100px;"> <div style="text-align: center;">  <p>UNUSED</p> </div> </div> <hr/>				
20	CD	Data Terminal Ready	+10V	+10V
22	CE	Ringling Indicator	- NOT USED	

\* Used only with 202C modem; not with 103 modem.

APPENDIX B - ASCII CONTROL AND GRAPHIC CHARACTERS IN HEXADECIMAL AND BINARY NOTATION

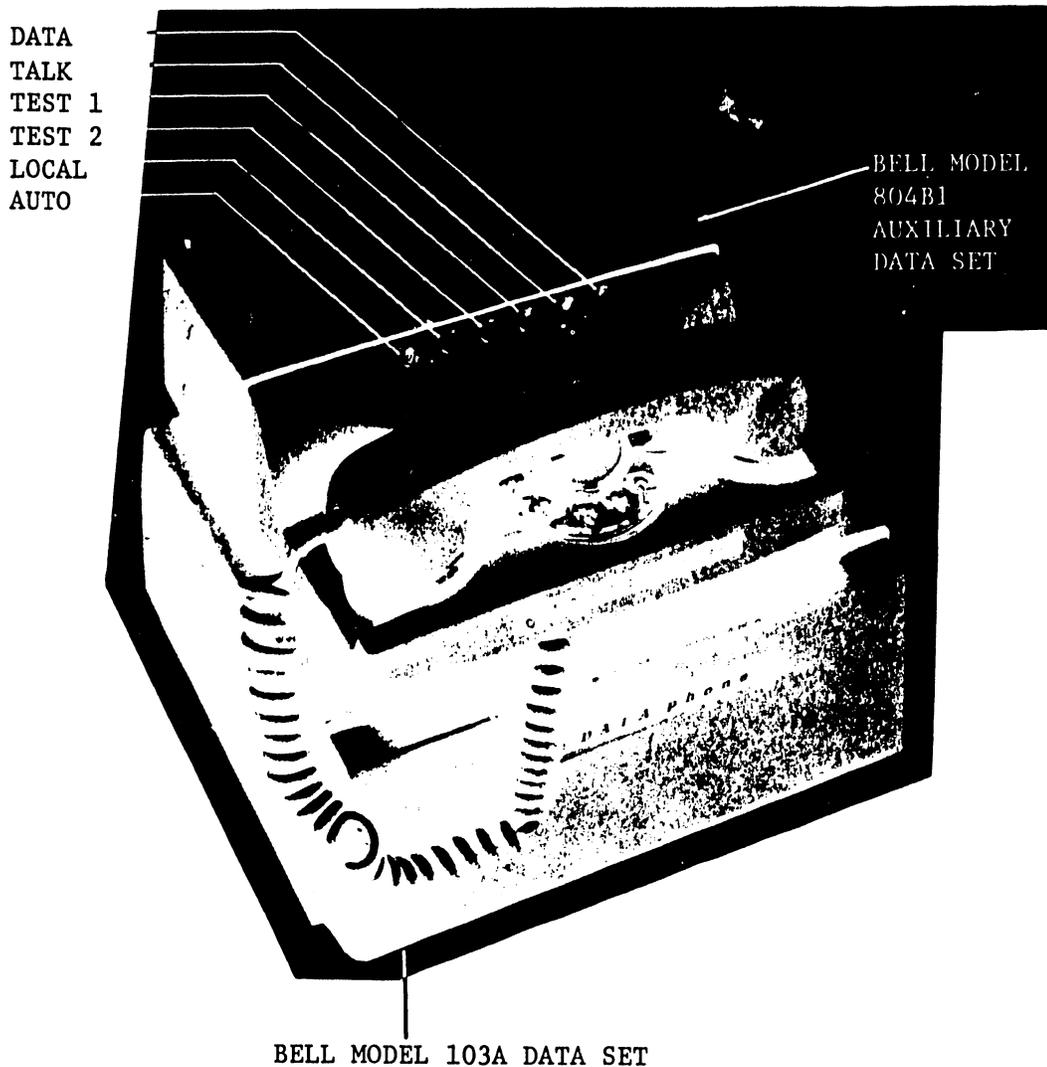
HEXADECIMAL CODES: HEX ( $a_1 a_2$ )

7-BIT BINARY CODES: ( $b_7 b_6 b_5 b_4 b_3 b_2 b_1$ )



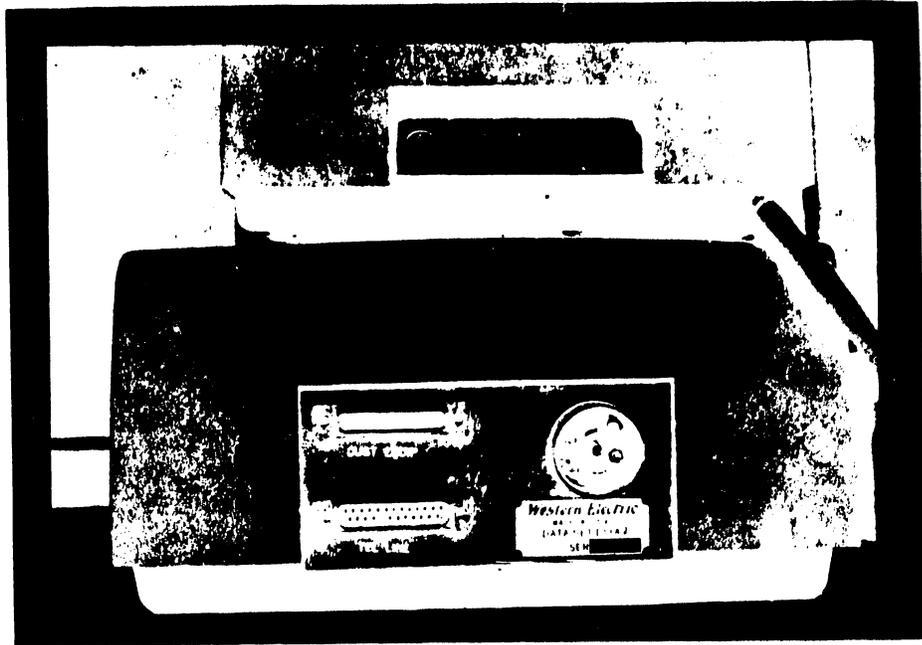
LEGEND FOR ASCII CONTROL CHARACTERS			
NUL	Null	DLE	Data Link Escape
SOH	Start of Heading	DC1	Device Control 1
STX	Start of Text	DC2	Device Control 2
ETX	End of Text	DC3	Device Control 3
EOT	End of Transmission	DC4	Device Control 4
ENQ	Enquiry	NAK	Negative Acknowledge
ACK	Acknowledge	SYN	Synchronous Idle
BEL	Bell (audible or attention signal)	ETB	End of Transmission Block
BS	Backspace	CAN	Cancel
HT	Horizontal Tabulation (punched card skip)	EM	End of Medium
LF	Line Feed	SUB	Substitute
VT	Vertical Tabulation	ESC	Escape
FF	Form Feed	FS	File Separator
CR	Carriage Return	GS	Group Separator
SO	Shift Out	RS	Record Separator
SI	Shift In	US	Unit Separator
		DEL	Delete

APPENDIX C - MODEM OPERATION (103A, 202C, Acoustic Couplers)



MODEL 103A CONTROLS

- (a) **AUTO BUTTON:** Establishes automatic answer circuit for customer equipment.
- (b) **LOCAL BUTTON:** Disconnects voice channel and connects transmit circuit to receive circuit, a test feature.
- (c) **TEST 1 BUTTON:** Turns on test circuit #1, a test feature.
- (d) **TEST 2 BUTTON:** Turns on test circuit #2 a test feature.
- (e) **TALK BUTTON:** Connects voice channel of phone for voice transmission.
- (f) **DATA BUTTON:** Establishes a line between customer terminals for data trasmission.



BELL 103A DATA SET - REAR VIEW

#### MODEL 103A JACKS

- (a) CUSTOMER EQUIPMENT: This is a female cannon connector which connects to the Wang 2227 via the Data Set Cable.
- (b) TELEPHONE LINE: This is a male cannon connector which connects to the telephone and telephone box via a cable coming from the telephone box.
- (c) POWER PLUG: This is a male three prong A.C. plug which connects to the 110 VAC line.

#### ESTABLISHING A LINE BETWEEN BELL 103'S

##### MANUAL ANSWER

To establish a line manually simply dial the number of the desired terminal you wish to make contact with. (Talk button depressed on both 103's). When contact is made the operators must determine which end will send and which end will receive. Each end must depress the DATA button on their 103A modems. This establishes a line; transmission should now be possible.

## AUTO ANSWER

Establishing a line automatically requires no assistance on the answer end, however, the originate end must make the initial contact. To make contact, the originate end, with the TALK button depressed, dials the answer end's number. When the answer end switches on it will generate a tone on the line and at this time the originate end should depress the data button and hang up. The data button stays lit and a line is established. On the answer end the 103A must have the AUTO button depressed, (AUTO button light should be on). When the originate end dials the answer end the bell will ring momentarily then the data light will illuminate.

## CONTROLS

The associated control unit is equipped with six push button keys for control of the station:

**DATA** - (nonlocking; releases any depressed locking key) - If the Talk key has been depressed and the telephone handset is off the cradle, the DATA key transfers the set from the voice mode to the data mode. It is illuminated when the set is in the data mode.

**TALK** - (Locking) - When depressed and the handset is lifted the set is placed in the voice mode. If it had been in the data mode, it is transferred to the voice mode.

**TEST 1** - (nonlocking) - Places the data set in the answer mode for test purposes. This key should be used only when and as directed by Telephone Company personnel. It is illuminated when the data set is in the test mode. If activated accidentally, the test mode may be canceled by operating the DATA key.

**TEST 2** - (nonlocking) - Returns the set from the answering to the originating mode for test. This key should be used only when and as directed by Telephone Company personnel.

**LOCAL** - (locking) - Places data set in the local mode. In this mode signals sent into circuit BA (Transmitted Data) appear on circuit BB (Received Data). This permits customers to make a check of the continuity of the interface connections and of the signal handling stages adjacent to the interface in the customer's equipment. It may be released by depressing the DATA, TALK, or AUTO keys.

**AUTO** - (locking) - When automatic answer is provided on a key-controlled basis, this key is depressed to enable the feature. Circuit CD (Data Terminal Ready) must also be "ON" for the feature to function. The key is illuminated when depressed. It may be released by depressing the DATA, TALK, or LOCAL keys.

If the option for continuous automatic answer is provided, the AUTO key is inoperative.

Automatic answer is available for use as desired by the customer to automatically answer all calls placed to the telephone line on which the data set has been installed. When the customer elects to use the automatic answer feature, the customer's data terminal equipment commands the data set to automatically answer calls by placing an "ON" condition on the CD (Data Terminal Ready) interface lead. If the data terminal equipment is not ready or if the customer does not want calls to be automatically answered, the CD (Data Terminal Ready) lead may be held in the "OFF" condition. Under this condition, the telephone bell on the associated control unit will ring without answering the call. Circuit CE (Ringing Indicator) will come "ON" with each ringing cycle. The customer may answer the call manually by lifting the telephone handset or command the data set to automatically answer the call by placing an "ON" condition on the CD (Data Terminal Ready) lead.

When the automatic answer feature is used, careful consideration for the disconnect of calls answered must be provided in the data terminal equipment.

The options available regarding the automatic answer feature are:

1. Automatic answer controlled by AUTO key
2. Automatic answer always available

The automatic answer feature is effective only when circuit CD (Data Terminal Ready) is "ON."

When all conditions for automatic answer have been met, an incoming call will be automatically answered, the data set will be put in the data mode, and channel establishment will proceed.

The DATA key will be illuminated when the data set achieves the data mode.

A short "ON" signal on circuit CE (Ringing Indicator) will occur as the call is answered.

### Local Mode

When the LOCAL key (locking) is depressed, the data set enters the local mode. In this mode, the signals applied to circuit BA (Transmitted Data) are repeated out through the circuit BB (Received Data). This permits a "loop-back" test of the customer's interface cable, the interface connectors, and the signal handling stages in the customer's equipment adjacent to the interface. Circuits CB (Clear to Send), CC (Data Set Ready) and CF (Carrier Detector) are "OFF" while in the local mode.

If an incoming call should be automatically answered while in the local mode, the data set will revert to normal operation for the duration of the call. The local mode is inoperative while in the test mode.

### Test Mode

A remote test feature has been provided with Data Set 103A in order to permit customer participation in determining maintenance responsibility, in the interest of holding service outages to a minimum. In the event that trouble in the data set is suspected, the customer should call the Telephone Company Repair Service. The trouble report then will be forwarded to a Telephone Company data test center where an attendant can call the customer at the data set location and request the customer to operate the data set TEST keys as described in Section 5. The remote tests performed check circuits in the data set up to the customer interface for the purpose of determining whether Telephone Company maintenance forces need to be dispatched or whether the customer should arrange for a maintenance check of his own equipment.

### Circuits:

Certain control circuits shall be designed to "fail safe." These include such circuits as Data Set Ready and Data Terminal Ready. "Fail safe" operation implies that the destination can interpret the signal condition as "OFF" when the source has lost power. In this case, no potential is applied by the source.

### Loss of Circuit

Loss of continuity of either direction of transmission of the telephone channel will cause circuits CB (Clear to Send) and CF (Carrier Detector) to go "OFF" at the end or ends 30 ms after losing tone. This may be used to call attention to this loss, if return to voice is not expected at the time.

### Circuit Functions

Circuit AA (Protective Ground) is tied to the frame of the data set, which is in turn grounded to the power system ground through the power cord. It may be tied to the frame of the customer's data terminal equipment. Such equipment, if operated by commercial power, should also have an appropriate ground applied to its frame.

In no case should Circuit AA (Protective Ground) be used to provide the sole protective ground to commercially powered data terminal equipment.

Whenever possible the data set and data terminal equipment should obtain their frame grounds from the same receptacle box or ground bus.

Circuit AB (Signal Ground) provides the reference point for all other interchange circuits. In this data set it is tied to the frame. It may be tied to the frame of the customer's data terminal equipment if the circuit so requires.

Circuit BA (Transmitted Data) is used by the data terminal equipment to present the data to be transmitted. It is only operative when circuit CB (Clear to Send) is "ON."

Circuit BB (Received Data) delivers the data received by the data set. When the data set is idle, or when circuit CF (Carrier Detector) is "OFF," circuit BB (Received Data) is held in the MARK condition.

Circuit CB (Clear to Send) indicates when "ON" that the data set has established a connection with the distant data set and that signals may be applied to circuit BA (Transmitted Data).

Circuit CC (Data Set Ready) indicates when "ON" that the data set is connected to

the telephone line and is in the data mode; that is, that it is not in the idle, talk, test, or local condition, nor is it without power.

Circuit CD (Data Terminal Ready) is used by the customer-provided data terminal to permit the data set to enter and remain in the data mode. It should be turned "ON" to allow the data set to automatically answer an incoming call, if all other conditions are met. It should also be turned "ON" to allow the set to be manually placed in the data mode. It is turned "OFF" to command the data set to disconnect the line at the end of the call.

Circuit CE (Ringing Indicator) turns "ON" to indicate the receipt of a ringing signal by the data set. If all conditions for automatic answering are met, it will turn "ON" for a brief period when the call is answered. If automatic answering is not enabled, the "ON" indication follows the ringing cycle, typically 2 seconds "ON," 4 seconds "OFF."

Circuit CF (Carrier Detector) indicates when "ON" that data carrier is being received from the distant end. In the method of operation used by Data Set 103A, this circuit and circuit CB (Clear to Send) carry simultaneous signals.

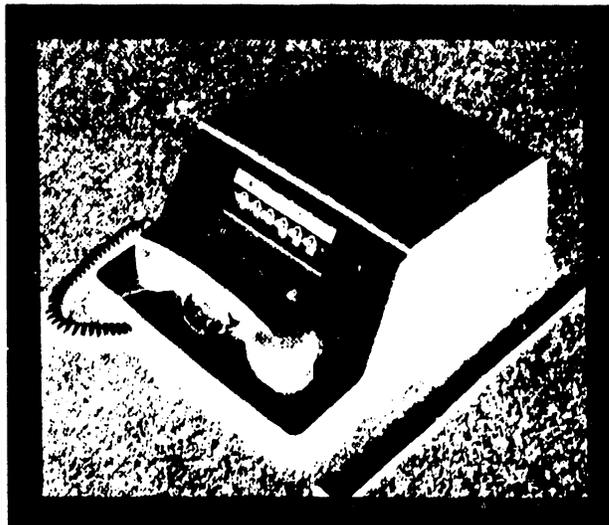
#### Modulation Rate

The maximum modulation rate of the channel provided by Data Set 103A is 300 bauds (300 bits per second maximum)

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Notes on 103A modem:

#### BELL 202C MODEM:



#### Originating Data Calls

The operator depresses the TALK key and places a telephone call to the distant terminal in the normal telephone manner. After the distant terminal answers:

Manually verbal agreement is reached as to when data is to be sent. A lamp is lighted under the TALK key of the called party. The called party pushes the DATA key first, the calling (or originating) party listens for a high pitched (2025 cps) tone, when that tone changes to a lower pitch (1200 cps – lead Request to Send ON or 387 cps – Request to Send OFF, Supervisory Transmitted Data ON, on station with reverse channel) and he then pushes the DATA key down until the associated lamp lights.

Automatically the high pitched tone will be heard for a few seconds. When that changes to a lower tone or goes OFF the DATA key (at the calling station) should be depressed until the associated lamp lights.

Noises that may get into the telephone transmitter while the operator is listening for the change in tone could keep the echo suppressor disabling circuit from functioning properly. To minimize this possibility, the operator should not talk during this interval.

When calling a station equipped with an earlier model data set (202A or 202B) it is not necessary to wait for the change in tone (sometimes there won't be any) before going to the data mode.

### Answering Data Calls

A data call can be answered manually or automatically. If the call is answered manually, the operator should insure that the TALK key is depressed and answer in the normal manner. The lamp will light under the TALK key at the called station. When verbal agreement is reached as to when transmission of data is to begin, the operator should depress the DATA key until its associated lamp lights. The set is now in the data mode and transmission can begin. If the call is answered automatically, no operation is required. The optional AUTO key can be used where it is desirable to answer in the unattended mode sometimes and the manual mode at other times. The operator depresses the AUTO key to permit the station to answer unattended.

### Terminating Data Calls

A data call can be terminated in two ways; the operator can depress the TALK key, lift the handset, and hang up, or the business machines can be arranged to use Data Terminal Ready to terminate the call.

### Telephone Lines

In order to maintain high quality service and to minimize interference from related devices, it is preferable to use data sets on individual lines that do not have extensions. Data Set 202C can be installed on conventional key telephone systems but the hold feature can not be provided. When the Data Set 202 is used on a 4-wire private line, a line and test key is installed to permit back-to-back testing and to provide uninterrupted termination to multipoint private lines when the data set is disconnected for maintenance or testing.

### Standard Interface Lead Definitions

**Circuit AA – Protective Ground – Lead 1**  
This conductor is electrically bonded to the equipment frame. It is further connected to external grounds through the power cord.

### Circuit AB – Signal Ground – Lead 7

This conductor establishes the common ground reference potential for all interchange circuits except Protective Ground. It is connected to the frame and to Protective Ground, to minimize the introduction of noise into electronic circuitry.

### Circuit BA – Transmitted Data – Lead 2

Direction: TO data set

Signals on this circuit are generated by the transmitting business machines and are connected to the transmitting data set for transmission to remote business machine equipment.

The transmitting business machine equipment must hold Transmitted Data in the OFF condition when no signals are to be transmitted.

Business Machine equipment designed for Receive-Only service must hold this circuit OFF at all times.

The OFF or ON signal condition shall be held for the total duration of each signal element.

### Circuit BB – Received Data – Lead 3

Direction: FROM data set

Signals on this circuit are generated by the receiving data set in response to data signals received from remote business machine equipment.

In half-duplex service, the receiving data set holds OFF condition on Received Data when both data processing terminals have their Request to Send in the OFF condition. In half-duplex service, the Received Data Circuit follows the Local Transmitted Data Circuit and may be used to monitor transmitted signals (e.g., for local copy).

The OFF or ON signal condition is held for the total duration of each signal element.

### Circuit CA – Request to Send – Lead 4

Direction: TO data set

Signals on this circuit are generated by the business machine equipment to condition the local data set to transmit. The carrier signal is transmitted during the ON

condition of Request to Send.

The ON condition must be maintained whenever the business machine equipment has information ready for transmission or being transmitted. The data set transmits all data on Transmitted Data, while the ON condition is maintained on Request to Send, Clear to Send, and Data Set Ready. The Request to Send lead must not be turned OFF for at least 1 millisecond after the end of the last bit that is applied to the Transmitted Data lead. This is to insure that the last bit clears the modulator before carrier is turned OFF. If local copy is being received on 2-wire circuits from the demodulator of the set that is transmitting, it will be necessary to delay the OFF signal on the Request to Send lead four milliseconds instead of one millisecond. This is to allow the last bit to clear the demodulator before the squelch circuit clamps the output of the demodulator.

In half-duplex service, the OFF condition holds the data set in the receive-data condition, and the ON condition holds the data set in the transmit-data condition. The above conditions are established without regard to signals on Transmitted Data and Received Data.

Business machine equipment designed for Receive-Only service must hold Request to Send in the OFF condition at all times.

Business machine equipment designed for either Transmit-Only or Full-Duplex service may hold Request to Send in the ON condition at all times.

On a multipoint communication channel which may successively carry data signals transmitted by several data communication equipment stations, Request to Send must be used by each data processing terminal equipment to condition its local data set to transmit.

**Circuit CB – Clear to Send – Lead 5**  
Direction: FROM data set

Signals on this circuit are generated by the transmitting data set to indicate that it is prepared to transmit data. The ON condition is a response to the ON condition on Request to Send delayed  $200 \pm 20$  milliseconds (except when Request to Send is turned ON during handshaking) to permit the data communication equipment to

establish a communication channel to a remote data processing terminal. When Request to Send is turned OFF, Clear to Send is also turned OFF.

In Receive-Only service, the data set holds Clear to Send OFF at all times.

**Circuit CC – Data Set Ready – Lead 6**  
Direction: FROM data set

Signals on this circuit are generated by the local data set to indicate that it is ready to operate.

The OFF condition indicates either:

- A. Any abnormal or test condition which disables or impairs the service furnished.
- B. That the communication channel is switched to the voice mode.
- C. That the local data set is not connected to a communication channel (i.e., the data set is on hook).

The ON condition appears at all her times.

This circuit indicates the status of the local data set. The ON condition should not be interpreted either as an indication that a communication channel has been established to a remote station or the status of any remote station or equipment.

**Circuit CD – Data Terminal Ready – Lead 20**

Direction: TO data set

Signals on this circuit are used to control switching the data set to the communication channel. The ON condition permits the data set to be connected to the communication channel. However, if the station is equipped only for call origination by means external to this interface (e.g., manually or an automatic call origination unit), then the ON condition serves only to maintain the connection established by these external means. When the station is wired for automatic answering of received calls, connection to the line is arranged to occur in response to a ringing signal.

The OFF condition removes the data set from the communication channel, for such reasons as:

- A. Freeing the line for alternate use (e.g., voice or use by other stations).

- B. Permitting use of the business machine equipment for an alternate function.
- C. Terminating a call (i.e., going on hook).

The OFF condition does not disable the operation of Circuit CE (Ring Indicator).

It should be noted that in stations wired for unattended answering (not using the AUTO key option) when it is desired to answer manually, Data Terminal Ready will be held OFF. Once the operator answers manually and decides to go to the data mode, the call will fall down if Data Terminal Ready is OFF when the DATA key is pushed.

#### Circuit CE – Ring Indicator – Lead 22

Direction: FROM data set

Signals on this circuit indicate that a ringing signal is being received from a remote station. This circuit is used for automatic answering of received calls.

The ON condition indicates that a ringing signal is being received. The OFF condition is maintained at all other times.

Operation of this circuit is not disabled by an OFF condition on Data Terminal Ready.

#### Circuit CF – Data Carrier Detector – Lead 8

Direction: FROM data set

Signals on this circuit are used to provide an indication that the data carrier is being received and has been received for at least  $40 \pm 10$  milliseconds. When the data carrier is lost because the transmitting data set is turned OFF or because of a fault condition, the OFF condition follows after a 15 millisecond guard time delay.

In half-duplex service the Data Carrier Detector responds to carrier signals from either the local or remote transmitting data set.

The ON condition indicates reception of the data carrier. The OFF condition provides an indication of the end of present transmission activity or a fault condition.

#### Circuit SA – Supervisory Transmitted Data – Lead 11

Direction: TO data set

Signals on this circuit are used for com-

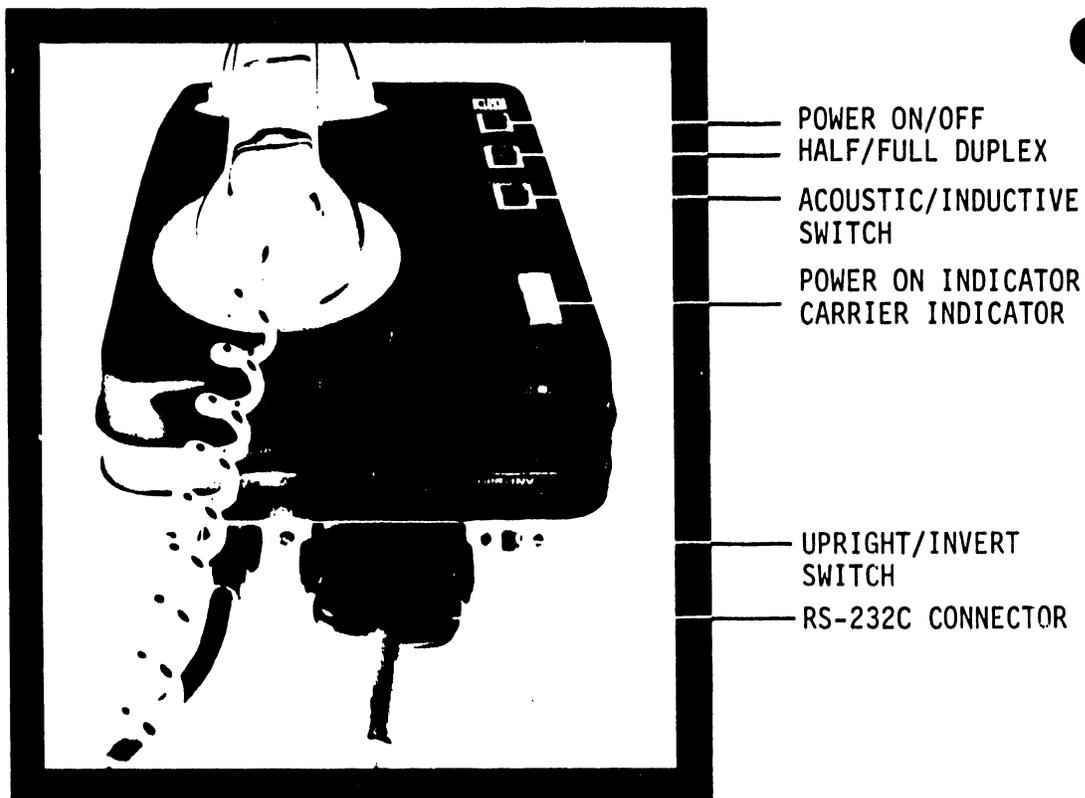
munication from the receiving data set to the transmitting data set simultaneous with the normal data channel. This channel can only be used when Request to Send is OFF. This lead is provided only on data sets equipped with reverse channels.

#### Circuit SB – Supervisory Received Data – Lead 12

Direction: FROM data set

Signals on this circuit are used to inform the transmitting data set of conditions at the receiving data set simultaneous with the normal data channel. This lead is provided only on data sets equipped with reverse channels.

## ACOUSTIC COUPLERS



DEI ACOUSTIC COUPLER

### ACOUSTIC COUPLER AND DATA SET JACKS

- (a) DATA TERMINAL: The 2227 Controller/Data Set Cable plugs into this terminal.
- (b) 117 VAC INPUT: Three prong power cord connects to this jack and to a 117 VAC OUTLET.
- (c) ADAPTOR INPUT (DATA SET ONLY): Acoustic Adaptor cable connects to this jack.

### ACOUSTIC COUPLER AND DATA SET CONTROLS

- (a) ON/OFF SWITCH: Turns A.C. power on and off.
- (b) HALF/FULL SWITCH: Set to Full duplex.
- (c) ORIGINATE/ANSWER SWITCH: To establish a line between two couplers one unit must be the originate unit and the other the answer-back unit. Unless originating, leave in ANSWER.

## ACOUSTIC COUPLERS

- (d) ACOUSTIC/INDUCTIVE SWITCH: (With a Data Set Acoustic Adaptor System). This switch determines whether the receiver of the acoustic adaptor will pick up data acoustically or inductively. With the switch in the INDUCTIVE position, isolation from ambient room noise will be at its maximum. Some couplers provide additional shielding to minimize magnetic fields, in these cases acoustic pick-up will provide optimum performance.
- (e) UPRIGHT/INVERT SWITCH: Adapts to output polarities of Wang Controller the 2227 uses the *INVERT* position.
- (f) CARRIER INDICATOR: A light which indicates that a line has been established successfully between two terminals.

### ESTABLISHING A LINE BETWEEN TWO COUPLERS OR DATA SETS.

An acoustic coupler and an acoustic adaptor contain two rubber cups mounted on the top of the unit (See Figure). One of these cups contains a pick up device and the other a speaker. The handset of a telephone should fit snugly into these cups and because of their design, should isolate the pick up device from room noises. When a telephone handset is placed into these cups, any signals transmitted from the other terminal are picked up by the pick-up devices within the cup and transfers these signals to the modulator-demodulator unit. Do not place the handset into the cups until the following procedure is followed.

- (a) Place ON/OFF Switch to ON position.
- (b) Place HALF/FULL Switch to FULL position.
- (c) Place ACOUSTIC/INDUCTIVE Switch to position which will give maximum performance.
- (d) Place UPRIGHT/INVERT Switch to INVERT.
- (e) Phone desired terminal and determine which end will be the originate end and which end will be the answer end. With this determined place the ORIGINATE/ANSWER Switches in their appropriate positions.
- (f) Now the handsets at both terminals may be placed in the rubber cups of their couplers\*.

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\*At least one of the two couplers must be capable of originating a carrier tone. Some couplers have no carrier origination capability.

APPENDIX D - WANG SYSTEM 2200/2227 TELECOMMUNICATIONS CHECK LIST

- 1) Is the transmission asynchronous?

The answer must be "yes"; synchronous transmission is not possible with the System 2200/2227.

- 2) Is the transmission rate 110, 150, 300, 600, or 1200 baud?

Sending and receiving rates must match. Depress the appropriate baud rate switch on the Model 2227 board.

Check the feasible rates below:

- (a) Over telephone lines, from (or to) a System 2200/2227 connected to a Bell 103A modem or equivalent: 110, 150, or 300 baud.
- (b) Over telephone lines, from (or to) a System 2200/2227 connected to a Bell 202C modem or equivalent: 110, 150, 300, 600 or 1200 baud.
- (c) Over direct connection lines, from (or to) a System 2200/2227 connected to the WANG Model 2227-N null modem or equivalent: 110, 150, 300, 600, or 1200 baud.

- 3) What is the character set of the other systems?

Hopefully, ASCII. The System 2200 uses the ASCII character set consisting of 7-bit coded control and graphic characters (8 bits including the parity check bit). A different character set requires conversion either in the System 2200 or the other system.

- 4) What is the character format of the other system?

The Model 2227 Telecommunications Controller can interact with most character formats; e.g., a typical timesharing service uses one start bit, seven data bits, even parity, and two stop bits.

Set switches, as required, for the following items:

- (a) Is there 1 start bit? (No switch. This is standard.)

SUGGESTED TYPICAL CHECKLIST FOR CUSTOMER FILES:

2200 TELEPROCESSING INFORMATION

Customer:

System Configuration:

Length of Cable between 2200 CPU and Modem:

Terminal previously used (if any):

Date system is operational:

COMPUTER NOMENCLATURE:

- 1) Main Frame:
- 2) Front End: (Line control unit, concentrator, etc.)
- 3) Modem Type (or) Type Compatible:

4) Character Structure:

(a) Number of data bits per character:

- 5
- 6
- 7
- 8

(b) No Parity/Parity; Even or Odd:

- No Parity
- Even Parity
- Odd Parity

(c) Number of Stop Bits:

- 1
- 2

5) E.O.M. (End of Message Character - Switch Setting):

6) Baud Rate(s):

- 110
- 150
- 300
- 600
- 1200

- (b) Are there 5, 6, 7, or 8 data bits? (Set switches NB1 and NB2 according to instructions printed on the Model 2227 faceplate.)
  - (c) Is there parity or no parity? (Set switch PAR: DOWN for parity; UP for no parity.)
  - (d) If parity, is it odd or even? (Set switch OPS: DOWN for odd parity; UP for even parity.)
  - (e) Are there 1 or 2 stop bits? (Set switch LSB: DOWN for 1 stop bit; UP for 2 stop bits.)
- 5) What modem is connected to the System 2200? To the other system?
- (a) Is the modem a Bell 103A3, a Bell 202C, or equivalent to one of these? If so, determine the appropriate dialing procedure for hookup to a host CPU (which must be using an equivalent level modem).
  - (b) Is the modem an acoustic coupler? If so, set the FULL/HALF duplex switch in the "FULL" position. Then, initiate the phone call for hookup to a host CPU.
- 6) What is the protocol of the System being contacted?
- 6.1 What telephone number should be called?
    - For 110 baud:
    - For 300 baud:
    - To ask questions:
  - 6.2 What is the normal event sequence immediately after the carrier is established?
    - (a) Does the host CPU send a code to the System 2200 first? If so, what is the code? Is it a single character or a whole text line? (If communicating under program control, the BASIC language receiving variables must be dimensioned properly.) What response from the System 2200 is required by the host?

(b) Does the WANG System 2200 transmit first? If so, what code is required? For example: Send a single character "ESCAPE" code; i.e., HEX (1B), with no carriage return character. Or, send the code "GTWX". Or, send a sign-on message with a specified format.

6.3 What is the end-of-message (EOM) code; i.e., what is the termination code for a text line and/or a query line?

(a) Is it a carriage-return-character; i.e., HEX (0D)?

(b) Is it a Teletype X-ON character; i.e., HEX (11)?

(c) Is it another character? If so, what code?

If the EOM code of the host CPU is not HEX (0D), the internal EOM switch on the Model 2227 printed circuit board may require resetting; e.g., to HEX (11) or other code. The EOM switch automatically converts the code set on the switch to HEX (0D) required by the System 2200.

6.4 What message or code is sent by the host system when it wants the System 2200 to respond? (Such as "COMMAND?" - WYLBUR)

7) Is there a sample run on file to demonstrate a successful connection with the system being contacted?

If not, document a sample run as soon as a successful hookup is made. Indicate what codes, messages, and control characters should be received and sent.

APPENDIX E - QUESTIONS AND ANSWERS ON SYSTEM 2200 COMMUNICATIONS

- 1) Q. Can communication take place if one end has a 103 modem and the other end a 202C?  
  
A. NO. Both ends must have the same type of modems.
  
- 2) Q. Can communications take place if both ends have acoustic couplers?  
  
A. NO. One end must have a modem or originate/answer coupler.
  
- 3) Q. Can a 2227 controller be connected directly to another 2227 controller to enable one 2200 system to communicate with another?  
  
A. NO. However 2200 to 2200 communication is possible using a Null modem in conjunction with the two 2227 controller boards.
  
- 4) Q. Can a 2227 controller be used to run a Teletype?  
  
A. Yes, if they are connected with a Null modem. The Teletype codes ESCAPE and BREAK will not generate RESET and HALT/STEP.
  
- 5) Q. If a 2207A controller is used, in what mode must the Teletype be wired?  
  
A. Full Duplex mode; 20 milliamperes wiring.
  
- 6) Q. Customer has a Teletype for input and output instead of a CRT and keyboard. What should the address switches be set to on the 2207 controller board?  
  
A. The RCV address switch to  $01_{16}$  and the XMT address switch to  $05_{16}$ .

7) Q. With same configuration as question 6, what address must be used to punch or read paper tape?

A. SELECT TAPE 405 to load or save tape.

DATALOAD/405, A\$

DATASAVE/405, A\$

**END**