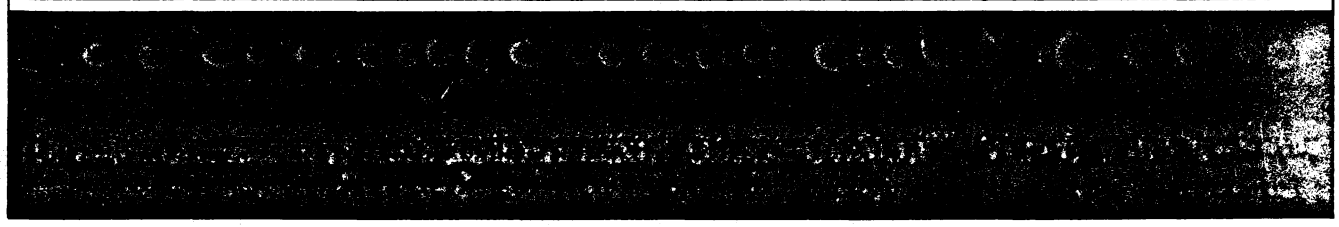
INSTALLATION AND OPERATION

Model 990 Computer TTY/EIA Terminal Interface

Part No. 946240-9701 *A
15 December 1980

TEXAS INSTRUMENTS



MANUAL REVISION HISTORY

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(946240-9701 *A)

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Preface

This manual provides installation, operation, and programming information for the Texas Instruments TTY/EIA Terminal Interface Module, part number 945075. The information in this manual is divided into four sections and one appendix:

Section

1 General Description — This section provides a brief description of the TTY/EIA Terminal Interface Module, including characteristics and operating mode.

2 Installation — This section provides instructions for unpacking, inspecting, and installing the interface module into a Model 990 Computer mainframe or expansion chassis. It also provides interconnection information for establishing the communication link with the Model 990 Computer.

3 Programming — This section provides programming instructions for the interface module and a description of the way the software controls its operation.

4 Operation — This section contains an interface description of the TTY/EIA Terminal Interface Module, describes the interfaces with the Model 990 Computer and a peripheral device, and provides a discussion of the module's operation.

Appendix

A Communication System Information — This appendix contains information on the Bell data sets and telephone handsets that may be used with the interface module.

Additional information related to the TTY/EIA Terminal Interface Module may be found in the following documents:

Title	Part Number
Model 990 Computer Programming Card	943440-9701
Model 990 Computer 733 ASR/KSR Terminal Installation and Operation	945259-9701
Model 990 Computer Family Maintenance Drawings	945421-9701
Model 990 Computer TTY/EIA Interface Module Depot Maintenance Manual	945408-9701
Model 990 Computer Diagnostics Handbook	945400-9701

Title	Part Number
Model 990 Computer Model 743 KSR Data Terminal, Installation and Operation	946257-9701
Model 990/4 Computer System Hardware Reference Manual	945251-9701
Model 990/10 Computer System Hardware Reference Manual	945417-9701
Model 990/12 Computer Hardware User's Guide	2264446-9701
Model 990 Computer Communications System Installation and Operation	945409-9701
Model 990 Computer Model 820 KSR Data Terminal Installation and Operation	2250454-9701
Model 990 Computer Model 810 Printer Installation and Operation	939460-9701
Logic Diagram, Full Duplex TTY/EIA Module	945077

1

General Description

1.1 GENERAL

The Texas Instruments TTY/EIA Terminal Interface Module (Figure 1-1) provides an interface between a Model 990 Computer and local peripheral devices that conform to one of the following interface standards:

- Teletypewriter (TTY) 20 milliampere nonpolar current loop
- Electronic Industries Association (EIA) RS-232C

The interface module may also be used to provide an interface between a Model 990 Computer and an asynchronous modem when used with a special cable available from TI for that purpose.

In the TTY mode of operation, the interface module supplies the power for operating a 20 milliampere nonpolar current loop. The loop power is limited to +5 volts, 20 milliamperes direct current. TTY operation of the interface module requires four-wire circuits as listed in Table 2-3.

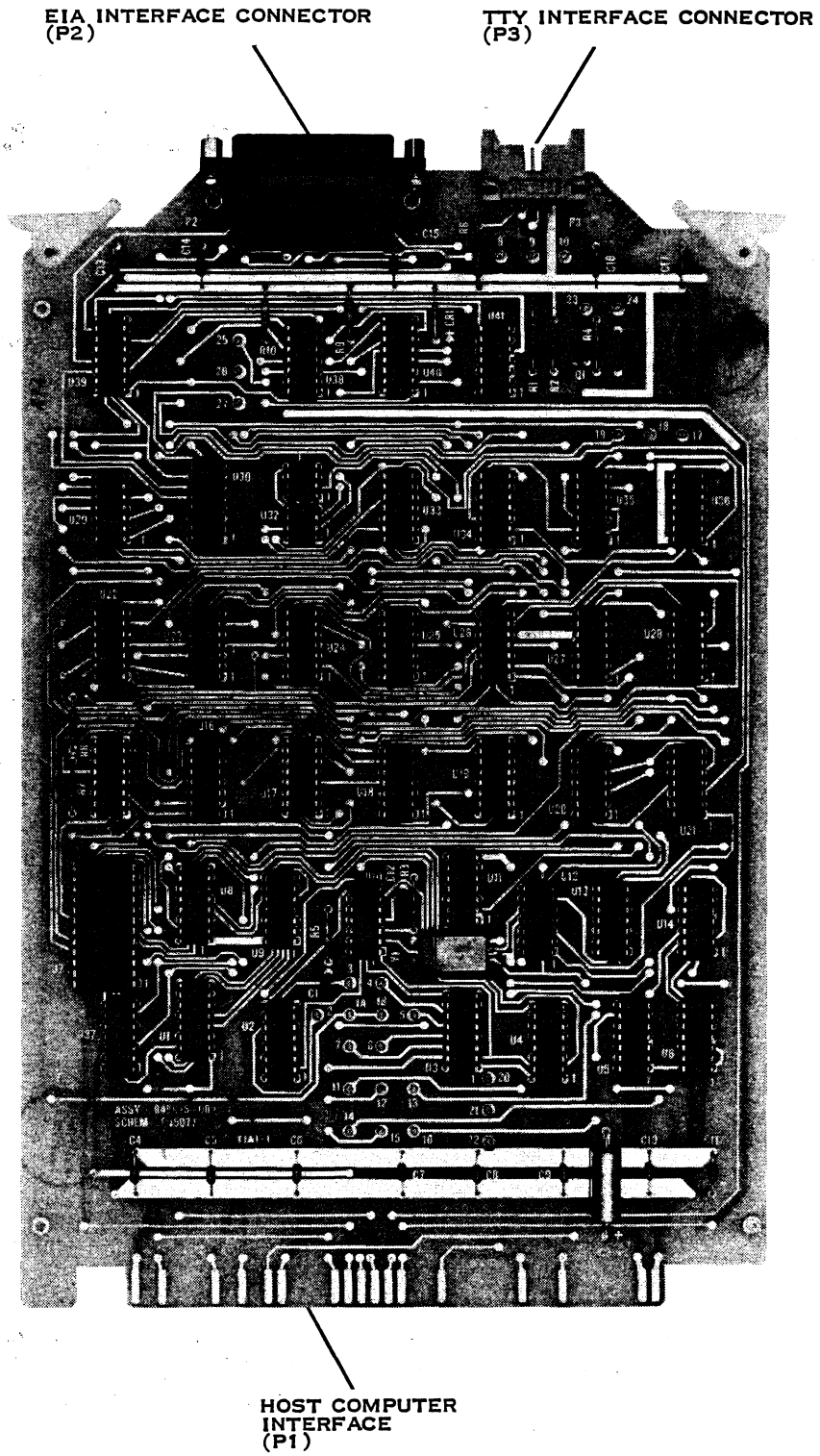
The signals at the EIA interface connector on the interface module are designed to emulate asynchronous modem signals. This allows most terminals that operate from an EIA RS-232C interface to be connected to the interface module via the cable supplied with the terminal. Although most terminals that operate from an RS-232C interface are electrically compatible with the interface module, TI software is not available to support all terminals.

It is important to note that the signals appearing at the EIA connector have different mnemonics from the standard set of RS-232C interface signals. The differences are pointed out in detail in Table 2-4.

Table 1-1 is a list of some terminals and modems that are commonly interfaced to a Model 990 Computer via the interface module. Transmit and receive rates ranging from 75 to 9600 baud and character code formats of 10 or 11 bits are selectable by plug-in jumpers on the module.

1.2 EQUIPMENT OVERVIEW

Figure 1-2 is a simplified block diagram of the logic on the TTY/EIA Terminal Interface Module. The interface module contains transmit, receive, timing, and diagnostic logic. The transmit and receive logic are capable of operating simultaneously to achieve full duplex asynchronous operation of the interface module. Module timing is provided by a 4.0 megahertz oscillator and a group of counters. The counter outputs may be selected by plug-in jumper to provide the timing necessary for baud rates from 75 to 9600.



(A) 143840

Figure 1-1. TTY/EIA Terminal Interface Module, Printed Wiring Board, Top View

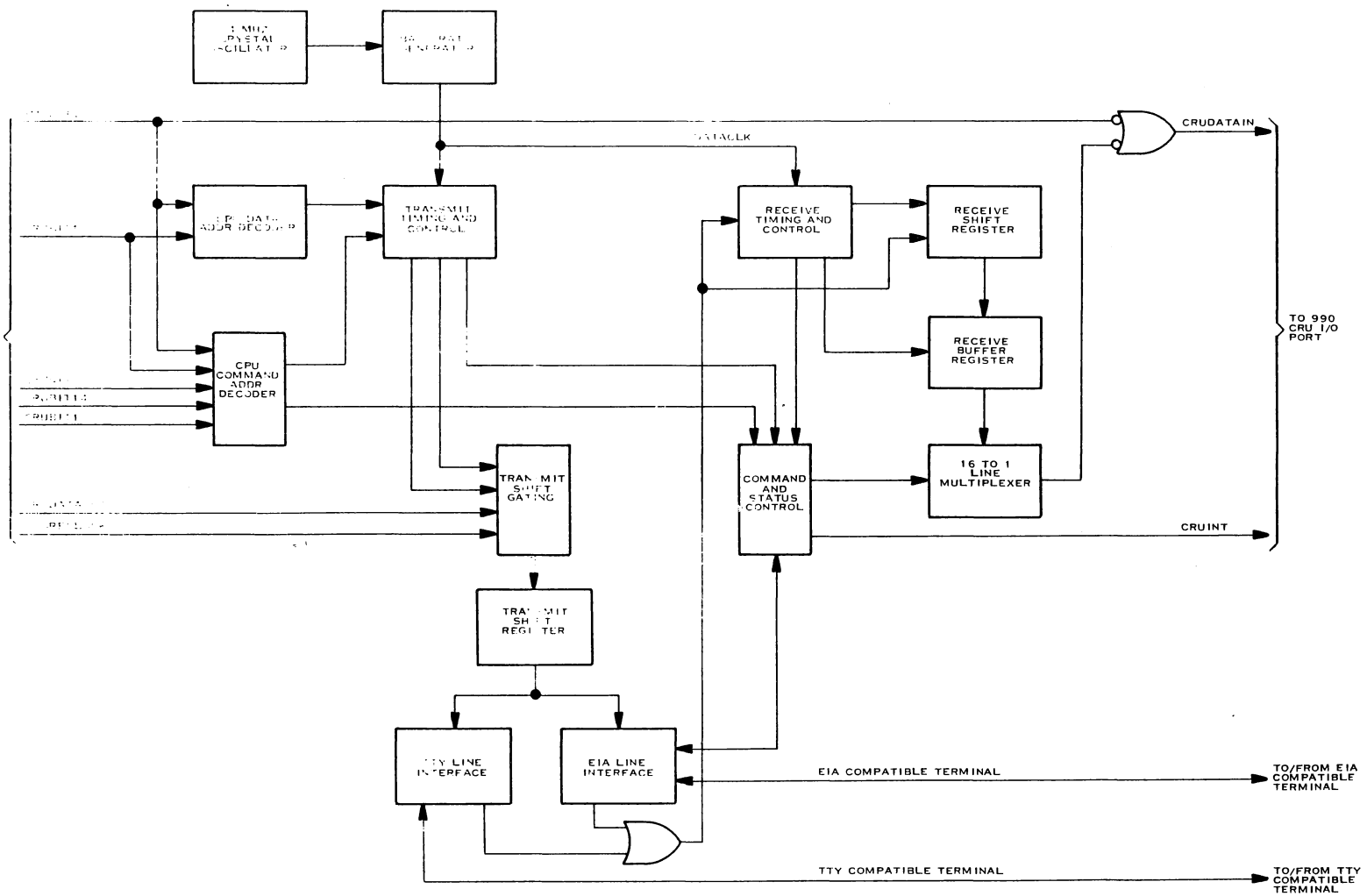


Figure 1-2. Full Duplex TTY/EIA Terminal Interface Module, Simplified Block Diagram

In either the TTY or EIA mode of operation, parity generation and checking must be provided by software if it is required. The interface module does not support break generation and detection or false start bit detection.

Table 1-1. Typical Terminal Devices

Model	Device Name	Manufacturer
Model 733 ASR/KSR	Data Terminal	Texas Instruments
Model 743/745/820 KSR	Electronic Data Terminal	Texas Instruments
Model 306/588/603/810	Printer	Texas Instruments
Model 103 (A, F, or J)	Data Set	Bell
Model 113 (C or D)	Data Set	Bell
Model 212 (A)	Data Set	Bell
DEC Writer II	Data Terminal	Digital Equipment Corp.
Interdata Carousel	Data Terminal	Interdata
Hy Type	Data Terminal	Diablo Systems
Model 3320/5JE	Teletypewriter	Teletype Corp.

1.2.1 Transmit Mode

In the transmit mode, the computer transfers serial data into the transmit shift register with a STORECLK- signal. Address bits and a module enable signal allow the shifting process to continue until an eight-bit character has been loaded into the shift register. When a full character has been received from the computer, the transmit go flag is set. The transmit go flag enables development of a transmit shift clock whose frequency is determined by the oscillator/counter network. The transmit shift clock serially transfers the start bit, the eight-bit character, and one or two stop-bits to the attached data terminal. The write request flag is set to indicate that the character has been output to the data terminal and the interface module is ready for another transmission cycle.

1.2.2 Receive Mode

In the receive mode, the data terminal holds either the TTY or EIA input in a mark (logic 1) condition until a space (logic 0) condition indicates that a new character is about to be transmitted to the interface module. The space condition sets the receive go flag, which enables the development of a receive shift clock whose frequency is determined by the oscillator/counter network. The receive shift clock gates the serial input data into an eight-bit shift register until a full character has been received. The shift register character is transferred in parallel to a buffer register and applied to a multiplexer for reading by the computer. The read request interrupt logic is set to indicate that the buffer register holds a character for the computer. The computer then enters a service routine that supplies the necessary module enable and address bits to fetch the character.

1.2.3 Interrupt Response

An interrupt line from the interface module informs the computer when the write request flag or read request interrupt logic is set, or when a transition occurs in the data set ready or data carrier detect signals from the data terminal. All four signals are applied to the multiplexer and can be read by the computer to determine the source of the interrupt. The computer instruction repertoire includes single (SBO, SBZ, and TB) and multiple (LDCR and STCR) bit instructions that can be used to control operation of the interface module. The SBO and SBZ instructions set and clear the addressed control flip-flop; the TB instruction tests the addressed input status line. The LDCR instruction serially transfers an eight-bit character from memory to the interface module transmit shift register, and the STCR instruction reads an eight-bit character from the interface module receive buffer register into the computer memory.

1.2.4 Character Format

The interface module transmits and receives 10- or 11-bit format code as illustrated in Figure 1-3. Eight data bits are provided by either the computer or the attached terminal. The terminal also supplies, with its input data, a start bit and either one or two stop bits. The terminal requires these start and stop bits in data transmitted to it. The interface module removes the start and stop bits from data before transmitting the data to the computer. The start and stop bits synchronize the receiving circuitry with the remote transmitter for each character transmitted. Thus, characters may be transmitted in blocks or in random bursts. The 10- or 11-bit code formats are selected by jumper connections on the interface module.

1.2.5 Diagnostic Mode

The diagnostic mode is enabled by setting CRU output bit 15 to a one. In this mode, EIA outputs are looped back into the EIA inputs. Output and input signals are connected as follows (Table 1-2):

Table 1-2. Diagnostic Mode Output-to-Input Signals

EIA Output Signal		EIA Input Signal
Data Terminal Ready (DTRE)	to	Data Set Ready (DSRE)
Request to Send (RTSE)	to	Data Carrier Detect (DCDE)
Transmitted Data (XMTDE)	to	Received Data (RCVDE)
Request to Send Negated (RTS negated)	to	Reverse Channel Receive (RCRE)

1.3 PHYSICAL CHARACTERISTICS

The TTY/EIA Terminal Interface Module is implemented on a two-layer half-size printed wiring board (PWB) using discrete TTL logic. It may be inserted into any CRU slot in a Model 990 Computer chassis or CRU expansion chassis. The interface module PWB is 177.8 millimeters (7.00 inches) wide and 274 millimeters (10.8 inches) long.

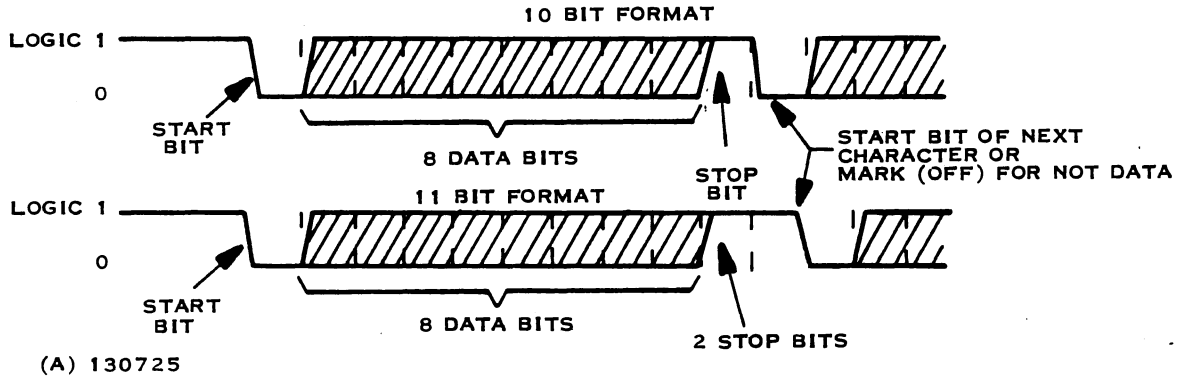


Figure 1-3. Asynchronous (START/STOP) Data Transmission Formats

Bottom-edge connector P1 is an 80-pin male connector that mates with an 80-contact female connector in the backplane of the chassis to provide the interface between the host computer and the interface module. Connector P2, on the top of the interface module, is a 25-pin connector that provides the interface to EIA RS-232C type devices. Connector P3, also on the top of the interface module, is a 10-pin connector used to provide the TTY interface for devices that operate in the current loop mode. The pin assignments for connector P2 and P3 are listed in Section 2.

The interface module contains eight sets of jumper sockets labeled E1 through E27 supplied with plug-in jumpers. The jumper plugs (Figure 1-4) should be installed as instructed in Section 2 before the interface module is installed in the chassis.

1.4 POWER REQUIREMENTS

Power from computer or expansion chassis:

+5 Vdc at 0.38 A
+12 Vdc at 20.0 mA
−12 Vdc at 20.0 mA

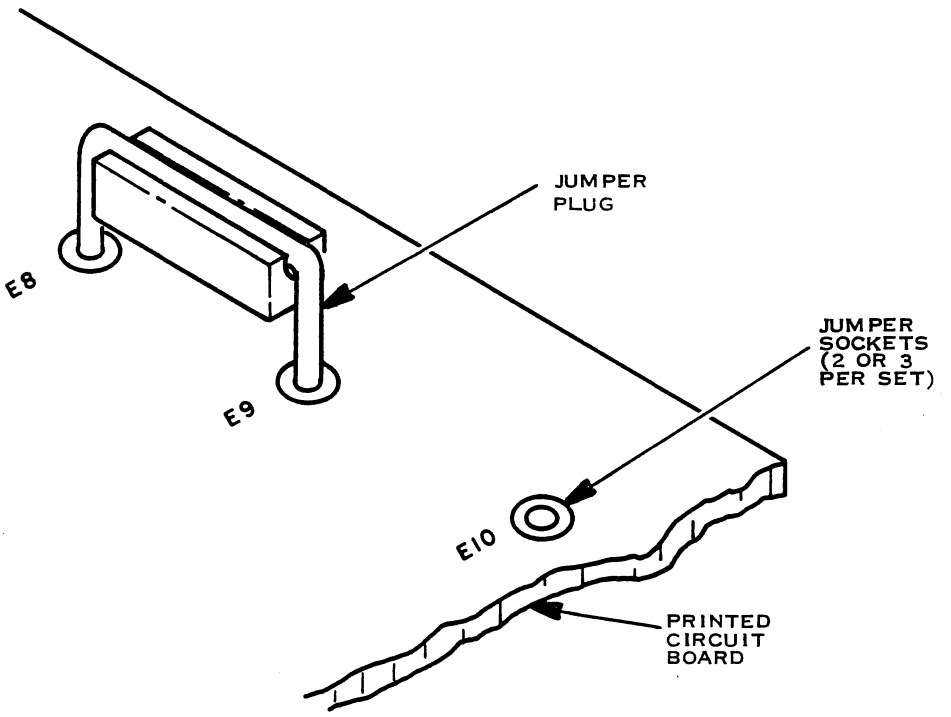


Figure 1-4. Typical Jumper Plug Installation

2

Installation

2.1 GENERAL

This section provides instructions for unpacking, inspecting, and installing a TTY/EIA Terminal Interface Module. Particular attention is given to the connection of the jumper plugs provided with the circuit board.

2.2 UNPACKING

The interface module is packed in one box and wrapped in plastic bubble-pack wrapping. Visually inspect the box for signs of damage. Open the box and remove the interface module from the bubble-pack wrapping. Verify that at least eight jumper plugs have been received. (They are shipped plugged into the circuit board.) Do not discard any packing material until all equipment is accounted for.

2.3 INSPECTION AND PREPARATION FOR INSTALLATION

Perform the following steps prior to installing the interface module into a chassis slot:

1. Visually inspect the circuit board for cracks, corrosion, loose components, and loose connectors.

2. Remove all jumper plugs from their sockets.

3. According to the predetermined operating requirements for the interface module, insert the jumper plugs into the sockets. Table 2-1 gives the recommended connections for several terminals and printers with which the interface module may be used. See Figure 2-1 for jumper socket locations.

NOTE

If a cable length greater than 150 meters (approximately 500 feet) is necessary, the baud rate may have to be reduced to achieve error free performance.

4. Install a center card guide (if one is not present) for the selected chassis slot.

Table 2-1. Jumper Configuration Schedule

0 = Options

X = Recommended Options

		Jumper		EIA						TTY						EIA	TTY
				ASR	KSR					ASR	KSR					Printer	Printer
		From	To	733	733	742	743	745	820	33	733	733	742	743	820	306, 603, 588, 810	306, 603, 588, 810
Baud Rate	75	EIA	E2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	*110	EIA	E2	0	0	0	0	0	0	X	0	0	0	0	0	0	0
	300	EIA	E3	0	X	0	X	X	0	—	0	X	0	X	0	0	0
	1200	EIB	E4	X	0	X	0	0	0	—	X	0	X	0	0	0	0
	2400	EIB	E5	—	—	—	—	—	0	—	—	—	—	—	0	0	0
	4800	EIB	E6	—	—	—	—	—	X	—	—	—	—	—	X	X	X
	9600	EIA	E7	—	—	—	—	—	0	—	—	—	—	—	0	0	0
Logic Level	EIA	E9	E8	X	X	X	X	X	X	—	—	—	—	—	—	X	—
	TTY	E9	E10	—	—	—	—	—	—	X	X	X	X	X	X	—	X
Code Format (Receive)	10 bit	E12	E11	X	X	X	X	X	X	—	X	X	X	X	X	X	X
	11 bit	E12	E13	—	—	—	—	—	—	X	—	—	—	—	—	—	—
Code Format (Transmit)	10 bit	E15	E14	X	X	X	X	X	X	—	X	X	X	X	X	X	X
	11 bit	E15	E16	—	—	—	—	—	—	X	—	—	—	—	—	—	—
Enable Receive During RTS		E17	E18	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Disable Receive During RTS		E18	E19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Disable 110 Baud (enables other rates)		E20	E21	X	X	X	X	X	X	—	X	X	X	X	X	X	X
Enable 110 Baud		E21	E22	—	—	—	—	—	—	X	—	—	—	—	—	—	—
110 Baud Filter (TTY mode only)		E23	E24	—	—	—	—	—	—	X	—	—	—	—	—	—	—
RTSE = RTSE		E26	E25	X	X	X	X	X	X	X	X	X	X	X	X	—	—
RTSE = DTSE		E26	E27	—	—	—	—	—	—	—	—	—	—	—	—	X	X

* If 110 baud is selected, jumper E21 to E22. Otherwise, jumper E20 to E21.

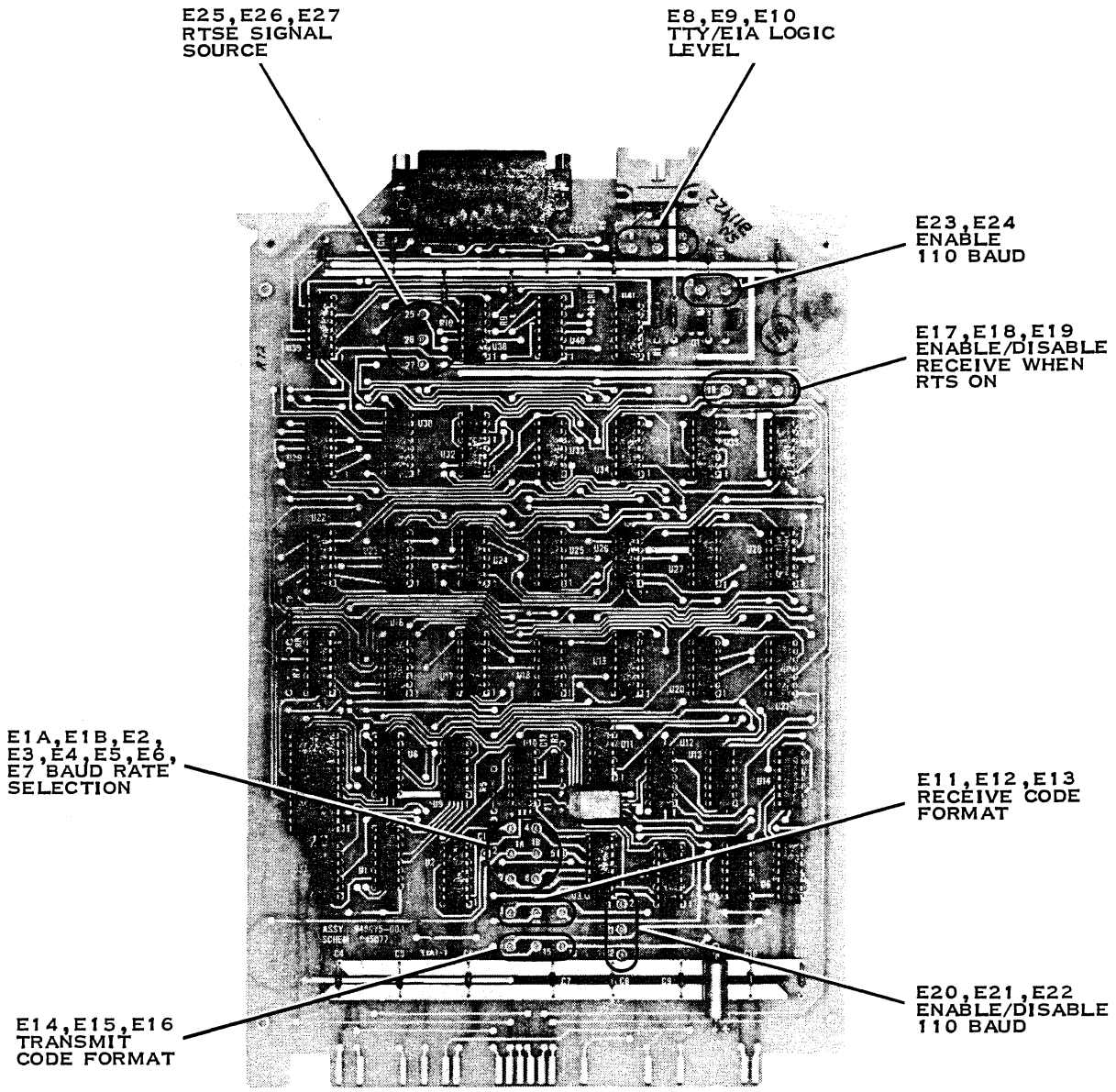


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Figure 2-1. Jumper Socket Locations

2.4 INSTALLATION

After defining a location for the interface module and checking the jumper plug configuration, perform the following steps to install the interface module in the desired location:

1. Ensure that chassis power is off.

2. Insert the circuit board, component side up, into the selected slot until the sides of the board slide into the card guides on either side of the slot (one guide is in a center card guide that must have been installed before card insertion).

3. Gently push the board straight in until the card edge connector engages the edge connector in the backpanel.

4. Connect the applicable cable to the desired peripheral device in accordance with the interconnection instructions in paragraph 2.5.

The TTY/EIA Terminal Interface Module is designed to work with peripheral devices that operate in the TTY (20 milliampere current-loop) mode or with devices that have a standard EIA RS-232C interface. Instructions for interconnecting some of the devices that are typically interfaced to a Model 990 Computer through the interface module are presented in the following paragraphs. Sufficient information is provided to allow connection of other EIA RS-232C devices meeting the interface requirements listed in Table 2-2. Table 2-3 lists the pin assignments in the TTY interface connector P3.

Figure 2-2 is a view of the interface module showing how the pins in connector P2 (EIA interface) and P3 (TTY interface) are numbered. The user should be aware that the interface at connector P2 does not provide all of the standard EIA RS-232C signals. Table 2-4 shows a comparison of the standard EIA RS-232C signals to the signals provided at connector P2. Figures 2-3 and 2-4 show typical interface circuits for current loop and EIA operation.

Table 2-2. EIA Interface Interconnection Data

Connector P2					
Pin (in P2)	**Mnemonic**	**Signal Name**	**Signal Flow[1]**	**Voltage**	**Remarks**
2	RCVDE	Received Data	Input	High Level = +3 to +25 Vdc Low Level = −3 to −25 Vdc	Receiver: See Figure 2-4A
3	XMTDE	Transmitted Data	Output	High Level = +5 to +11 Vdc Low Level = −5 to −11 Vdc	Driver: See Figure 2-4B
5	PCTS	Pseudo Clear to Send	Output	+5 Vdc	390 Ohm pull up to +5 Vdc
6	DTRE	Data Terminal Ready	Output	Same as pin 3	
7		Signal Ground			
8	RTSE	Request to Send	Output	Same as pin 3	
14	RCRE[2]	Reverse Channel Receive	Input	Same as pin 2	
16	RCTE	Reverse Channel Transmit	Output	Same as pin 3	
18	DCDE	Data Carrier Detect	Input	Same as pin 2	
20	DSRE	Data Set Ready	Input	Same as pin 2	
21	PDCD	Pseudo Data Carrier Detect	Output	Same as pin 5	

Notes:

[1] Signal flow Input is into the interface module on EIA interface connector P2. Output is out of interface connector P2.

[2] With kits 2265150-0001/0002, RCRE is replaced by Ring Indicator (RI).

Table 2-3. TTY Interface Connector (P3)

Pin Number	Mnemonic	Function
2	TTYLX	Transmit Low
4	TTYHX	Transmit High
6	TTYLR	Receive Low
8	TTYHR	Receive High
9, 10		Signal Ground

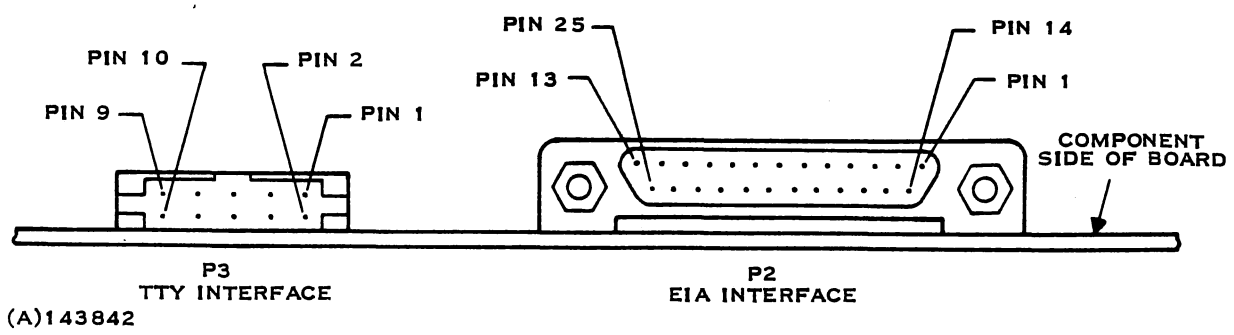


Figure 2-2. TTY and EIA Connector Pin Numbering

Table 2-4. Comparison Between RS-232C and TTY/EIA Terminal Interface Module

RS-232C Interface Information				TTY/EIA Terminal Interface Module Information			
Pin Number	Designation	Description	In/Out[1]	Pin Number	Mnemonic	Description	In/Out
1	AA	Protective Ground		1		NOT USED[2]	
2	BA	Transmitted Data[1]	(I)	2	RCVDE	Received Data[1]	(I)
3	BB	Received Data[1]	(O)	3	XMTDE	Transmitted Data[1]	(O)
4	CA	Request to Send	(I)	4		NOT USED[2]	
5	CB	Clear to Send	(O)	5	PCTS	Pseudo Clear to Send[4]	(O)
6	CC	Data Set Ready[1]	(O)	6	DTRE	Data Terminal Ready[1]	(O)
7	AB	Signal Ground		7		Signal Ground	
8	CF	Received Line Signal Detector	(O)	8	RTSE	Request to Send[5]	(O)
9		Reserved for Testing		9		NOT USED[2]	
10		Reserved for Testing		10		NOT USED[2]	
11		Unassigned		11		NOT USED[2]	
12	SCF	Sec. Recd. Line Sig. Det.	(O)	12		NOT USED[2]	
13	SCB	Sec. Clear to Send	(O)	13		NOT USED[2]	
14	SBA	Sec. Transmitted Data	(I)	14	RCRE[3]	Reverse Channel Receive	(I)
15	DB	Transmission Sig. Element Timing	(O)	15		NOT USED[2]	
16	SBB	Sec. Received Data	(O)	16	RCTE	Reverse Channel Transmit	(O)
17	DD	Receive Sig. Element Timing	(O)	17		NOT USED[2]	
18		Unassigned		18	DCDE	Data Carrier Detect	(I)
19	SCA	Sec. Request to Send	(I)	19		NOT USED[2]	
20	CD	Data Terminal Ready[1]	(I)	20	DSRE	Data Set Ready[1]	(I)
21	CG	Signal Quality Detector	(O)	21	PDCD	Pseudo Data Carrier[4] Detect	(O)
22	CE	Ring Indicator		22		NOT USED[2]	
23	CH/CI	Data Signal Rate Selector	(I/O)	23		NOT USED[2]	
24	DA	Transmit Signal Element Timing	(I)	24		NOT USED[2]	
25		Unassigned		25		NOT USED[2]	

Notes:

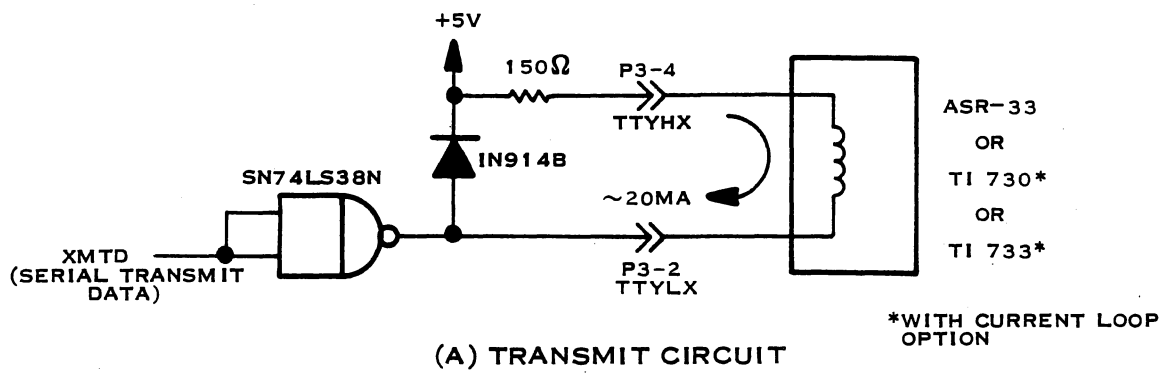
[1] The In/Out designation for the standard RS-232C signals assumes that the external device is a data set (modem) as defined by the RS-232C specification.

[2] Wire in the cable but not used.

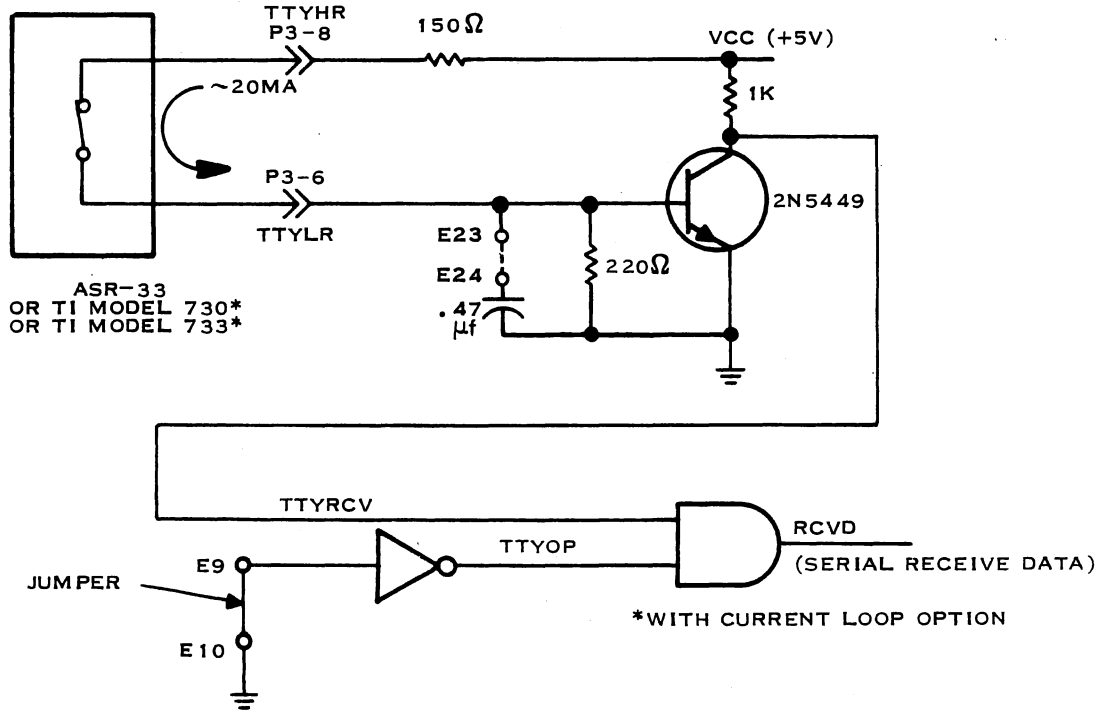
[3] With kits 2265150-0001/0002, RCRE is replaced by Ring Indicator.

[4] Two pseudo signals (PCTS and PDCD) are provided to aid the user when the external device to be interfaced is a data terminal and not a data set. These signals may cause conflicts when interfaced with a data set if the recommended cable (part number 2255151) is not used.

[5] The source for Request To Send is either DTRE or RTSE, selected by a jumper option on the interface module. Jumper E25 to E26 for RTSE or E26 to E27 for DTRE.



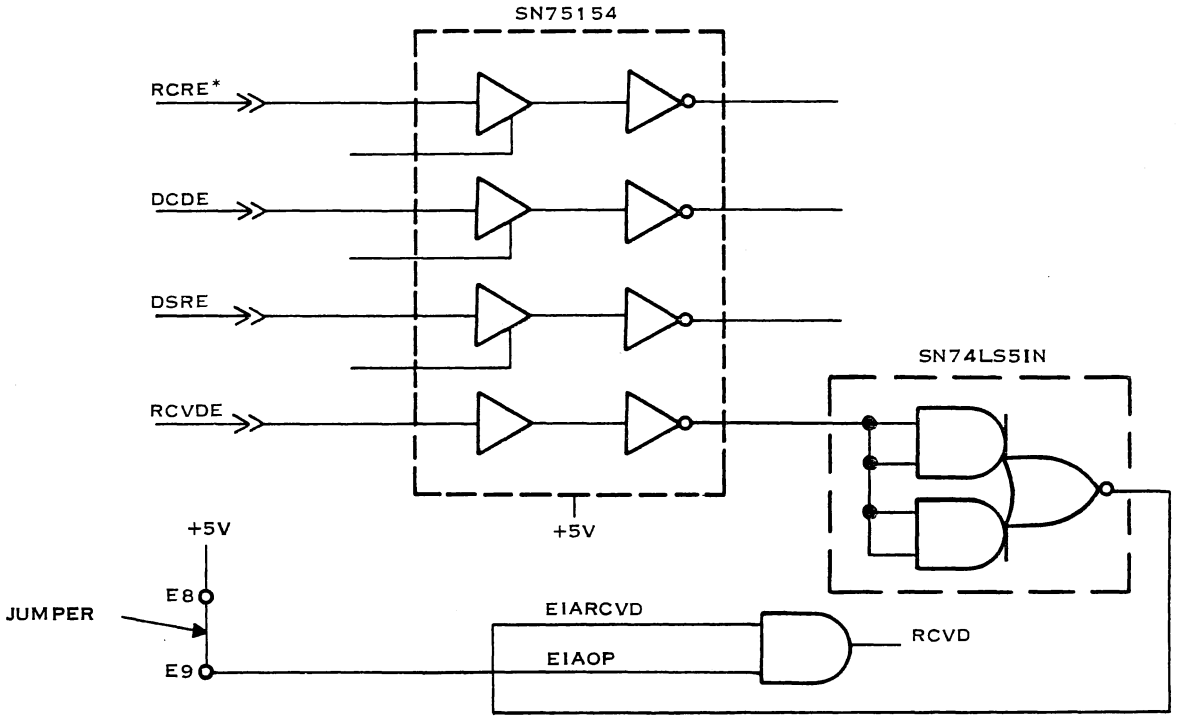
(A) TRANSMIT CIRCUIT



(B) RECEIVE CIRCUIT

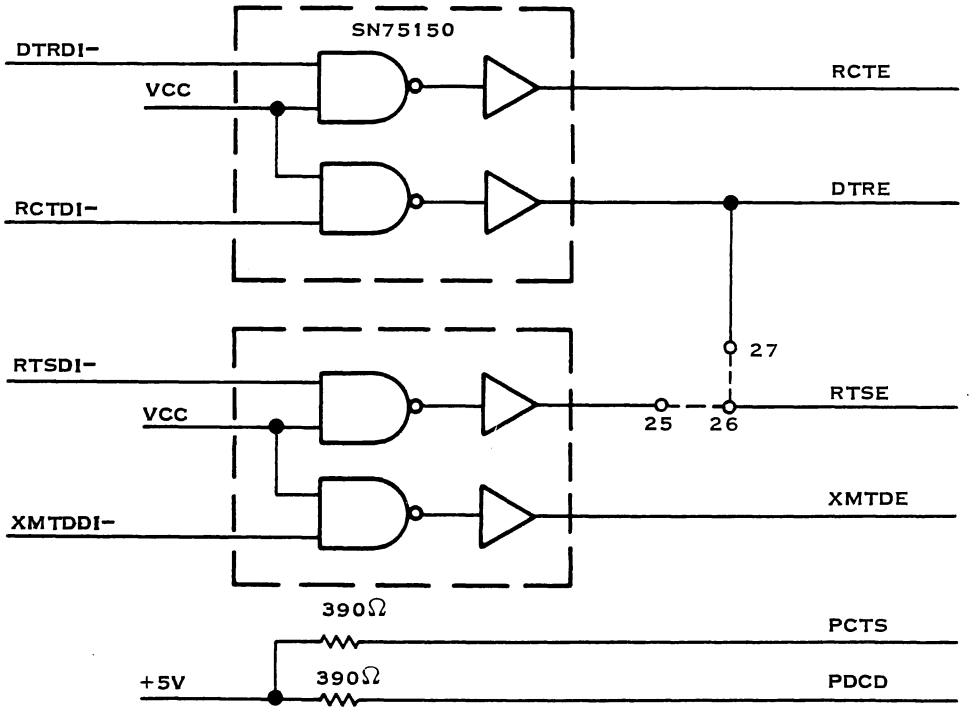
(A)130732C

Figure 2-3. Current Loop Interface Circuits



*With kits 2265150-0001/0002, RCRE is replaced by Ring Indicator.

(A) QUAD EIA RECEIVER



(B) DUAL EIA TRANSMITTER

(A)130733B

Figure 2-4. EIA Interface Receiver/Transmitter Circuits

2.5.1 Model 733 ASR/KSR to EIA Interface Connection

NOTE

For EIA interface operation, the 733 must have a transmit card (part number 962293) in position A8, and a receive card (part number 962291 or 973907) in position A5 of the terminal.

1. Use cable part number 959372-3 (Figure 2-5) supplied with the Model 733 ASR/KSR. Connect P2 on the cable to P2 on the interface module and secure with the attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 on the cable to communications interface connector J1 on the rear of the 733 terminal and secure with the attaching screws.

3. For checkout procedures refer to *Model 990 Computer Model 733 ASR/KSR Data Terminal Installation and Operation* manual, part number 945259-9701. Refer to paragraph 2.7 for information on diagnostics that may be used in checking the interface module.

2.5.2 Model 743/745 to EIA Interface Connection

1. Use cable part number 948968 (Figure 2-6) supplied with the 743/745 KSR. Connect P2 on the cable to P2 on the interface module and secure with attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 on the cable to communications line interface connector J1 on the rear of the 743/745 terminal and secure with attaching screws.

3. For checkout procedures refer to *Model 990 Computer Model 743 KSR Data Terminal Installation and Operation* manual, part number 943462-9701. Refer to paragraph 2.7 for information on diagnostics that may be used in checking the interface module.

2.5.3 Model 810 to EIA Interface Connection

1. Use cable part number 938114-0001 (Figure 2-7), supplied as a part of the 810 printer kit. Connect P2 on the cable to P2 on the interface module and secure with attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 on the cable to J13 on the 810 and secure with attaching screws.

3. For checkout procedures on the 810, refer to *Model 990 Computer Model 810 Printer Installation and Operation*, part number 939460-9701. Refer to paragraph 2.7 for information on diagnostics that may be used in checking the interface module.

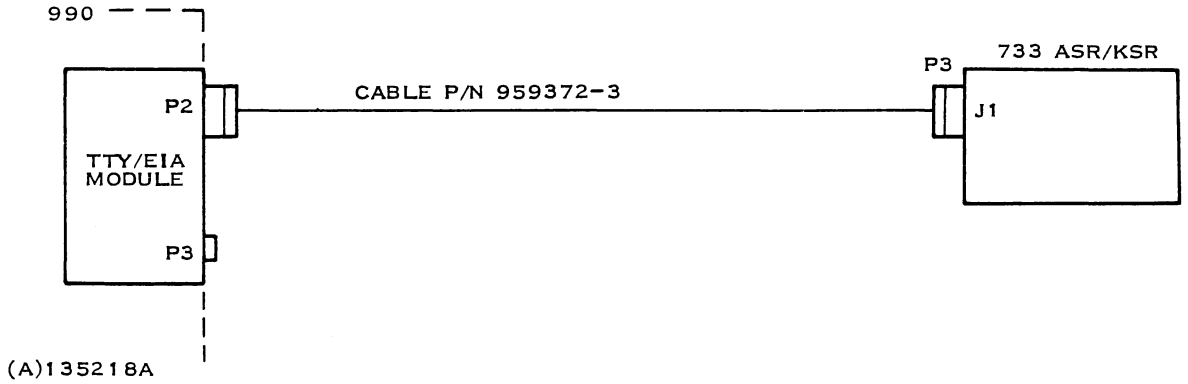


Figure 2-5. 990 Computer/733 ASR/KSR Interface, Cable Interconnection

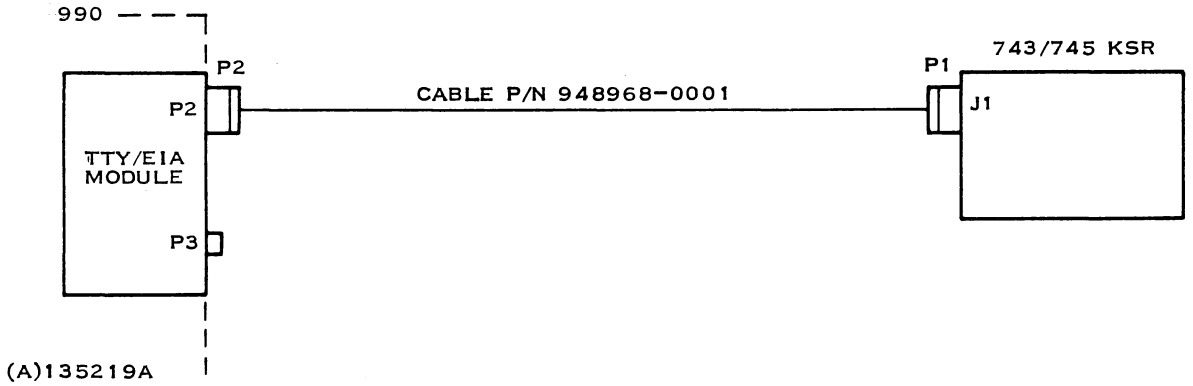


Figure 2-6. 990 Computer/743-745 KSR Interface Cable Interconnection

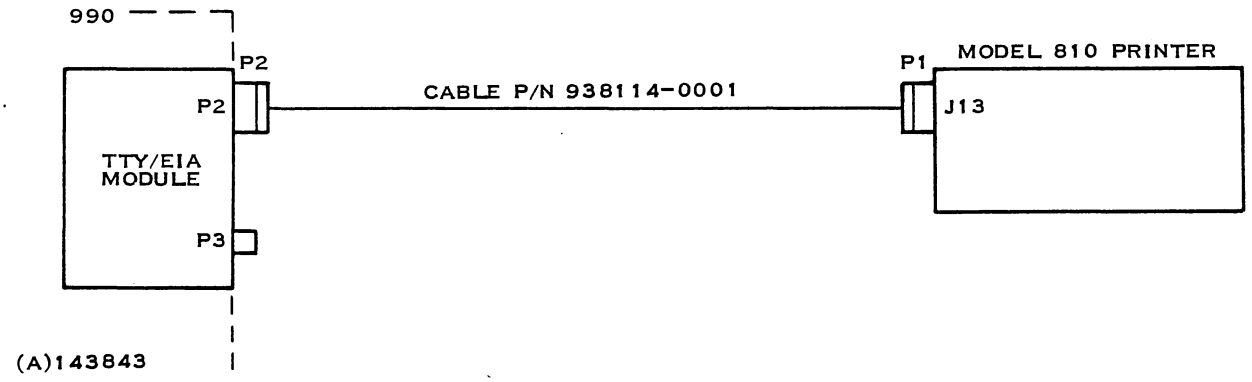


Figure 2-7. 990 Computer/810 Printer Interface, Cable Interconnection

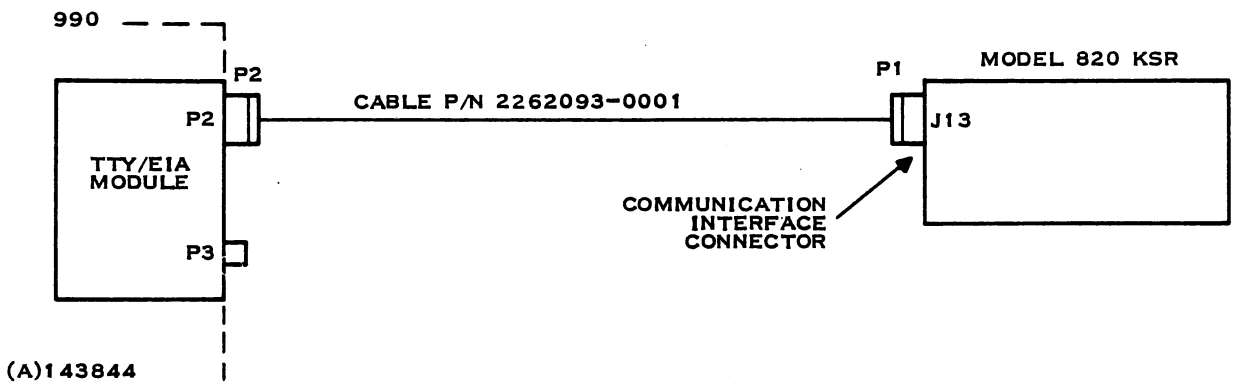


Figure 2-8. 990 Computer/820 KSR Interface, Cable Interconnection

2.5.4 Model 820 KSR to EIA Interface Connection

1. Use cable part number 2262093 (Figure 2-8), supplied as a part of the 820 KSR kit. Connect P2 on the cable to P2 on the interface module and secure with attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 on the cable to the communication interface connector on the 820 and secure with attaching screws.

3. For checkout procedures on the 820, refer to *Model 990 Computer Model 820 KSR Data Terminal Installation and Operation*, part number 2250454-9701. Refer to paragraph 2.7 for information on diagnostics that may be used in checking the interface module.

2.5.5 Model 33 ASR Teletypewriter to Current-Loop Interface Connection

The Model 33 ASR Teletypewriter operates in a current loop mode. The current loop mode of the interface module may be selected by installing jumpers as listed in Table 2-1 for the Model 33 ASR.

NOTE

The following interconnections apply solely to teletypewriter model 3320/5JE. Possible differences between the user's teletypewriter and teletypewriter model 3320/5JE should be carefully investigated and defined if this procedure is to be used for a teletypewriter other than the model 3320/5JE.

A teletypewriter interface cable (part number 936403) is supplied with the 33 ASR interface kit to interconnect the interface module and the 33 ASR teletypewriter (Figure 2-9). The cable has a 10-pin connector (P1) on one end and four wires terminated with spade lugs on the other end. Each wire has an identifying marker. Connect the teletype interface cable as follows:

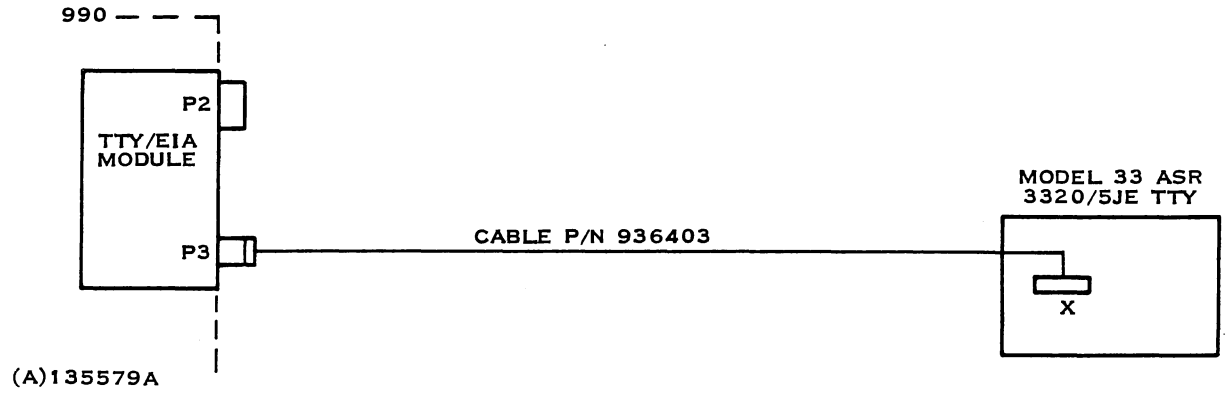


Figure 2-9. 990 Computer/Model 33 ASR Interface, Cable Interconnection

1. Connect P1 on cable to P3 on the interface module and secure with attaching screw. Secure the cable with one of the cable clamps in the computer or expansion chassis.
2. Connect the wire marked E1 to terminal 7 of terminal board X on the TTY.
3. Connect the wire marked E2 to terminal 6 of terminal board X.
4. Connect the wire marked E3 to terminal 3 of terminal board X.
5. Connect the wire marked E4 to terminal 4 of terminal board X.

2.5.6 Model 3320/5JE Teletypewriter Modification

For best operation of the teletypewriter when interconnected with the Model 990 Computer, the teletypewriter should be modified for full duplex communications, 20 milliampere neutral signaling, improved noise suppression and removal of answerback functions; parity generation should be disabled, and automatic carriage return and line feed should be enabled. The following procedures completely define the modifications for user-supplied terminals.

1. Use the following procedures to remove the top cover from the teletypewriter for access to the area for the remaining modifications.
   a. Remove the paper roll and paper tape (if installed).
   b. Remove the paper advance (platen) knob.
   c. Remove the knob from the LINE/OFF/LOCAL switch.
   d. Remove the teletypewriter nameplate strip by pulling it down and out.
   e. Remove the four screws uncovered by the removal of the nameplate strip.
   f. Remove the three thumbscrews from the rear of the cover.

g. Remove the screw located on the left rear corner of the tape reader cover.

h. Lift off the carrier top.

2. Use the following procedure to modify the teletypewriter for full duplex operation.

   a. Locate the X terminal board at the left rear (viewed from the rear) of the machine.

   b. Move the white/blue wire from terminal 4 to terminal 5 on the X terminal block.

   c. Move the brown/yellow wire from terminal 3 to terminal 5 on the X terminal block.

3. Use the following procedure to modify the teletypewriter for 20 milliampere neutral signaling.

   a. Move the purple wire from terminal 8 to terminal 9 on the X terminal block.

   b. Move the blue wire from terminal 3 to terminal 4 on the power resistor (R1 on the call control unit).

4. Use the following procedure to modify the teletypewriter for improved noise suppression.

   a. Remove the green/black wire from terminal 8 of the X terminal block, insulate the wire end to prevent inadvertent electrical connections, and tie the wire end back out of the way.

   b. Move the two black wires from terminal 2 to terminal 8 of the X terminal block.

   c. Move the two white wires from terminal 1 to terminal 2 of the X terminal block.

   d. Install the capacitor and inductor as shown in Figure 2-10.

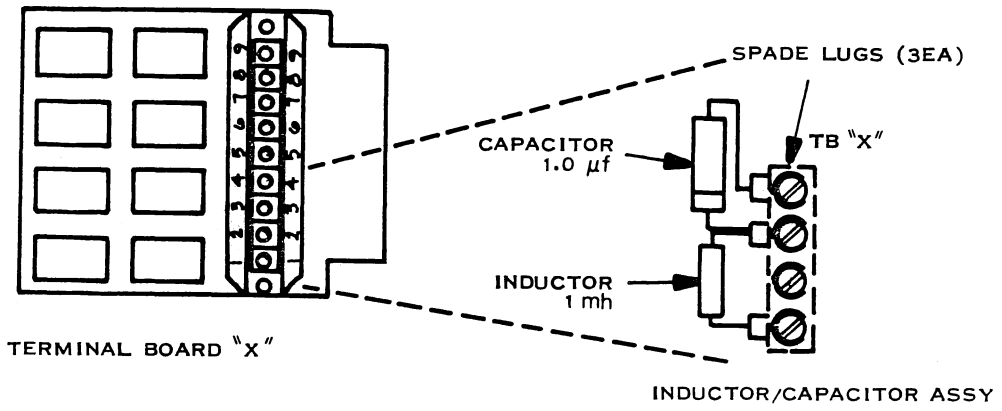
5. Use Figure 2-11 to remove the answerback and WRU function bars from the teletypewriter.

6. Use the following procedure to disable the parity generation function and enable the automatic carriage return and line feed functions.

   a. Remove the white/blue wire from the left-hand terminal of the terminal block located on the right side of the teletypewriter below the keyboard, insulate the end of the wire, and tie it back out of the way.

   b. Remove the copper-colored clip from the A position on the code bar. The clip is located below the print mechanism.

7. Reinstall the carrier top by performing the procedure in step 1 in reverse order (installing what was removed before and going in reverse order, h through a).



(A)128696A

Figure 2-10. Capacitor and Inductor Installation

2.5.7 RS-232C EIA Data Terminal to EIA Interface Connection

NOTE

Most user-provided data terminals that operate in the EIA interface mode may be connected to the interface module with cable part number 937533. The interfacing information for the specific terminal should be checked carefully before proceeding, and the plug-in jumpers on the interface module must be placed in the appropriate positions to be compatible with the requirements of the terminal.

Perform the following procedure:

1. Connect P2 of cable part number 937533 (Figure 2-12) to P2 on the interface module and secure with attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 on the cable to the communications line interface connector on the RS-232C EIA data terminal and secure with attaching screws.

3. For checkout procedures, refer to the documentation on the data terminal. Refer to paragraph 2.7 for information on diagnostics that may be used in checking the interface module.

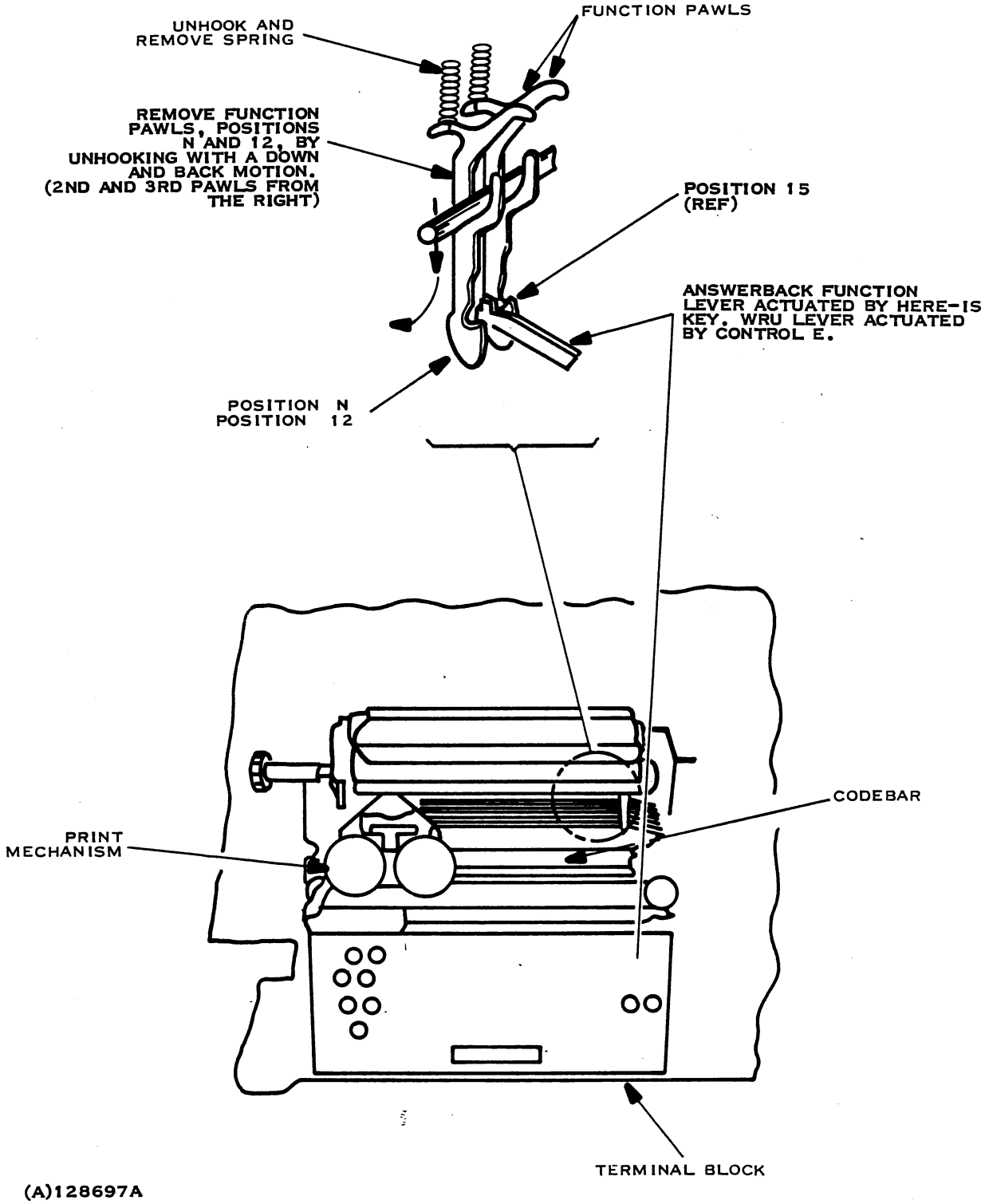


Figure 2-11. Answerback and WRU Function Bar Removal

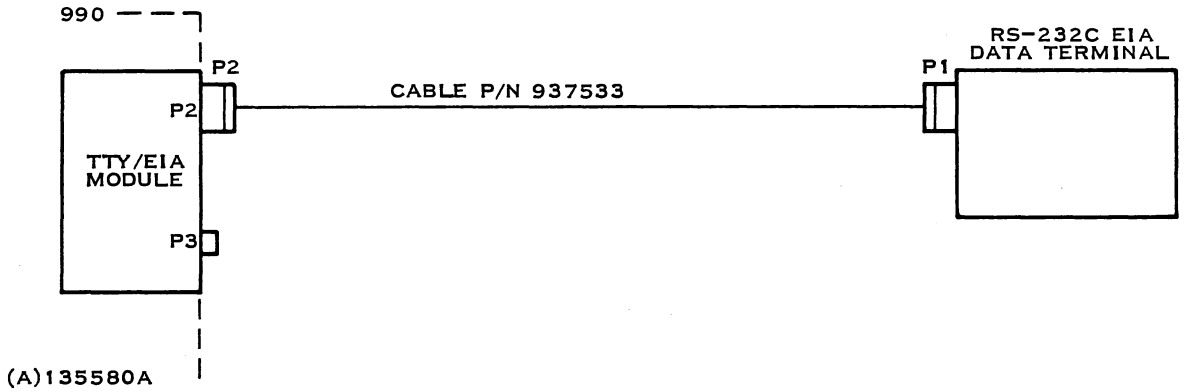


Figure 2-12. 990 Computer/RS-232C EIA Data Terminal Interface, Cable Interconnection

2.6 USING THE TTY/EIA TERMINAL INTERFACE MODULE WITH COMMUNICATION EQUIPMENT

The TTY/EIA Terminal Interface Module may be used to provide the interface between a Model 990 Computer and an external data set (modem). Figure 2-13 illustrates four typical dial-up communication system configurations using the interface module with data sets leased from the telephone company. The interface module is compatible with Bell 103, 113, and 212 asynchronous data sets. The telephone handsets illustrated in Figure 2-13 are provided with the data sets.

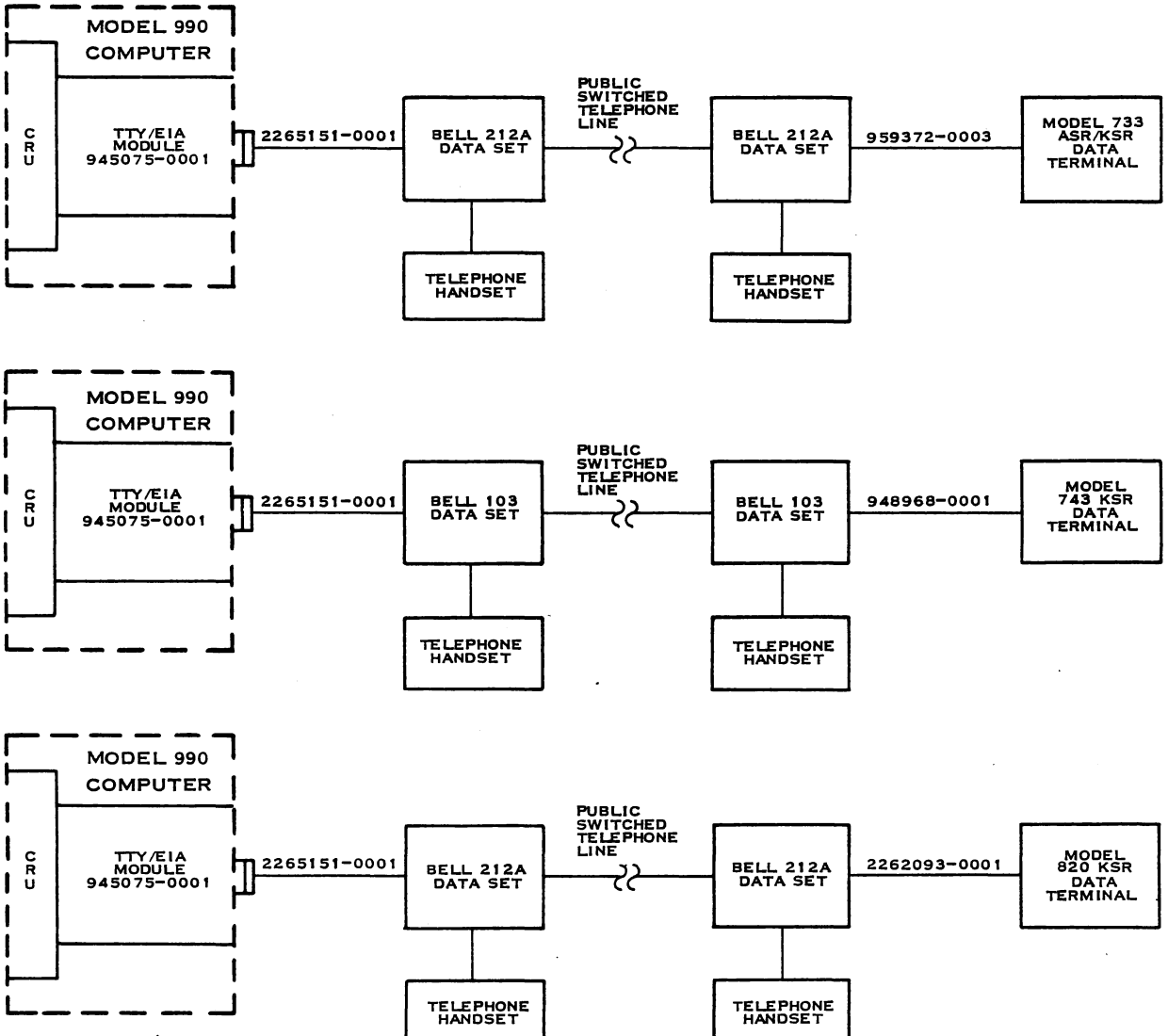
Any device that interfaces with the public telephone network must be registered with the Federal Communications Commission (FCC). All data sets leased from the telephone company have the necessary FCC registration and the connection to the phone line is made by telephone company personnel.

If the interface module is used with a data set that does not have the FCC registration, an FCC registered data access arrangement (DAA) must be used between the unregistered data set and the telephone line. Information on the selection, installation and use of DAAs may be found in the *Model 990 Computer Communications System Installation and Operation*, part number 945409-9701B.

Two TTY/EIA kits are available for use with Bell data sets; part number 2265150-0001 for 300 baud operation and part number 2265150-0002 for 1200 baud operation. The 300 baud kit, part number 2265150-0001, should be used with Bell 103 or 113 data sets. The Bell 212 data set will operate at either 300 or 1200 baud in the asynchronous mode so either kit may be used with it. Both kits contain the interface module (part number 945075-0001) and module-to-data set cable part number 2265151-0001. The only difference in the two kits is that the jumpers on the interface module are configured for 300 baud operation in the -0001 kit and 1200 baud in the -0002.

The TTY/EIA-to-data set cable, part number 2265151-0001, is 9.1 meters (30 feet) long. A 3-meter (10-foot) cable is also available and may be ordered by specifying part number 2265151-0002.

The options that are recommended or required on the Bell data sets and telephone handsets to make them compatible with TI hardware and software are described in detail in Appendix A. Appendix A also contains information on establishing communications between local and remote sites via the telephone line.



(B)143197 (1/2)

Figure 2-13. Typical Dial-Up Systems Using the TTY/EIA Terminal Interface Module (Sheet 1 of 2)

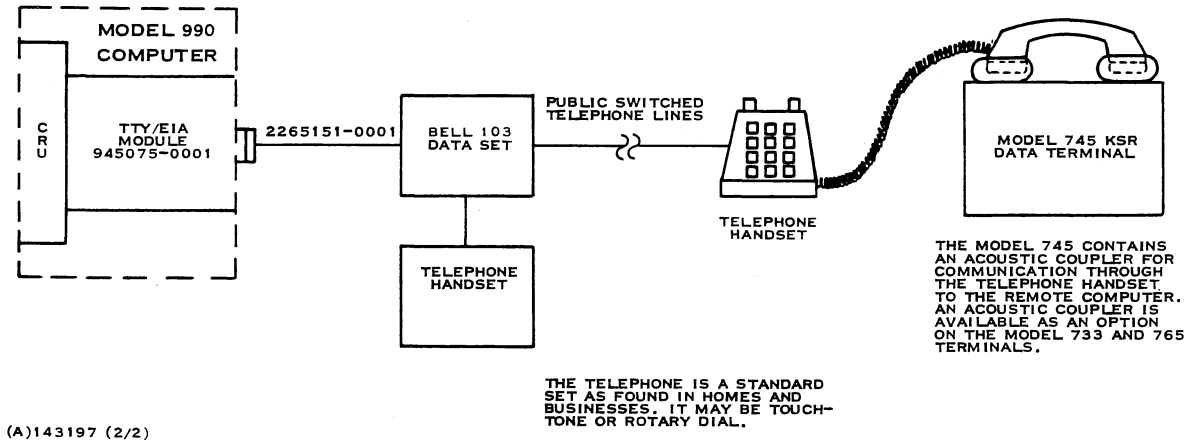


Figure 2-13. Typical Dial-Up Systems Using the TTY/EIA Terminal Interface Module (Sheet 2 of 2)

2.6.1 Communication System Interconnections

When the interface module is used with Bell data sets, the following procedure should be used to connect the system:

NOTE

Telephone company personnel will install and verify operation of the equipment leased from the telephone company.

1. Connect P2 of cable 2265151 to P2 on the interface module and secure with attaching screws. Secure the cable with one of the cable clamps in the computer or expansion chassis.

2. Connect P1 of cable 2265151 to the EIA connector on the back of the Bell data set. It is not labeled in most cases but is the only connector that mates with P1.

3. At the remote site, the cable that normally connects the interface module to the particular peripheral device may be used (in most cases) for the connection between the data set and the peripheral device. The installation manual for the particular peripheral should be consulted for the exact cable requirement before this connection is made. The part numbers of the cables used with models 733, 743/745 and 820 are shown in Figure 2-13. Once the correct cable part number has been determined, connect P2 of the cable to the EIA connector on the data set and P1 to the communication line interface connector on the peripheral device. Secure both ends with attaching screws.

2.6.2 Checkout and Operation

A booklet describing how to operate, test, and report problems in the Bell equipment is provided by the telephone company when the equipment is leased from them. It should be used as a guide for use of the communications equipment.

Checkout of the interface module and remote peripheral device may be done according to instructions in the installation and operation manual for the peripheral device once the communications link has been established. Appendix A contains information on establishing the communications link via the telephone line. The diagnostics described in the next paragraph are also valuable checkout aides.

2.7 TTY/EIA TERMINAL INTERFACE MODULE DIAGNOSTICS

There are two diagnostic programs that deal directly with the TTY/EIA Terminal Interface Module and can be used to verify proper installation: TTYEIA and REMEIA.

TTYEIA, part number 945453, performs a complete check of the interface module. REMEIA, part number 2250242, is used with kits 2265150-0001 and -0002 to check communications between a host computer and remote terminal connected with the standard TTY/EIA interface module and cable 2265151. A loopback connector, part number 2262130-0001, is used with some of the diagnostic programs to check operation of the interface module. The loopback connector mates with P2 on the interface module and jumpers pins as follows (Table 2-5):

Table 2-5. Pins Jumpered by Loopback Connector

From	To
Pin 2 Received Data	Pin 3 Transmitted Data
Pin 6 Data Terminal Ready	Pin 20 Data Set Ready
Pin 8 Request to Send	Pin 18 Data Carrier Detect
Pin 14 Reverse Channel Receive	Pin 16 Reverse Channel Transmit

Test programs and diagnostics are also available for installation of TI peripherals that use the interface module as an interface to the Model 990 Computer. For procedural information, refer to the *Model 990 Computer TTY/EIA Interface Module Depot Maintenance Manual* and the *Model 990 Computer Diagnostic Handbook.*

3

Programming

3.1 GENERAL

Operation of the TTY/EIA Terminal Interface Module consists of the programming required to perform the necessary interface functions with the attached data terminal or data set. The service routines implemented to handle this interface use the SBO, SBZ, TB, LDCR and STCR instructions. These instructions normally use an effective CRU address that addresses bit zero of the module under consideration. Since the interface module can be inserted into any of the available CRU chassis locations and the locations are wired for preestablished addresses, the base address depends upon that hardware configuration.

The only consideration other than programming that affects the interface module's operation is the selection of the proper jumper configuration to match the transfer rate and code format of the attached data terminal. Refer to Section 2 of this manual for details of the various jumper configurations.

3.2 PROGRAMMING

The interface between the computer and the interface module consists of 16 addressable I/O bits. The output bits can be divided into two groups of eight, as shown in Figure 3-1. The first eight bits make up the character to be sent to the data terminal, and the last eight bits are used primarily for control. The input bits may be divided into two groups of eight also, as shown in Figure 3-1. The first eight bits of input make up the character being received from the data terminal, and the last eight bits provide the computer with status data. Tables 3-1 and 3-2 describe the output command bits and input status bits, respectively.

The standard software packages (TX5, DX5, DX10) for the Model 990 Computer are designed to work with various terminals, printers, data sets, etc., via the interface module. Refer to the reference documentation for the particular software package used in your system for more detail.

The I/O routines written to handle communications with the data terminals or data sets attached to the interface module vary with each device type and method of connection. This is due to the difference in the controls accepted and status returned by the devices. Generally, the I/O routine must first establish communications with the data terminal or data set and then proceed to read/write data on a character-by-character basis. At the same time, the routine must be prepared for irregular status indicators and be capable of handling interrupts.

By appropriate wiring of the cable connecting the interface module to the data terminal or data set, it is possible to substitute other signals at the device for the standard control signals. For example, in kit 2265150-0001/0002, the signal reverse channel receive (RCR) is replaced by ring indicator (RI). The programmer must be aware of the signals provided to the external device by the cable.

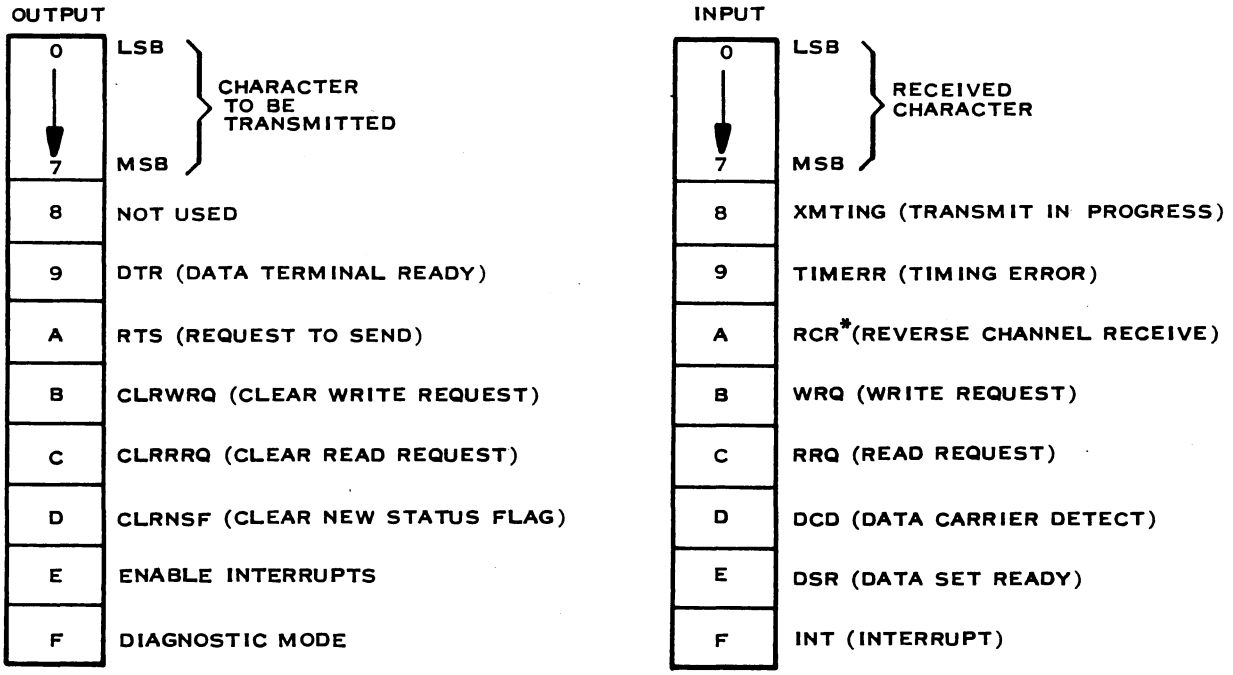


Figure 3-1. TTY/EIA Terminal Interface Module, Addressable Input/Output Bit Lines

Table 3-1. TTY/EIA Terminal Interface Module Output Command Signals

Signal	Description
Data Terminal Ready	Enables data terminal operation (must be on before any communication using the interface module). Equates to DTRE at peripheral interface.
Request to Send	Places data terminal in transmit mode (not used with teletypewriters). Equates to RTSE at peripheral interface.
Clear Write Request	Clears write request flag on module to prepare for another character write (transmit).
Clear Read Request	Clears read request interrupt logic on interface module to prepare for another character read (receive).
Clear New Status Flag	Clears new status flag on interface module to enable new interrupts.

Table 3-1. TTY/EIA Terminal Interface Module Output Command Signals (Continued)

Signal	Description
Enable Interrupts	Enables interrupt generating logic on interface module. (DTR must also be on.)
Diagnostic Mode	Gates EIA outputs to EIA inputs.

Table 3-2. TTY/EIA Terminal Interface Module Input Status Signals

Signal	Description
Transmit In Progress	Interface module is currently transmitting to a data terminal.
Timing Error	Indicates data in receive buffer register may be in error because two or more characters have been located in the buffer and no read operation has been performed by the computer.
Reverse Channel Receive*	Indicates reverse channel receive status of data set (not used by teletypewriter). Equates to RCRE at peripheral interface.
Write Request	Write request flag set to indicate a character has been sent to the data terminal.
Read Request	Read request flag set to indicate a character has been received from the data terminal and is ready to be read by the computer.
Data Carrier Detect	Indicates carrier is detected at the data terminal (not used by teletypewriter). Equates to DCDE at peripheral interface.
Data Set Ready	Indicates data terminal is ready to communicate (not used by teletypewriter). Equates to DSRE at peripheral interface.
Interrupt	Interface module interrupt flag set when the write request or read request flags are set or when a transition occurs in the data set ready or data carrier detect signals. DTR must have been set.

Note:

* With kits 2265150-0001/0002, this signal becomes ring indicator signifying a remote station is calling the host station.

3.2.1 Interrupts

An interrupt is a signal that informs the computer that the module requires attention. The interrupt flag for the TTY/EIA Terminal Interface Module is input bit >F. This bit sets whenever one of three conditions occurs:

- Write Request (input bit >B) — When the interface module has completed transmission of a character and requires a new character from the computer, it sets input bit >B and the interrupt flag, input bit >F, to a one. This flag is reset by a CPU output to bit >B (clear write request).

- Read Request (input bit >C) — One-half bit time after the interface module receives an input character and loads it into the receive buffer register, it sets input bit >C and the interrupt flag, input bit >F, to a one. This flag is reset by a CPU output to bit >C (clear read request).

- New Status Flag — The new status flag (NSTFG) consists of a flip-flop, two AND gates, and two retriggerable monostable multivibrators for transition detection. The NSTFG is set when data set ready (DSRE) status goes from a logic high to low, or when DSR (data set ready) goes from a logic low to high with data carrier detect (DCDE) at a logic low. NSTFG is also set when DCD (data carrier detect) status changes state (high to low) with DSRE status a logic high. NSTFG is reset when the data terminal ready (DTRE) latch is reset or when ADDS 13- is low. When the new status flag is set, NSTFG- provides an interrupt to the device (if the interrupt mask latch is not set). (See Table 3-3.)

Table 3-3. Status Transitions Affecting New Status Flag

CRU Output Bit >D	CRU Input Bits (EIA) Status >E(DSR)	>D(DCD)	New Status Flag
0	0 to 1	0	1
0	1	1 to 0	1
0	X	0 to 1	1
0	1 to 0	X	1
pulse	X	X	0

X = either 1 or 0

The interrupt signal to the computer is generated when the interrupt flag is set, and interrupts are enabled by setting the enable interrupts latch, CRU output bit >E, to a one. This interrupt signal is connected to an interrupt level by jumper wiring on the computer backpanel. Refer to the *Model 990/4 Computer System Hardware Reference Manual* (part number 945251-9701) or the *Model 990/10 Computer System Hardware Reference Manual* (part number 945417-9701) for information on this wiring.

When the interrupt signal is recognized by the computer, the following steps occur. If the interrupt occurs at a level less than or equal to the interrupt level in the computer status register, then:

1. The new workspace pointer and program counter contents are fetched from memory locations determined by the interrupt level.

2. The current workspace pointer, program counter and status register contents are stored in workspace registers 13, 14 and 15 of the new workspace.

3. The new status register contents are set to inhibit interrupts of lower priority than the level of the interrupt.

4. The interrupt processing routine is entered at the address specified by the new program counter.

The interrupt processing routine determines which module generated the interrupt by interrogating bit >F of all modules corresponding to the interrupt level until it finds an active interrupt bit. The program then examines input bit >B (write request), >C (read request), >D (data carrier detect), and >E (data set ready) of that module to determine the condition that caused the interrupt and then services that condition. The routine must clear the interrupt condition by generating an output (either 1 or a 0) to the applicable address bit.

3.2.2 Timing Considerations

When data is being transferred to the CPU, a timing error can occur if the program does not store a received character into memory before a new character is received. When such an overrun occurs, CRU input bit >9 (TIMERR) from the interface module sets to flag the condition. This bit clears automatically when the read request interrupt logic is reset.

Timing is not critical when data is being transferred from the CPU. However, efficient use of the communication line requires that the next character to be transmitted be presented to the interface within one bit time following the write request interrupt.

The time interval, in seconds, between characters for a particular format and baud rate is given by the number of bits per character (including start and stop bits) divided by the baud rate. The reciprocal of this character time is the character rate. The interval between bits (bit time) is the reciprocal of the baud rate.

3.2.3 Output Operation

Output operations are initiated by any reference to bit 7 of the interface word. This may be accomplished by issuing SBO 7, SBZ 7, or an eight-bit LDCR instruction (when R12 contains the CRU address of bit 0 of the interface word). When using an eight-bit LDCR instruction, any of the addressing modes of the 990 computer may be used. The direct addressing mode is of the form:

```
LDCR @CHAR,8
```

The instruction results in an eight-bit transfer from memory location CHAR to the current CRU base address starting with bit 0 and incremented through bit seven. Figure 3-2 illustrates this transfer. Initiating this sequence starts data transmission from the interface module when the entire eight-bit character is present in the interface module. The data is sent serially on the communication line.

During the transfer operation, CRU bit eight (transmit in progress) remains true; it resets when the character has been completely transmitted and write request (bit >B) has been set. A new character output to the interface module must not be started until Transmit in Progress drops and Write Request sets.

3.2.4 Input Operation

A character is input to the computer from the interface module using an eight-bit STCR instruction. Any of the addressing modes of the 990 computer may be used. The direct addressing mode is of the form:

```
STCR @CHAR,8
```

This instruction results in an eight-bit transfer from the current CRU base address (bits >0 through >7) to memory location CHAR. Figure 3-3 illustrates this transfer. The STCR operation usually occurs after the interface module has notified the program that data is ready for transfer by the read request (bit >C) and the interrupt (bit >F). The program must then transfer the data and reset the interrupt before the next character arrives from the input device and is transferred into the interface module buffer register. Failure to respond within this time constraint results in a data overrun error and the timing error input bit becoming set.

3.2.5 Error Detection

All data error detection, except data overrun conditions, is the responsibility of the data handling program. If one of the eight bits from the interface module represents a parity bit, the program must check the input data character parity. This is done by testing the parity bit in the computer status register after the STCR instruction. Similarly, if the device connected to the interface module requires a parity bit, the program must generate that bit. Cyclical redundancy characters to maintain the integrity of a data stream, if used, must also be generated and checked by the program. Module input bit >9 (timing error) indicates a data overrun condition.

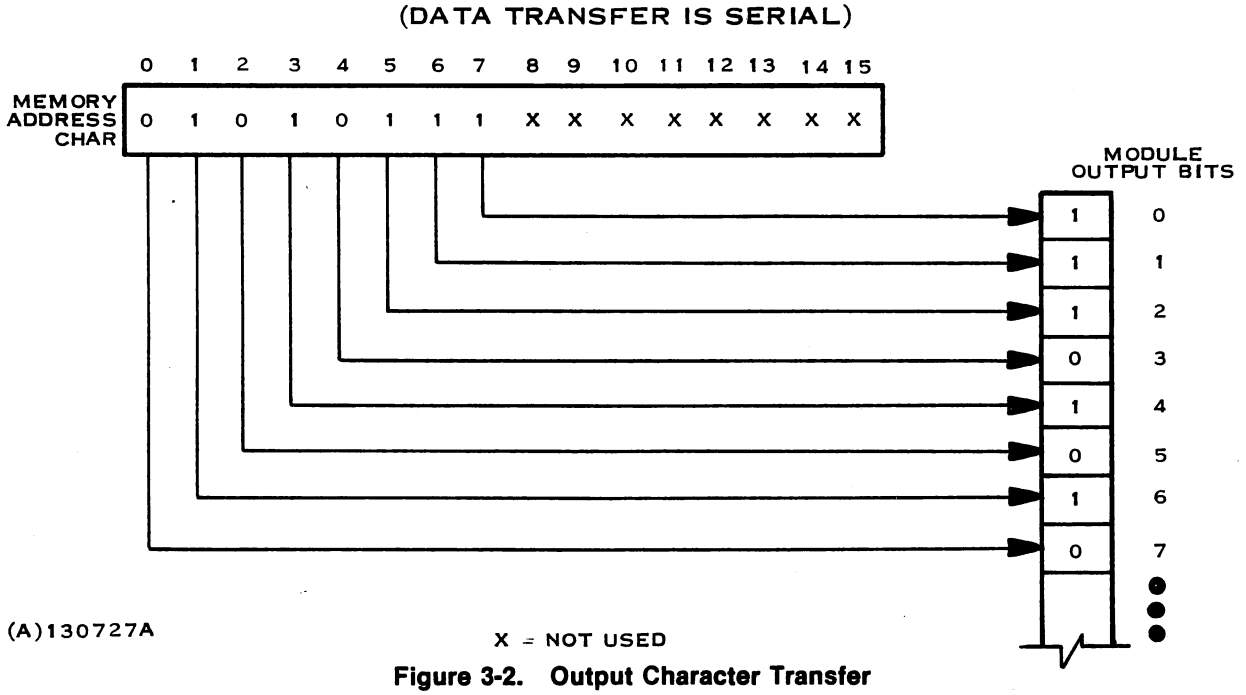


Figure 3-2. Output Character Transfer

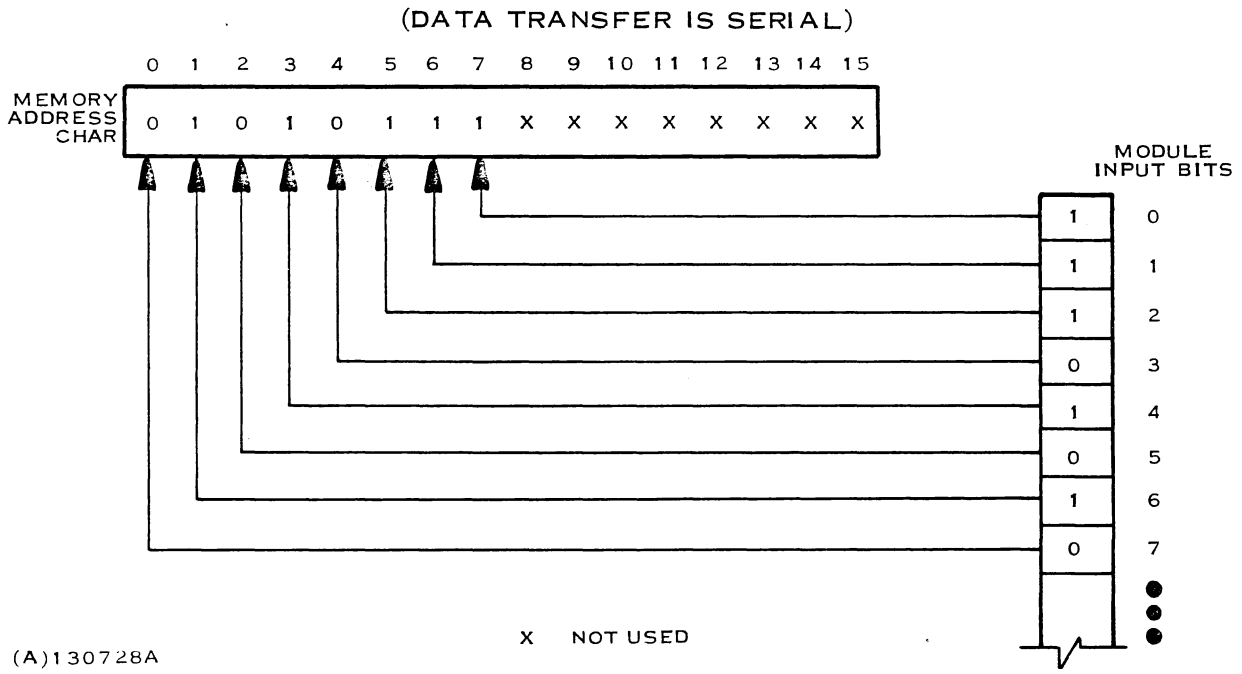


Figure 3-3. Input Character Transfer

3.2.6 Sample Program Sequences

This paragraph contains sample program sequences to illustrate the fundamental mechanics required for input and output operations. Actual routines are more efficient by controlling these low-speed input/output operations with interrupts.

3.2.6.1 Echo Character. Figure 3-4 illustrates an instruction sequence that reads a character typed on the keyboard of a 733 ASR/KSR Data Terminal, echoes that character to the printer of that device, and loops to read another character.

3.2.6.2 Output Character String. Figures 3-5 through 3-7 illustrate an instruction sequence that outputs a character string to the printer of a Model 733 ASR Data Terminal. Figure 3-5 illustrates the definition of the input and output CRU bits to the interface module. This is not necessary, but makes subsequent reference to these bits easier. Figure 3-6 shows code that fetches a string of characters for transfer to the data terminal.

This routine is called as follows:

```
BLWP    @OUTASR
DATA    BUFFER
```

(where BUFFER is the name of the buffer containing the character string to be output. The final character of this string must be the two's complement of the desired character.)

```
0001                    IDT  'SAMPL1'
0002                * SAMPLE PROGRAM SEQUENCE - ECHO TYPED INPUT TO THE PRINTER
0003 0000 020C          LI   R12,0          SET 733 ASR/KSR CRU BASE
     0002 0000
0004 0004 1D09          SBO  9              SET DATA TERMINAL READY
0005 0006 1D0A          SBO  10             SET REQUEST TO SEND
0006                * GET INPUT CHARACTER
0007 0008 04CB  LOOP    CLR  R11            CLEAR R11
0008 000A 1F0C  TBRRQ   TB   12             EXAMINE READ REQUEST
0009 000C 16FE          JNE  TBRRQ          WAIT UNTIL RRQ TRUE
0010 000E 360B          STCR R11,8          GET KEYBOARD ENTRY
0011 0010 1E0C          SBZ  12             RESET READ REQUEST
0012                * ECHO CHARACTER
0013 0012 320B          LDCR R11,8          PUT CHARACTER OUT
0014 0014 1F0B  TBWRQ   TB   11             EXAMINE WRITE REQUEST
0015 0016 16FE          JNE  TBWRQ          WAIT UNTIL WRQ TRUE
0016 0018 1E0B          SBZ  11             RESET WRITE REQUEST
0017 001A 10F6          JMP  LOOP           REPEAT
0018                    END
NO ERRORS,     NO WARNINGS
```

(A)143845

Figure 3-4. Echo Character Sample Routine

```
0001                    IDT  'SAMPL2'
0002                    DEF  OUTASR
0003                * SAMPLE PROGRAM SEQUENCE - DEFINE INPUT AND OUTPUT BITS
0004                * INPUT BITS
0005       0008 XMTING  EQU  8              TRANSMIT IN PROGRESS
0006       0009 TIMERR  EQU  9              TIMING ERROR
0007       000A RCR     EQU  10             REVERSE CHANNEL RECEIVE
0008       000B WRQ     EQU  11             WRITE REQUEST
0009       000C RRQ     EQU  12             READ REQUEST
0010       000D DCD     EQU  13             DATA CARRIER DETECT
0011       000E DSR     EQU  14             DATA SET READY
0012       000F INT     EQU  15             INTERRUPT
0013                * OUTPUT BITS
0014       0009 DTR     EQU  9              DATA TERMINAL READY
0015       000A RTS     EQU  10             REQUEST TO SEND
0016       000B CLRWRQ  EQU  11             CLEAR WRITE REQUEST
0017       000C CLRRQQ  EQU  12             CLEAR READ REQUEST
0018       000D CLRNSF  EQU  13             CLEAR NEW STATUS FLAG
0019       000E ENAINT  EQU  14             ENABLE INTERRUPTS
0020       000F DIAG    EQU  15             DIAGNOSTIC MODE
```

(A)143846

Figure 3-5. Input/Output Definition

```
0022                * SAMPLE PROGRAM SEQUENCE - FETCH CHARACTER STRING
0023                * AND PRINT ONE CHARACTER AT A TIME
0024 0000 020C      OUTENT LI   R12,0         SET 733 ASR CRU BASE
     0002 0000
0025 0004 0300             LIMI 1             DISABLE INTERRUPTS
     0006 0001
0026 0008 04C4             CLR  R4            CLEAR LAST CHARACTER FLAG
0027 000A C2BE             MOV  *R14+,R10     GET BUFFER ADDRESS
0028 000C 1D09             SBO  DTR           SET DATA TERMINAL READY
0029 000E 1D0A             SBO  RTS           SET REQUEST TO SEND
0030 0010 04C7             CLR  R7            INITIALIZE FOR SUBROUTINE
0031 0012 0208             LI   R8,>D00       INITIALIZE FOR SUBROUTINE
     0014 0D00
0032 0016 D27A      GETOUT MOVB *R10+,R9      GET OUTPUT CHARACTER
0033 0018 1505             JGT  PRINT         JUMP TO OUTPUT ROUTINE
0034 001A 1304             JEQ  PRINT         IF NOT LAST CHARACTER
0035 001C 0584             INC  R4            SET LAST CHARACTER FLAG
0036 001E 0549             INV  R9            COMPLEMENT CHARACTER
0037 0020 0229             AI   R9,>0100      MAKE LEFT CHARACTER 2'S COMP
     0022 0100
0038 0024 06A0      PRINT  BL   @NULL         PRINT CHARACTER AND NULLS
     0026 0054'
0039 0028 C104             MOV  R4,R4         CHECK LAST CHARACTER FLAG
0040 002A 13F5             JEQ  GETOUT        REPEAT UNTIL LAST CHARACTER
0041 002C 1D0B             SBO  CLRWRQ        CLEAR WRITE REQUEST
0042 002E 0380             RTWP               RETURN TO CALLING PROGRAM
0043                * BLWP ENTRY, WORKSPACE
0044 0030 0034' OUTASR DATA OUTWS,OUTENT BLWP ENTRY DATA
     0032 0000'
0045 0034           OUTWS  BSS  32            WORKSPACE

(A)143847
```

Figure 3-6. Fetch Character String Sample Routine

Figures 3-7 illustrates a sequence that must be observed when transmitting a string of characters to the printer of a model 733 ASR Data Terminal. Since the baud rate of the interface module is set to four times that of the data terminal printer, three null characters must be sent by the interface module to the terminal with each character that is to be printed by the terminal. When connecting to other terminal devices, the instruction manual for that device must be consulted to determine carriage return, line feed, and associated mechanical timing requirements, etc.

```
0047                    * SAMPLE PROGRAM SEQUENCE - OUTPUT A CHARACTER AND NULLS
0048 0054 1D0B  NULL    SBO   CLRWRQ        CLEAR WRITE REQUEST
0049 0056 3209          LDCR  R9,8          OUTPUT CHARACTER FROM R9
0050 0058 0703          SETO  R3            SET MAX LOOP COUNT TO R3
0051 005A 0603  DOWN    DEC   R3            DECREMENT LOOP COUNT
0052 005C 1311          JEQ   ERROR         NO RESPONSE FROM CHARACTER OUPUT
0053 005E 1F0B          TB    WRQ           EXAMINE WRITE REQUEST
0054 0060 16FC          JNE   DOWN          LOOP IF NOT SET
0055 0062 0206  DELAY   LI    R6,3          SET TO OUTPUT 3 CHARACTERS
     0064 0003
0056 0066 1D0B  OUTPUT  SBO   CLRWRQ        CLEAR WRITE REQUEST
0057 0068 3207          LDCR  R7,8          OUTPUT CHARACTER
0058 006A 0703          SETO  R3            SET MAX LOOP COUNT TO R3
0059 006C 0603  DECLOO  DEC   R3            DECREMENT LOOP COUNT
0060 006E 1308          JEQ   ERROR         NO RESPONSE FROM CHARACTER OUTPUT
0061 0070 1F0B          TB    WRQ           EXAMINE WRITE REQUEST
0062 0072 16FC          JNE   DECLOO        LOOP
0063 0074 0606  DECHAR  DEC   R6            DECREMENT CHARACTER COUNT
0064 0076 16F7          JNE   OUTPUT        OUTPUT NEXT CHARACTER
0065 0078 9209  CRET    CB    R9,R8         CHECK FOR CARRIAGE RETURN
0066 007A 1603          JNE   END           NO DELAY IF NO CR
0067 007C 04C9          CLR   R9            FORCE NOT EQUAL NEXT TIME
0068 007E 10F1          JMP   DELAY         DELAY FOR CARRIAGE RETURN
0069 0080 0584  ERROR   INC   R4            FORCE PROGRAM TERMINATION
0070 0082 045B  END     RT                  RETURN TO CALLING ROUTINE
0071                    END
NO ERRORS,      NO WARNINGS

(A)143848
```

Figure 3-7. Output Character String Sample Routine

4

Operation

4.1 GENERAL

This section discusses the basic operation of the TTY/EIA Terminal Interface Module on a functional level. A detailed discussion of the logic circuits used to perform the various functions is contained in the *Model 990 Computer TTY/EIA Interface Module Depot Maintenance Manual.*

4.2 INTERFACE MODULE, DETAILED SIGNAL FLOW DISCUSSION

Figure 4-1 shows the interfaces between the module and a Model 990 Computer and both a current loop (TTY) device and an EIA device. All of the interfaces are shown in one diagram even though the interface module can be used only with a current loop device or an EIA device for a given set of jumper connections. The following paragraphs describe the signals on the module's interfaces.

4.2.1 TTY/EIA Terminal Interface Module-to-Model 990 Computer Interface Signals

The following paragraphs describe the TTY/EIA Terminal Interface Module-to-Model 990 Computer interface signals.

4.2.1.1 CRUDATAOUT. CRUDATAOUT is serial information from the computer to the interface module. The 16 bits of data represented by CRUDATAOUT are addressable, and provide both data and control signals for the interface module. Figure 4-2 illustrates the information contained on CRUDATAOUT.

Data Character. The first eight bits of information are data bits to be transmitted to the peripheral device. Reference to bit 7 initiates output.

Data Terminal Ready (DTR). Logic 1 sets the data terminal ready latch.

Request To Send (RTS). Logic 1 sets the request to send latch.

Clear Write Request (CLRWRQ). Logic 0 or 1 resets read request interrupt logic.

Clear New Status Flag (CLRNSF). Logic 0 or 1 resets the new status flag.

Enable Interrupts. Logic 1 sets interrupt mask latch.

Diagnostic Mode. Logic 1 sets diagnostic mode latch.

4.2.1.2 CRUBIT,12-15. CRUBIT,12-15 are the CRU bit select field of the 12-bit address word from the computer. They are used by the interface module to activate the latches and logic circuits that control the transfer of data.

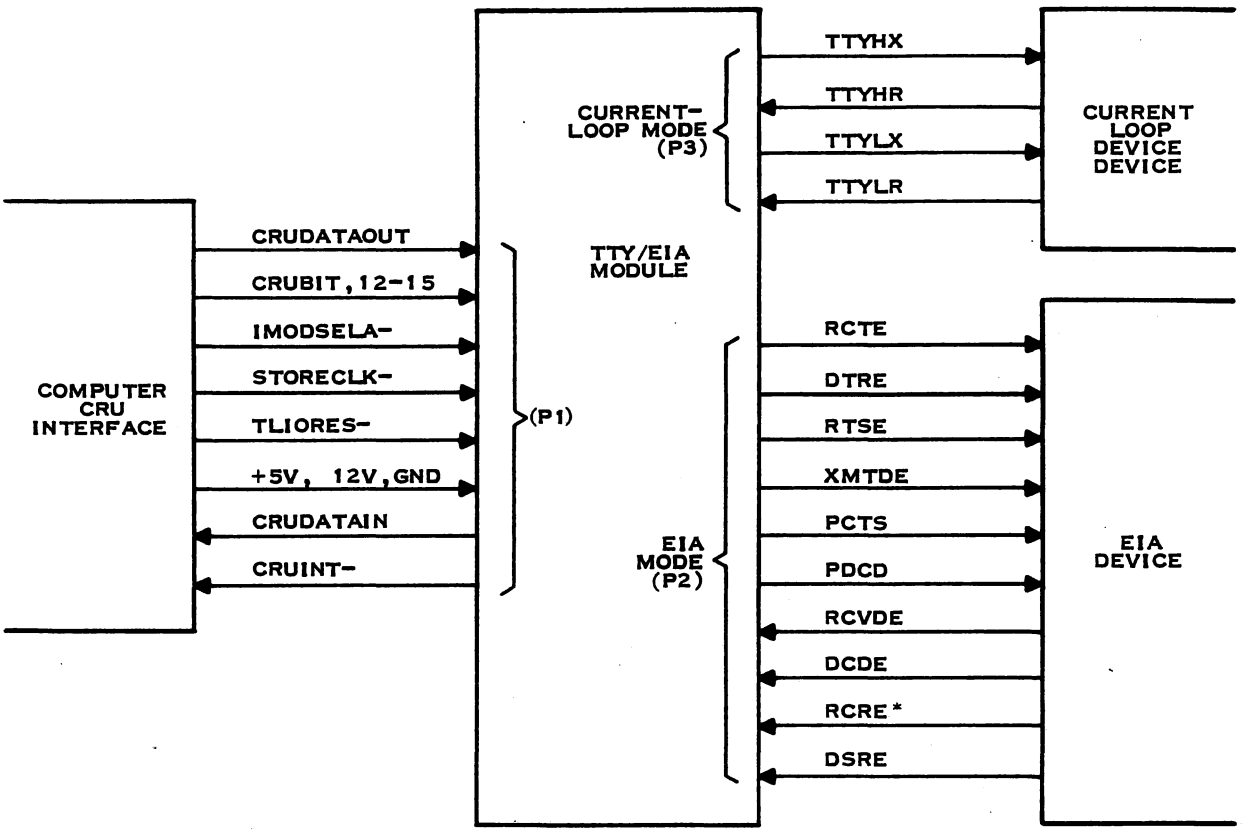


Figure 4-1. TTY/EIA Terminal Interface Module, Signal Flow Diagram

4.2.1.3 IMODSELA-. IMODSELA- is the address module select of a CRU chassis slot. IMODSELA- is wired into the computer backpanel and addressed by software. IMODSELA- is a low-active signal that enables the interface module to send and receive information between the computer and a peripheral device.

4.2.1.4 STORECLK-. STORECLK- is a low-active pulse from the computer that indicates to the interface module that the operation is a write operation (SBO, SBZ, or LDCR). STORECLK- transfers the data on CRUDATAOUT to the interface module serially.

4.2.1.5 TLIORES-. TLIORES- is the TILINE I/O reset signal. It is low-active and is generated either by an RSET instruction or during the computer's power-up sequence.

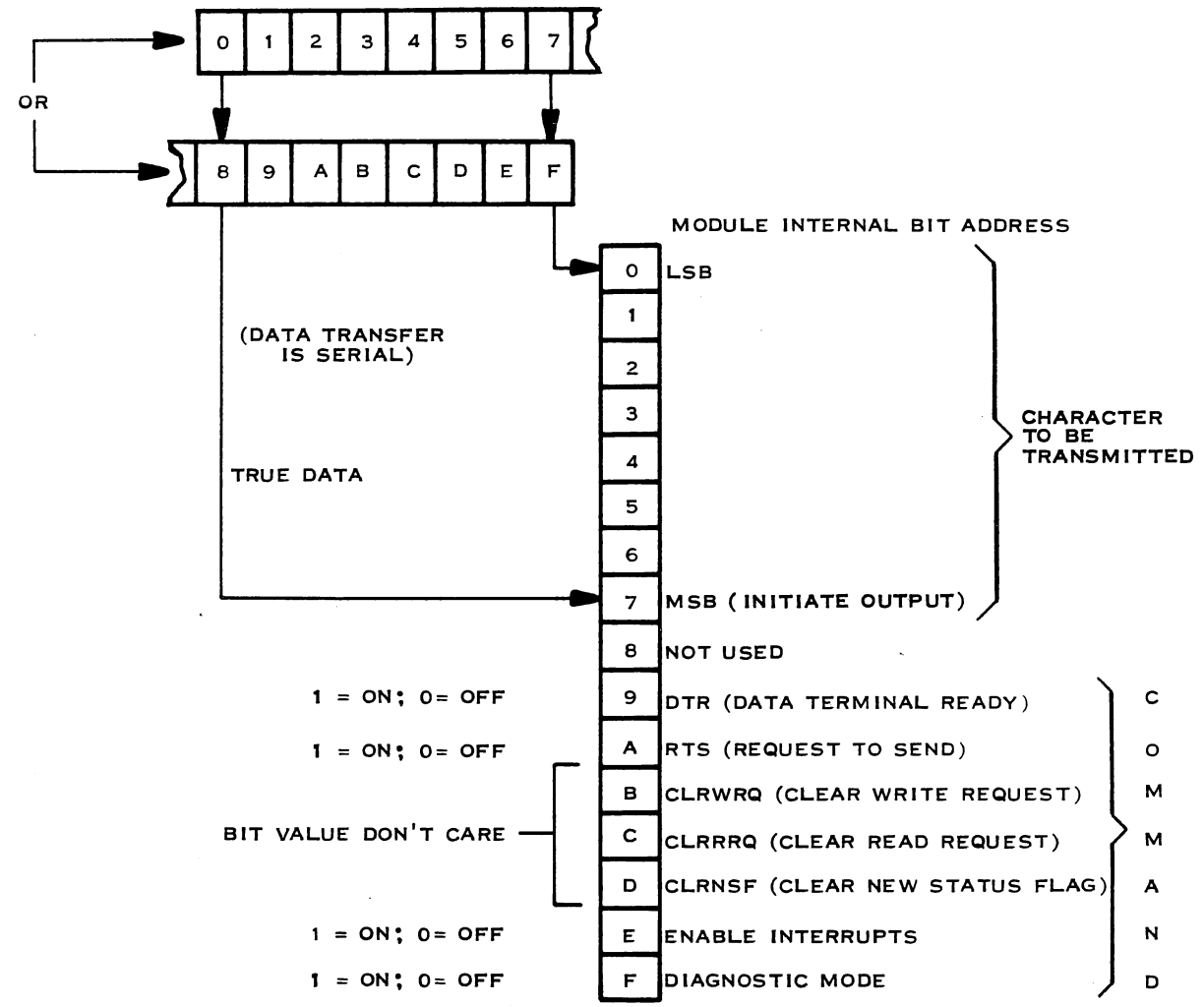


Figure 4-2. TTY/EIA Terminal Interface Module, Addressable Input Bit Lines

4.2.1.6 CRUDATAIN. CRUDATAIN is serial information from the interface module to the computer. The 16 bits of information represented by CRUDATAIN are addressable and provide data, status, and interrupts to the computer. Figure 4-3 illustrates the information contained by CRUDATAIN.

Data Character. The first eight bits of information are data bits to be transmitted to the computer.

Transmit in Progress (XMTING). Logic 1 active.

Timing Error (TIMERR). Logic 1 active.

Reverse Channel Receive (RCR). Logic 1 active.

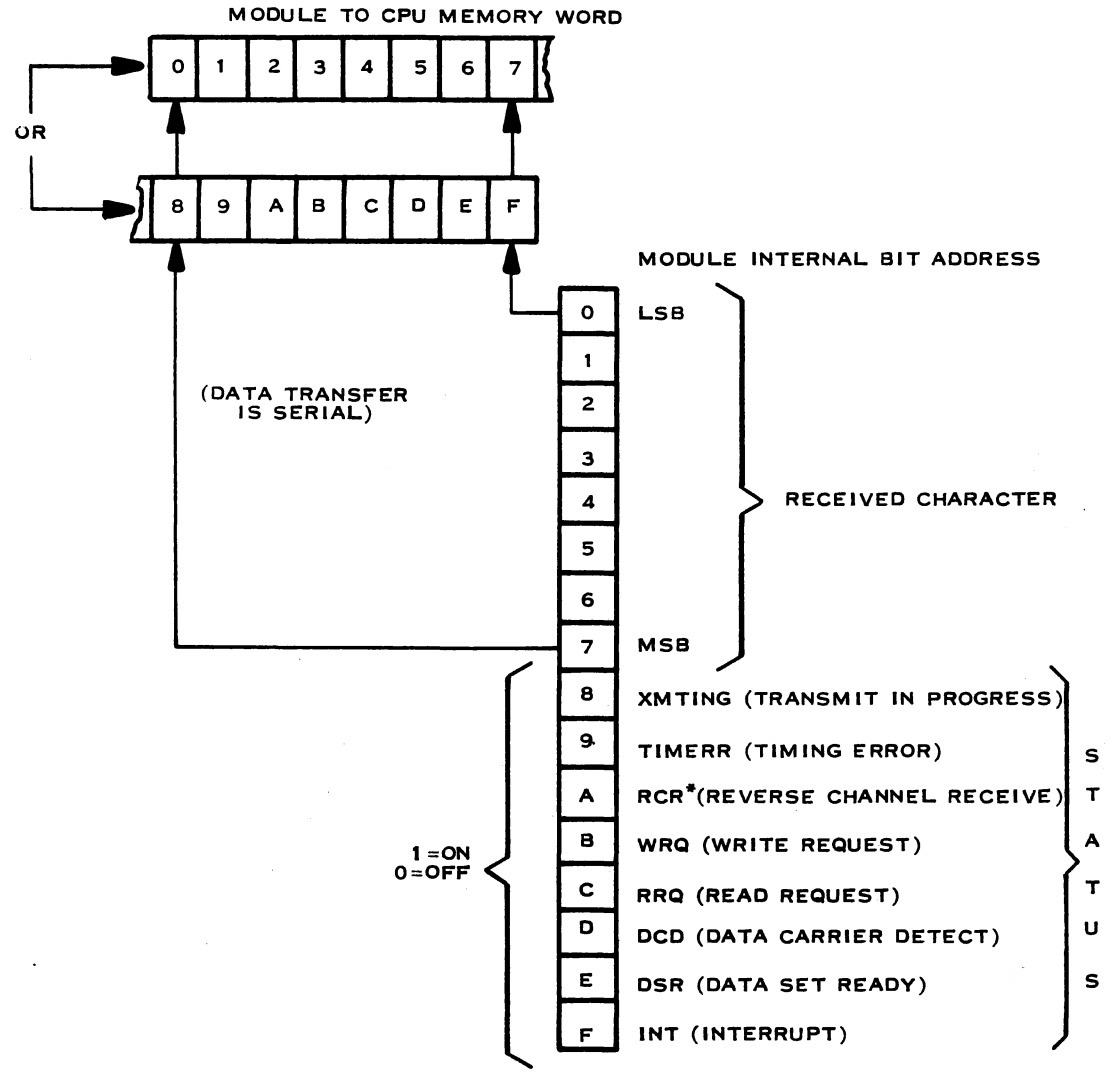
Write Request (WRQ). Logic 1 active.

Read Request (RRQ). Logic 1 active.

Data Carrier Detect (DCD). Logic 1 active.

Data Set Ready (DSR). Logic 1 active.

Interrupt (INT). Logic 1 active.



*With kits 2265150-0001/0002, RCRE is replaced by Ring Indicator.

Figure 4-3. TTY/EIA Terminal Interface Module, Addressable Output Bit Lines

4.2.1.7 CRUINT-. CRUINT- is the logical OR or read request, write request, and new status flag, and is always active (low) when bit F of the output word is set.

4.2.2 TTY/EIA Terminal Interface Module-to-Current Loop Device Interface Signals

The current loop interface consists of two pairs of lines, TTYHX and TTYLX from the transmit loop and TTYHR and TTYLR from the receive loop. A closed-loop current of 20 milliamperes is defined as a marking condition, or logic 1. Any break in this circulating current is sensed as a break condition, or logic 0.

4.2.3 TTY/EIA Terminal Interface Module-to-EIA Device Interface Signals

4.2.3.1 Reverse Channel Transmit (RCTE). Reverse Channel Transmit is used only when the module interfaces with a Bell 202 (C or D) data set or its equivalent. RCTE directs the data set to turn on/off the reverse channel carrier.

4.2.3.2 Data Terminal Ready (DTRE). Data Terminal Ready indicates to the peripheral device that the computer is ready to transmit or receive data. When the peripheral device is equipped for automatic answering of incoming calls, the off condition of DTRE prevents the data set from answering calls.

4.2.3.3 Request To Send (RTSE). Request To Send establishes the transmit condition for a Bell 103F data set. RTSE simulates Data Carrier Detect for direct interface to the terminal. Request To Send is not used with a Bell 103A data set.

4.2.3.4 Transmitted Data (XMTDE). Transmitted Data is the serial data from the computer for the device.

4.2.3.5 Pseudo Clear To Send (PCTS). Pseudo Clear To Send is high whenever the interface module's power is active and provides a simulated Clear To Send signal to the peripheral.

4.2.3.6 Pseudo Data Carrier Detect (PDCD). Pseudo Data Carrier Detect is high whenever the interface module's power is active and provides a simulated Data Carrier Detect to the peripheral.

4.2.3.7 Received Data (RCVDE). Received Data is the serial data from the device to be transmitted to the computer.

4.2.3.8 Data Carrier Detect (DCDE). Data Carrier Detect, when high, indicates that the peripheral has detected a carrier. When directly interfaced to the peripheral, DCDE reflects Request To Send.

4.2.3.9 Reverse Channel Receive (RCRE). Reverse Channel Receive indicates that the peripheral device is ready to receive data. RCRE is used only when interfacing with a Bell 202 data set with reverse channel option.

4.2.3.10 Data Set Ready (DSRE). Data Set Ready indicates that the peripheral is operative.

4.3 INTERFACE MODULE OPERATION

4.3.1 Preparation to Transmit

Prior to any character transmission, a typical I/O routine uses an SBO instruction to develop the DTRE and RTSE signals. The SBO instruction that develops DTRE places a logic 1 on CRUDATAOUT, sets CRUBIT,12-15 to 1001_2, and issues IMODSELA- and STORECLK-. This action sets the data terminal ready latch and drives DTRE to EIA logic 1. A second SBZ instruction, identical to the first except that CRUBIT,12-15 = 1010_2 resets the request to send latch and drives RTSE to EIA logic 1.

4.3.2 Data Transmission

When the I/O routine determines that the attached peripheral device is ready to accept a character, an LDCR instruction is issued to transmit an eight-bit character from computer memory to the transmit shift register. The LDCR instruction directs the computer to do the following: place eight bits of data serially on CRUDATAOUT, accompanying each bit with a STORECLK- pulse and an address (CRUBIT,12-15) that begins with 0000_2 and increments by one for each successive bit; issue IMODSELA- to enable the module. Upon receipt of the eighth bit of data (with its accompanying address and clock) the transmit go flag is set and enables the transmit shift clock generator, the transmit bit counter, and the transmit shift register. After the eighth bit is shifted out of the shift register into the transmit shift register's output flip-flop, one or two (depending on the code length) more clock pulses clock ones into the shift register to be clocked out as stop bits. After that last stop bit has been shifted out, the transmit go flag is reset, disabling the transmit shift clock generator, transmit bit counter, and transmit shift register. The write request flag is set to notify the computer that the interface module is ready to accept the next character.

4.3.3 Interrupts

The interrupt logic on the interface module monitors the write request flag, read request interrupt logic, and new status flag for set conditions. The computer uses the status of these circuits to control the starting and stopping of the applicable I/O routines to ensure efficient use of computer time. Write request indicates that a new character can be transmitted from the computer to the peripheral. Read request indicates that the interface module has a character ready for transmission to the computer. New status indicates a transition in the state of DSRE or DCDE from the peripheral.

4.3.4 Data Reception

The receiving data input is normally held in the mark (logic 1) condition. The occurrence of a space condition on the line activates the receive shift clock generator and the receive bit counter. The input line is examined after one-half bit time to determine whether a start bit has been received. If a start bit has been received, the receive go flag is set allowing the receive shift clock generator and receive bit counter to remain active independently of the receiving data input. The received data is shifted into the receive shift register at the center of each bit period. The ninth shift pulse loads the receive buffer register (parallel). At the beginning of the last (10th or 11th) shift pulse the receive go flag is reset, which terminates the character reception. The receive go flag sets the read request interrupt logic to inform the computer that a character is on the receive buffer register's output. The computer then addresses the multiplexer with successive CRUBIT,12-15 combinations to fetch the character, one bit at a time.

4.3.5 Testing

The interface module can be tested in two ways. The first way, using a diagnostic loop back, allows the EIA outputs from the computer to be gated back to the computer for examination. This is accomplished by setting the diagnostic mode latch output to a logic one (CRU bit >F = 1) and addressing the proper lines to the computer's multiplexer.

A loop-back test connector, TI part number 2262130-0001, provides the second means of testing the interface module. When connected to P2 on the interface module, the connector allows data from the interface module's EIA line drivers to be received by the EIA receivers for examination by the computer. The loop-back connector test is accomplished by setting the diagnostic mode latch to a logic zero (CRU bit >F = 0) and addressing the proper lines to the multiplexer.

Appendix A

Communication System Information

A.1 GENERAL

This appendix contains information intended to help the user select options for the Bell data sets and telephone handsets that are compatible with TI hardware and software. A procedure for using the telephone handset to establish communication between the local and remote sites is also included.

A.2 REMOTE TELEPHONE CONNECTION (RTC) OPTIONS

The telephone company refers to the telephone handsets used with their data sets as RTCs. Two types of RTC are commonly used with Bell data sets. Both types are shown in Figure A-1. The RTC shown in the top of Figure A-1 is switched between data and talk modes by the exclusion key located under the receiver. The RTC at the bottom of Figure A-1 is a six-button set that is switched between data and talk modes by the two push buttons on the left.

The options available on RTC telephones are as follows:

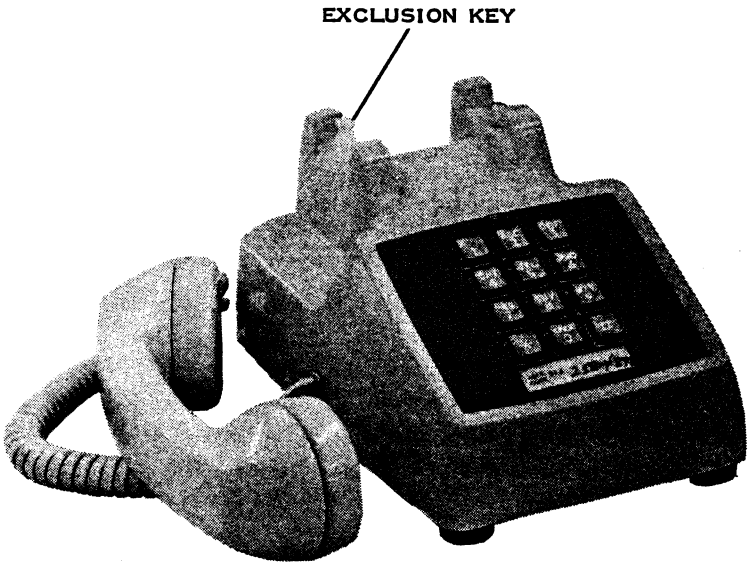
A1 — Telephone set controls the line
A2 — Data set controls the line
B3 — Aural monitoring not provided
B4 — Aural monitoring provided
C5 — Touch-Tone dial
C6 — Rotary dial
D7 — Switchhook indication only
D8 — Voice mode indication

TI recommends ordering USOC RTC 12 for Touch-Tone applications or USOC RTC 16 for rotary dial applications. USOC RTC 12 specifies the following options for a Touch-Tone system:

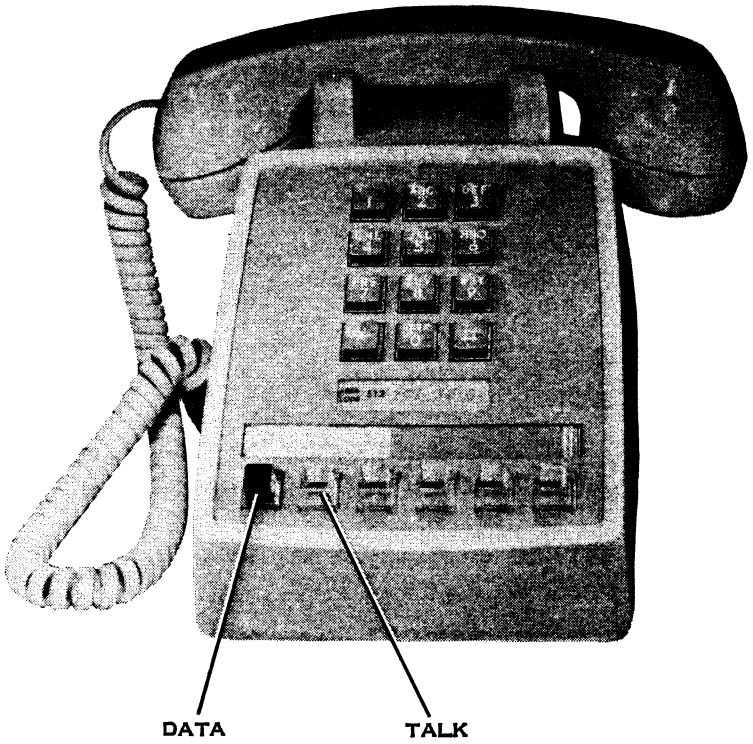
A2 — Data set controls the line
B4 — Aural monitoring provided
C5 — Touch-Tone dial
D8 — Voice mode indication

USOC RTC 16 specifies the following options for a rotary dial system:

A2 — Data set controls the line
B4 — Aural monitoring provided
C6 — Rotary dial
D8 — Voice mode indication



RTC TELEPHONE SET WITH
EXCLUSION KEY LIFTED



SIX-BUTTON RTC TELEPHONE WITH
DATA AND TALK MODES CONTROLLED
BY THE FIRST TWO BUTTONS ON THE
LEFT

(A)143211

Figure A-1. RTC Telephone Sets

CAUTION

The designations (A2, B4, C5, etc.) used to describe the recommended options for RTC telephones are different in some regions of the country. When ordering an RTC telephone be very careful to tell the person taking the order exactly how the telephone is to operate; do not tell them just the designations. For instance, if you want option A2, make sure that they understand that the "data set controls the line" is the option that you want. Describe each option desired on the telephone and be sure that they write the order to specify those options regardless of the alphanumeric designation they may assign.

Options that are not recommended and the consequences of specifying them are as follows:

A1 — If this option is specified, the telephone set controls the line. With this option, the data set cannot automatically answer or originate a call since it cannot control the line. Additionally, the data set cannot handle a manually answered call properly since it cannot sense when ringing occurs: therefore, it cannot transmit the answerback tone.

B3 — With this option, data transmission cannot be monitored with the telephone set. Without the capability of aurally monitoring data transmission, the user is not able to tell if the data set on either end of the line is transmitting unless special test equipment is available.

D7 — If this option is specified, the data set will not operate when the telephone set is off the hook. If this option and A1 are specified together, the data set cannot work at all. If option A2 is specified with this option, the data set will stop operating when the telephone is taken off the hook to monitor a call.

A.3 COMPATIBLE BELL DATA SETS

The following Bell data sets are compatible with Texas Instruments Model 990 Computer systems when used with the TTY/EIA Terminal Interface Module:

103J
113C
113D
212A

The 103J, 113C, and 113D all support asynchronous communications at rates of up to 300 baud. The 212A supports either asynchronous or synchronous communications. In the asynchronous mode, the 212A will operate at either 300 or 1200 baud. The asynchronous mode of operation is required with the interface module.

A.3.1 Bell 103J, 113C, and 113D (0-300 Baud) Data Sets

The Bell 103J, 113C, and 113D data sets all support half- or full-duplex asynchronous communications at rates of up to 300 baud on the two-wire switched telephone network. The 103J is an originate/answer (dual-mode) type data set. The 113C is an originate-only (single-mode) data set.

The 113D is an answer-only (single-mode) data set. All three sets are commonly used to provide asynchronous terminal support for TI models 743, 745, and 820 KSR.

A 103J may be used to communicate with another 103J, a 212A, or a 113C or D. The 113C will not communicate with another 113C; the 113D will not communicate with another 113D. The 113D (answer-only) data set is normally used at the system end with the 113C (originate-only) modem being used at the remote terminal end.

The basic 103J, 113C, and 113D data sets are all 55 millimeters (2.2 inches) high, 145 millimeters (5.8 inches) wide, and 270 millimeters (10.8 inches) deep. A standard six-button telephone is provided with each data set. The basic configuration, including the data set and associated telephone, is specified by USOC DN0 for the 103J, USOC DNW for the 113C, and USOC D1L for the 113D.

A.3.1.1 Bell 103J Data Set Options. The options (called decisions by Bell) that are required or recommended when the 103J is used with the interface module are as follows (Table A-1):

Table A-1. Bell 103J Data Set Decisions

Decision	Required/ Recommended	Options
A	Recommended	1. Send space disconnect (yes) 2. Send space disconnect (no)
B	Recommended	3. Receive space disconnect (yes) 4. Receive space disconnect (no)
C	Required	5. Loss of carrier disconnect (yes) 6. Loss of carrier disconnect (no)
D	Required	7. Fail safe state of CN circuit ON 8. Fail safe state of CN circuit OFF
E	Required	9. Automatic answer (yes) 10. Automatic answer (no)
F	Required	11. Factory-supplied EIA interface indication and ground options 12. Customer-selected EIA interface indication and ground options (See available options below)

Note:

Auto answer is not key selectable. It is determined by installation method.

The choices that follow are the customer-selected EIA interface and ground options that must be specified when decision F12 (required by TI) is selected (Table A-2).

Table A-2. Bell 103J EIA Interface and Ground Options

Option	Required/ Recommended	Choices
Data set ready (CC)	Required	1. Early indication 2. Delayed indication
Data set ready (CC) for analog loop	Recommended	1. On 2. Off
Clear to send (CB) and carrier detector (CF)	Recommended	1. Common 2. Separate
Common grounds	Required	1. Yes 2. No

The 103J configured for use with a DS990 system is summarized as follows:

- 103J data set, USOC DN0
- Decisions A1, B3, C5, D7, E9, F12
- Decision F12 options:
  - — Data set ready (CC) — Delayed indication
  - — Data set ready (CC) — On for analog loop
  - — Clear to send (CB) and carrier detector (CF) — Separate
  - — Common Grounds — No

A.3.1.2 Bell 113C Data Set Options. The options that are required or recommended when the 113C is used with the interface module are as follows (Table A-3):

Table A-3. Bell 113C Data Set Decisions

Decision	Required/ Recommended	Options
A	Recommended	1. Send space disconnect (yes) 2. Send space disconnect (no)
B	Recommended	3. Receive space disconnect (yes) 4. Receive space disconnect (no)
C	Required	5. Loss of carrier disconnect (yes) 6. Loss of carrier disconnect (no)
D		7. Factory-supplied EIA interface indications and ground options
	Required	8. Customer-selected EIA interface indications and ground options

The choices that follow are the EIA interface indications and ground options that must be specified when decision D8 (required by TI) is selected (Table A-4).

Table A-4. Bell 113C Interface and Ground Options

Option	Required/ Recommended	Indication	Choices
Data set ready		ZD	1. Early indication
	Required	ZC	2. Delayed indication
Data set ready (CC) for analog loop	Recommended	ZF	1. On
		ZE	2. Off
Clear to send (CB) and carrier detector (CF)	Recommended	A	1. Common
		B	2. Separate
Common grounds (AA and AB)	Required	Q or ZI[1]	1. Yes
		P or ZJ[1]	2. No

Note:

[1] Options Q and P are on the 47F1 data mounting. Options ZI and ZJ are on the 40A type data mounting.

The 113C configured for operation with a DS990 system is summarized as follows:

- 113C data set, USOC DNW
- Decisions A1, B3, C5, and D8
- Decision D8 options:

  — Data set ready, delayed indication — ZC

  — Data set ready for analog loop, on — ZF

  — Clear to send and carrier detector, separate — B

  Common grounds (AA and AB), no — P or ZJ

A.3.1.3 Bell 113D Data Set Options. The options that are required or recommended when the 113D is used with the interface module are as follows (Table A-5):

Table A-5. Bell 113D Data Set Decisions

Decision	Required/ Recommended	Options
A	Recommended	1. Send space disconnect (yes) 2. Send space disconnect (No)
B	Recommended	3. Receive space disconnect (yes) 4. Receive space disconnect (no)
C	Required	5. Loss of carrier disconnect (yes) 6. Loss of carrier disconnect (no)
D	Required	7. Fail safe state of CN circuit OFF 8. Fail safe state of CN circuit ON[1]
E	Required	9. Automatic answer (yes) 10. Automatic answer (no)
F	Required	11. Factory-supplied EIA interface indication and ground options 12. Customer-selected EIA interface indication and ground options

Note:

[1] The telephone set used with data set 113D is not provided with keys to select automatic or manual answer. An installer option determines whether the automatic answer feature is functional or not.

The choices that follow are the EIA interface indications and ground options that must be specified when decision F12 (required by TI) is selected (Table A-6).

Table A-6. Bell 113D EIA Interface and Ground Options

Option	Required/ Recommended	Option Designation	Choices
Clear to send and carrier detector	Recommended	A B	1. Common 2. Separate
Common grounds (AA and AB)	Required	Q or ZI P or ZJ	1. Yes[1] 2. No[1]
Data set ready (CC) for analog loop	Recommended	ZF ZE	1. On 2. Off

Note:

[1] Options Q and P are on 47E1 data mounting.
Options Z1 and ZJ are on 40A-type data mounting.

The 113D configured for operation with a DS990 system is summarized as follows:

- 113D data set, USOC D1L
- Decisions A1, B3, C5, D8, E9, AND F12
- Decision F12 options and indications
  - — Clear to send and carrier detector — B
  - — Common grounds — P or ZJ
  - — Data set ready for analog loop — ZF

A.3.2 Bell 212A (0-300 or 1200 Baud) Data Set

The Bell 212A supports half- or full-duplex asynchronous communications on the two-wire switched telephone network. The 212A is capable of operating in two asynchronous modes: 0 - 300 baud in the low-speed mode, and 1200 baud in the high-speed mode. The 212A is commonly used to provide asynchronous terminal support for TI models 733, 743, 745, and 820 KSR. Automatic answering is provided on the 212A when option B3 (required by TI) is selected.

The basic 212A is 55 millimeters (2.2 inches) high, 145 millimeters (5.8 inches) wide, and 270 millimeters (10.8 inches) deep and is supplied with a standard six-button telephone. The basic

configuration of the data set, including the associated telephone, is specified by USOC D2A. The following table lists the decisions and options that are required or recommended when the 212A is used for asynchronous communications (Table A-7).

Table A-7. Bell 212A Data Set Decisions for Asynchronous Operation

Decision	Required/ Recommended	Options
A	Recommended	1. Factory-supplied disconnect options 2. Customer-selected disconnect options
B	Required	3. Automatic answer (yes)[1] 4. Automatic answer (no)
C	Required	5. Factory-supplied EIA interface and ground options 6. Customer-selected EIA interface and ground options
D	Recommended	7. Factory-supplied dual mode, character formatted operation 8. Customer-selected modes of operation
E	Required	9. Make busy/analog loop (CN) circuit enable IN 10. Make busy/analog loop (CN) circuit disable OUT

Note:

[1] Auto answer is not key selectable — it is determined by installer option.

When you select decision A1 (recommended by TI), the 212A comes equipped with the following disconnect options:

- Send space disconnect, In — T
- Receive space disconnect, In — V
- Loss of carrier disconnect, In — S

The choices that follow are the customer-selectable EIA interface and ground options that must be specified when decision C6 (required by TI) is selected (Table A-8):

Table A-8. Bell 212A EIA Interface and Ground Options

Option	Required/ Recommended	Indication	Choices
Data set ready (CC) indication for analog loop	Recommended	ZF ZE	1. On 2. Out
Clear to send (CB) and carrier detector indications	Recommended	A B	1. Common 2. Separate
Signal ground to frame connection	Required	O P	1. In 2. Out
Answer mode indication (CE)	Required	X W	1. On 2. Off

The choices that follow are the customer-selectable modes of operation that must be specified when decision D8 (recommended by TI) is selected (Table A-9).

Table A-9. Bell 212A Modes of Operation

Option	Required/ Recommended	Indication	Choices
1200 BPS operation	Recommended	YG YH	1. Asynchronous/ start-stop 2. Synchronous
Character length	Recommended	YI YJ	1. 9 bit 2. 10 bit
Transmitter timing	Required	YC YD WI	1. Internal 2. External 3. Slave
Speed mode	Recommended	YO YP	1. High (1200 BPS only permitted) 2. Dual (1200 BPS or 0 to 300 BPS)

Table A-9. Bell 212A Modes of Operation (Continued)

Option	Required/ Recommended	Indication	Choices
Receiver responds to digital loop		YK YP	1. In 2. Out
Interface speed indication	Recommended	YQ YR	1. In 2. Out

The basic 212A modem configured to operate in the asynchronous mode with a DS990 system is summarized as follows:

- 212A data set, USOC D2A
- Decisions A1, B3, C6, D8, and E10
- Decision C6 options:
  - — Indication 7F — Data set ready (CC) indication for analog loop — ON
  - — Indication B — Clear to send (CB) and carrier detector indications — separate
  - — Indication P — Signal ground to frame connection — out
  - — Indication W — Answer mode indication (CE) — OFF
- Decision D8 options:
  - — Indication YG — Asynchronous/start-stop
  - — Indication YJ — 10-bit character length
  - — Indication YC — Internal transmitter timing
  - — Indication YP — Dual speed mode
  - — Indication YQ — Interface speed indication in

A.4 USING THE RTC TELEPHONE

The instructions in the following paragraphs cover the use of the RTC telephone set regardless of the option ordered. However, certain instructions are valid for use only with a specific option. Those instructions are identified to avoid confusion.

A.4.1 Establishing a Call

To establish a call to the far-end data set, proceed as directed in the following steps:

1. Lift the telephone handset. Lift the exclusion key (sets with A2 option only). Listen for the dial tone and dial the telephone number of the far-end station.

2. If the called data set is set for automatic answer, proceed as directed in steps a, b, and c below. If the called data set is set for manual answer, proceed to step 3.

   a. Listen for the answerback tone from the far-end data set.

   b. Select data mode on associated data set, lower the exclusion key when the data set has entered the data mode and hang up the handset (set with A2 option only). For set with A1 option proceed as described except lift the exclusion key and handset when data set enters data mode.

   c. Transmission of data is now under control of the business machine.

3. If the called station is set for manual answer, proceed as directed in steps a through e below.

   a. When the far-end data set operator answers the call, voice communication is possible.

   b. Inform the far-end data set operator that you have data to transmit and request him to transfer to data mode.

   c. After the answerback tone is heard (signifying that the called data set is in the data mode), transfer calling equipment to data mode as described in 2 above.

   d. Transmission of data is now under control of the business machine.

   e. When it is necessary to return to the talk mode, remove the handset from the cradle and lift the exclusion key (set with A2 option only), or return the exclusion key to the neutral position (set with A1 option only).

A.4.2 Answering a Call

When equipped for auto-answer, the data set answers automatically without prior conditioning by the operator. To answer calls manually proceed as follows:

1. When the telephone rings, lift the telephone handset, lift the exclusion key (set with A2 option only), and answer the call.

2. When instructed by the calling data set operator, transfer to the data mode.

3. When it is necessary to return to the talk mode, lift the handset and lift the exclusion key (set with A2 option) or return the exclusion key to the neutral position (set with A1 option).

A.4.3 Monitoring a Call

RTC telephone sets ordered from the telephone company with aural monitoring option B4 are equipped to monitor tones on the telephone line while the associated data set is in the data mode. When a call has been originated or answered and data exchange is in progress, simply lift the handset but leave the exclusion key in the position required for data exchange (neutral position for set with A2 option, raised position for set with A1 option).

The data transmission on the telephone line should now be clearly audible in the handset.

Alphabetical Index

Introduction

HOW TO USE INDEX

The index, table of contents, list of illustrations, and list of tables are used in conjunction to obtain the location of the desired subject. Once the subject or topic has been located in the index, use the appropriate paragraph number, figure number, or table number to obtain the corresponding page number from the table of contents, list of illustrations, or list of tables.

INDEX ENTRIES

The following index lists key words and concepts from the subject material of the manual together with the area(s) in the manual that supply major coverage of the listed concept. The numbers along the right side of the listing reference the following manual areas:

- Sections — Reference to Sections of the manual appear as "Sections x" with the symbol x representing any numeric quantity.

- Appendixes — Reference to Appendixes of the manual appear as "Appendix y" with the symbol y representing any capital letter.

- Paragraphs — Reference to paragraphs of the manual appear as a series of alphanumeric or numeric characters punctuated with decimal points. Only the first character of the string may be a letter; all subsequent characters are numbers. The first character refers to the section or appendix of the manual in which the paragraph may be found.

- Tables — References to tables in the manual are represented by the capital letter T followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the table). The second character is followed by a dash (-) and a number.

  Tx-yy

- Figures — References to figures in the manual are represented by the capital letter F followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the figure). The second character is followed by a dash (-) and a number.

  Fx-yy

- Other entries in the Index — References to other entries in the index preceded by the word "See" followed by the referenced entry.

CUT ALONG LINE

USER'S RESPONSE SHEET

Manual Title: Model 990 Computer TTY/EIA Terminal Interface Installation and Operation (946240-9701 *A)

Manual Date: 15 December 1980 **Date of This Letter:** _____

User's Name: _____ **Telephone:** _____

Company: _____ **Office/Department:** _____

Street Address: _____

City/State/Zip Code: _____

Please list any discrepancy found in this manual by page, paragraph, figure, or table number in the following space. If there are any other suggestions that you wish to make, feel free to include them. Thank you.

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