TEXAS INSTRUMENTS

Improving Man's Effectiveness Through Electronics

Model 990 Computer

Communications System Installation and Operation

MANUAL NO. 945409-9701 A

Digital Systems Group

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES DESTROY SUPERSEDED PAGES

Note: The portion of the text affected by the changes is indicated by a vertical bar in the outer margins of the page.

Model 990 Computer Communications System Installation and Operation (945409-9701)

Original Issue ..... 1 September 1976
Revision ..... 15 May 1979 (ECN 419732)

Total number of pages in this publication is 86 consisting of the following:

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
Cover	0				
Effective Pages	0				
iii-vii	0				
1-0 - 1-12	0				
2-1 - 2-28	0				
3-1 - 3-24	0				
A-1 - A-2	0				
B-1 - B-2	0				
C-1 - C-2	0				
Index-1 - Index-4	0				
User's Response	0				
Business Reply	0				
Cover Blank	0				
Cover	0				

PREFACE

This manual contains detailed instructions for installing and operating a TI communications system in conjunction with a Texas Instruments Model 990 Computer. The manual also contains information required to program the computer to use the communications system. The information is divided into the following three sections and three appendixes:

Sections

I General Description — briefly describes the features, major components, and operational configurations of a 990-based communications system.

II Installation — presents step-by-step instructions for unpacking the communications system components and installing them in a 990 computer or expansion chassis.

III Programming — presents interfacing information for use by a programmer in designing a service routine to control the communications system. This information is in addition to that contained in the *Model 990 Computer Assembly Language Programmers Guide,* part number 943441-9701.

Appendixes

A Contains excerpts from FCC rules that the user must read before installing and operating the data coupler.

B Presents operating instructions for the optional telephone set that may be ordered.

C Contains a list of USOC jacks that a local telephone company will install for use with data couplers.

If you would like for service personnel from Texas Instruments to install the communications system for you, please contact your local Texas Instruments Sales or Service Office. These offices can also obtain additional information for you concerning the communications hardware if you should decide to perform maintenance on the equipment. For information about available software, please contact your local Texas Instruments sales office. The following documents contain additional information related to the 990 Communications System:

Title	Part Number
Model 990 Computer DX10 Operating System Programmer's Guide	945257-9701
Model 990 Computer TMS9900 Microprocessor Assembly Language Programmer's Guide	943441-9701
Model 990/10 Computer System Hardware Reference Manual	945417-9701

Title	Part Number
990 Computer Family Systems Handbook	945250-9701
Model 990/4 Computer System Hardware Reference Manual	945251-9701
Model 990 Computer Communications Interface Module System Depot Maintenance Manual	945410-9701
Model 990 Computer Pulse/Tone Automatic Call Unit and External Automatic Call Unit Interface Installation and Operation Manual	945425-9701
Model 990 Computer Automatic Calling Unit Depot Maintenance Manual	946225-9701
Model 990 Computer Diagnostics Handbook	945400-9701
Model 990 Computer External Automatic Calling Unit Interface Depot Maintenance Manual	946425-9701

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

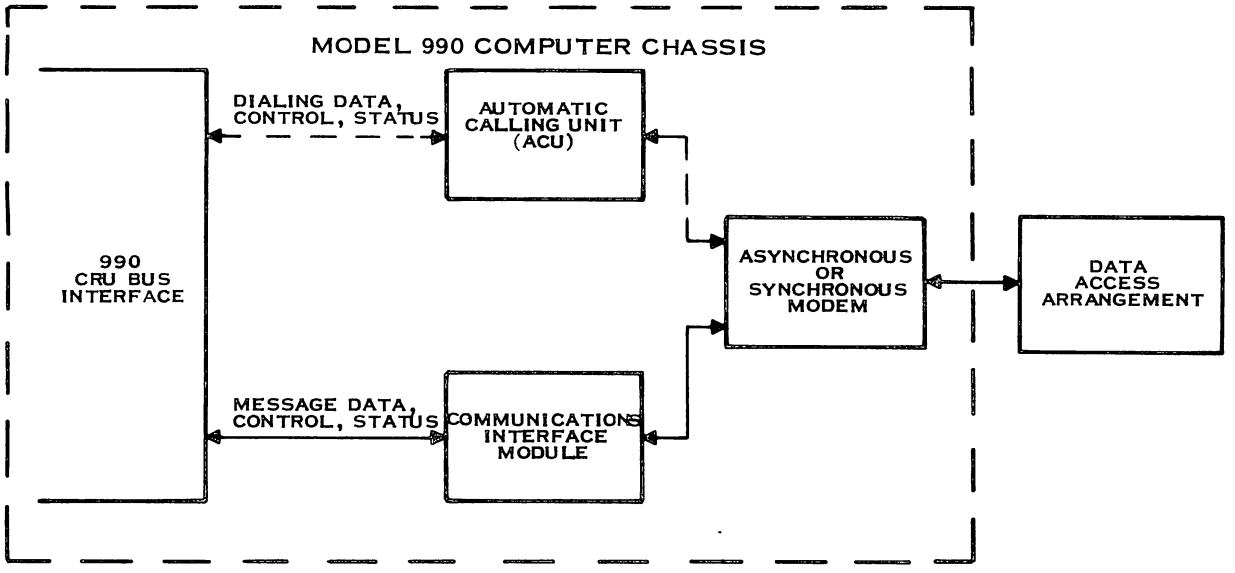
SECTION III. PROGRAMMING

LIST OF APPENDIXES

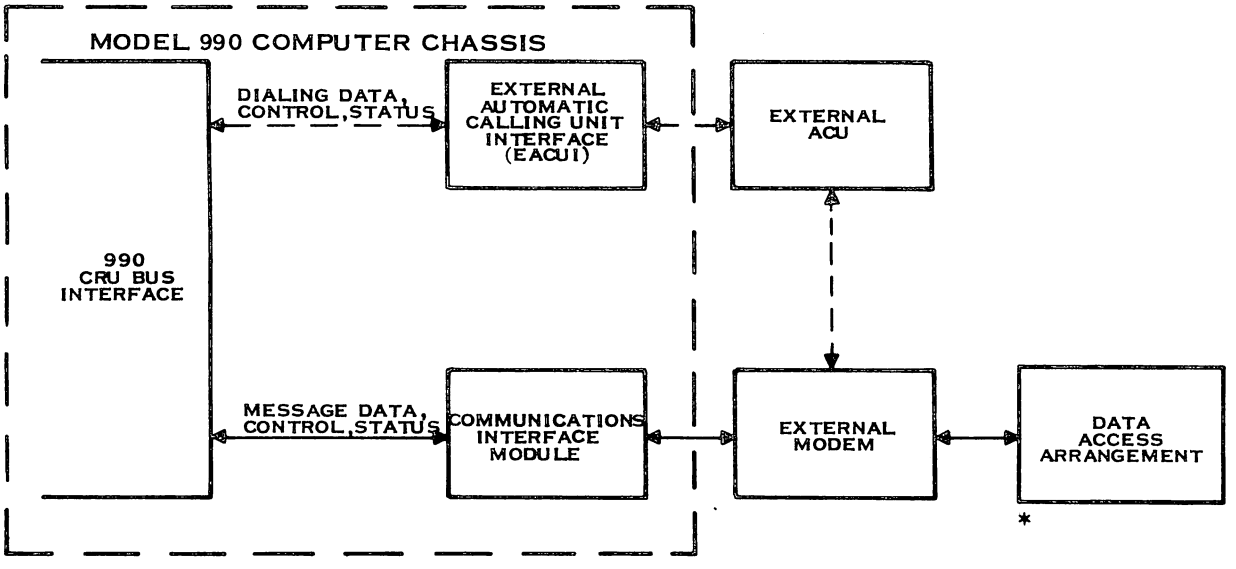
LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES



A. INTERNAL COMMUNICATIONS SYSTEM WITH OPTIONAL ACU



B. EXTERNAL COMMUNICATIONS SYSTEM WITH OPTIONAL EACUI AND EXTERNAL ACU.
*IF THE EXTERNAL MODEM IS SUPPLIED BY BELL OR PROPERLY CERTIFIED BY THE FCC, NO DATA ACCESS ARRANGEMENT IS REQUIRED.

(A)139656

Figure 1-1. Communications Systems, Block Diagram

SECTION I

GENERAL DESCRIPTION

1.1 GENERAL

The Texas Instruments Communications System for the Model 990 Computer family (shown in figure 1-1) provides an interface between the computer and either a dedicated telephone line or the public switched-telephone network. This interface provides two-way data transfers between the computer and a remote terminal (or terminals). The system provides the following features:

- Asynchronous or synchronous mode communications, depending on the type of modem used.
- 25 through 9600 bits-per-second interface controller.
- Either of two modems (not both):
  1. Internal 201C compatible 2400 bps synchronous modem.
  2. Internal 202 compatible 0-1200 bps asynchronous modem.
- FCC-registered Data Access Arrangement for use with the public switched-telephone network.
- Half- or full-duplex operation.
- Capacity to interface with an internal or external (to the computer chassis) auto call unit.
- Choice of even, odd, or no parity.
- 5-, 6-, 7-, or 8-bit code transfer.
- Provision for internal or remote loopback for testing.

The system is connected to the telephone lines by a Data Access Arrangement (DAA) which allows the computer to originate and answer calls involving the switched-telephone network and to terminate any subsequent data transfer. There are two types of DAA's available. See paragraph 1.2.5.2 for details. Using the Texas Instruments Auto Call Unit (ACU) or External Auto Call Unit Interface (EACUI) coupled with an External Auto Call Unit (EACU), dialing may be automatically performed by the computer system. Point-to-point or multipoint communication is possible without the need for automatic answering procedures.

The DAA provides the required Federal Communications Commission (FCC) registered protective interface between the Model 990 Computer Communications System and the public switched-telephone network, allowing two-way data transfer between the computer and other stations.

The DAA limits the transmitted signal applied to the telephone lines to a maximum level approved by the FCC for connecting privately-purchased data communications equipment to the public switched telephone network. When the Model 990 Computer Communications System is used with leased lines, the DAA is not necessary.

1.2 SYSTEM TERMINOLOGY

Figure 1-1 illustrates the relationship of the major components of the communications system. The following paragraphs describe the functions of the system components to provide an understanding of the system's operation.

The communications system establishes and maintains communications over telephone lines between a Model 990 Computer and a remotely-located terminal or terminals or another computer. The system converts digital data from the computer into a form that is compatible with transmission lines designed to carry analog (amplitude-, frequency-, or phase-modulated) data and converts analog data received over the lines into digital data for use by the computer. The system also provides the necessary timing and signal level adjustments to ensure accurate data transmission and retrieval.

1.2.1 COMMUNICATIONS REGISTER UNIT (CRU). The Communications Register Unit (CRU) is the serial interface of the Texas Instruments Model 990 computer. The CRU interface with the communications system handles all of the data, control and status signals associated with the Communications Interface Module (CIM) and the optional ACU or EACUI. For more details on CRU operation, refer to the appropriate hardware reference manual or hardware user's manual for the Model 990 computer used in the system.

1.2.2 COMMUNICATIONS INTERFACE MODULE (CIM). The Communications Interface Module, TI part number 946105-0001, is a printed circuit board that occupies one half-slot location in the 990 computer mainframe chassis or expansion chassis. The module provides timing and level translation circuitry to allow the transfer of serial digital data between the computer (TTL-compatible) and either an asynchronous or a synchronous modem (EIA-compatible). Table 1-1 lists the EIA RS-232-C cable assignments. The module supports half- or full-duplex communications at rates up to 9600 baud. Transparent communication in the synchronous mode is provided as a programmable option. See the Programming section.

The interface between the CIM and the TI internal modems or a user-supplied external modem comprises the signals defined in the following paragraphs. The signal name is followed by the EIA mnemonic, the cable pin number and then the direction (if applicable) of the signal, i.e., CIM to modem (MDM) or MDM to CIM.

- Transmitted Data (BA), pin 2, CIM to MDM

  Signals on this circuit are generated by the CIM and are transferred to the MDM for transmission of data to the remote data terminal. This circuit is held in the marking condition during intervals between characters and at all times when no data are being transmitted. The following four signals must be ON before data is transmitted:

  Request To Send (CA)
  Clear To Send (CB)
  Data Set Ready (CC)
  Data Terminal Ready (CD)

- Receive Data (BB), pin 3, MDM to CIM

Table 1-1. EIA RS-232-Cable Interface Signal Pin Assignments

Pin Number	RS-232-C/CIM Signature (EIA Mnemonic)	Implemented on CIM	Implemented in Ext. Modem Cable (946117-0001)	Implemented on Internal Modems		Communications Interface Mnemonic
				Async	Sync	
1	Protective Ground (AA)	No	No	No	No	
2	Transmitted Data (BA)	Yes	Yes	Yes	Yes	
3	Received Data (BB)	Yes	Yes	Yes	Yes	
4	Request To Send (CA)	Yes	Yes	Yes	Yes	RTS
5	Clear To Send (CB)	Yes	Yes	Yes	Yes	CTS
6	Dataset Ready (CC)	Yes	Yes	Yes	Yes	DSR
7	Signal Ground (AB)	Yes	Yes	Yes	Yes	
8	Received Line Signal Detect (CF) (See Note 1)	Yes	Yes	Yes	Yes	DCD
9	Reserved (See Note 2)	No	No	Yes	Yes	
10	Reserved (See Note 3)	No	No	Yes	Yes	
11	Secondary Request To Send (SCA) (See Note 4)	Yes	Yes	No	No	SRTS
12	Secondary Received Line Signal Detect (SCF) (See Notes 1 and 4)	Yes	Yes	No	No	SDCD
13	Analog Loopback	Yes	No	Yes	Yes	AN L B/REM TEST
14	New Sync (See Note 5)	Yes	Yes	No	Yes	PULSED MODEM LD
15	Transmission Signal Element Timing (DB)	Yes	Yes	No	Yes	

NOTES:

1. Also called Data Carrier Detect
2. Positive 12 volt supply provided by TI internal modems
3. Negative 12 volt supply provided by TI internal modems
4. Used on Bell 202 Series Modems for Reverse Channel Transmission/Reception
5. Used by Bell 201C and TI internal synchronous mode as New Sync
6. Used by TI internal modems to control the audio monitor
7. Used by Bell 202T as Carrier Detect Reset

Table 1-1. EIA RS-232-Cable Interface Signal Pin Assignments (Continued)

Pin Number	RS-232-C/CIM Signature (EIA Mnemonic)	Implemented on CIM	Implemented in Ext. Modem Cable (946117-0001)	Implemented on Internal Modems		Communications Interface Mnemonic
				Async	Sync	
16	Secondary Received Data (SBB)	No	No	No	No	
17	Received Signal Element Timing (DD)	Yes	Yes	No	Yes	
18	Audio Monitor (See Note 6)	Yes	No	Yes	Yes	RES MODEM LD OUT
19	Secondary Request To Send (SCA) (See Note 4)	Yes	No	No	No	SRTS
20	Data Terminal Ready (CD)	Yes	Yes	Yes	Yes	DTR
21	Signal Quality Detect (CG)	No	No	No	No	
22	Ring Indicator (CE)	Yes	Yes	Yes	Yes	RING
23	Data Signal Rate Selector (CH/CI)	No	No	No	No	
24	Transmit Signal Element Timing (DA)	Yes	Yes	No	Yes	
25	Carrier Detect Reset (See Note 7)	Yes	No	Yes	No	

NOTES:

1. Also called Data Carrier Detect
2. Positive 12 volt supply provided by TI internal modems
3. Negative 12 volt supply provided by TI internal modems
4. Used on Bell 202 Series Modems for Reverse Channel Transmission/Reception
5. Used by Bell 201C and TI internal synchronous mode as New Sync
6. Used by TI internal modems to control the audio monitor
7. Used by Bell 202T and TI internal 202 modem as Carrier Detect Reset

Signals on this circuit are generated by the MDM in response to data signals received from the remote terminal. This circuit is held in the marking condition at all times when the circuit Receive Line Signal Detect (CF) is OFF. On a half-duplex channel this circuit is held in the marking condition by the MDM when circuit Request To Send (CA) is ON and for a brief interval following the ON to OFF transition of Request To Send (CA) if the "Local Copy Squelch" and "Call Turnaround Squelch" options are selected.

- Request To Send (CA), pin 4, CIM to MDM

  This circuit is used to condition the MDM for data transmission and, on a half-duplex channel, to control the direction of data transmission. A transition from OFF to ON instructs the MDM to enter the transmit mode. The MDM responds by turning on the transmitter and transmitting a mark condition for a preselected interval and then turns on Clear To Send (CB), indicating data may be transferred to the MDM via circuit Transmitted Data (BA). The ON to OFF transition of this circuit instructs the MDM to complete transmission and turn the transmitter off. A synchronous modem will transmit the last bit combination required to complete its encoded data transmission scheme and turn off the transmitter. An asynchronous modem with "Soft Carrier Turnoff" selected will transmit an out of band tone (900 Hz for a 202 modem) for a preselected time interval and then turn the transmitter off.

- Clear To Send (CB), pin 5, MDM to CIM

  This circuit is used to indicate to the CIM that the MDM is ready to transmit data received on circuit Transmitted Data (BA). The ON to OFF and OFF to ON transitions of this cirucit are in response to transitions on circuit Request To Send (CA) as described above.

- Data Set Ready (CC), pin 6, MDM to CIM

  The ON condition of this circuit is used to indicate to the CIM that the MDM is connected to a data channel and all control circuits are valid. The ON condition indicates the following conditions are met:

  1. The local modem is connected to a data channel ("Off Hook" in switched service), and

  2. the local modem is not in test, talk, or dial mode, and

  3. the local modem has completed any timing functions required by the switched system to complete call establishment.

  The OFF condition shall appear at all other times and shall indicate to the CIM that all signals other than Ring Indicator (CE) shall be disregarded.

- Signal Ground (AB), pin 7

  This circuit is the common reference for all other circuits.

- Receive Line Signal Detect (CF), pin 8, MDM to CIM

The ON condition of this circuit indicates the modem is receiving a signal which meets its suitability criteria and the data on circuit Receive Data (BB) is valid. The OFF condition indicates that no signal is being received from the remote data terminal or that the receive signal is unsuitable for demodulation. On half-duplex channels this signal is held OFF whenever Request To Send (CA) is ON and for a brief interval after the ON to OFF transition of Request To Send if the "Local Copy Squelch" and "Call Turnaround Squelch" options are selected.

- Positive Supply Voltage, pin 9

  A positive 12-volt supply is provided by the TI internal modems and by most external modems so that control lines may be strapped ON.

- Negative Supply Voltage, pin 10

  A negative 12-volt supply is provided by the TI internal modems and by most external modems so that control lines may be strapped OFF.

- Secondary Request To Send (SCA), pins 11 and 19, CIM to MDM

  The ON condition of this signal requests the modem to transmit a tone on the secondary channel (also called reverse channel, supervisory channel, or backward channel). This option is not provided on the TI internal modems.

- Secondary Data Carrier Detect (SCF), pin 12, MDM to CIM

  The ON condition of this signal indicates a tone is being received which meets the criteria of the secondary data channel (also called reverse channel, supervisor channel, or backward channel). This option is not provided on the TI internal modems.

- Analog Loopback, pin 13, CIM to MDM

  The ON condition of this circuit instructs the TI internal modems to disconnect from the phone line and connect the transmitter output to the receiver input. All interface circuits except Data Set Ready (CC) operate as in normal full-duplex mode. Data Set Ready (CC) is forced OFF while the modem is in analog loopback. This circuit allows the computer to exercise the CIM and the modem in a local test mode. The OFF condition of this circuit returns the modem to the normal operating mode.

- New Sync, pin 14, CIM to MDM

  A one to two millisecond pulse (OFF ON OFF) on this circuit resets the receiver timing on the TI internal synchronous modem and on the external Bell 201C modem. This signal is used when the master modem in a multidrop configuration is required to synchronize its receiver to the next slave signal shortly after receiving data from the previous slave modem.

- Transmitter Signal Element Timing (DB), pin 15, MDM to CIM

  Signals on this circuit are used to provide the CIM with transmitter signal element timing information. The CIM provides signals on the Transmit Data (BA) circuit in which transitions between signal elements nominally occur at the time of the transitions from OFF to ON condition of this signal. The modem samples the data on circuit Transmitted Data (BA) on the ON to OFF transitions of the circuit Transmitter Signal Element Timing (DB).

- Receive Signal Element Timing (DD), pin 17, MDM to CIM

  Signals on this circuit are used to provide the CIM with received signal element timing information. The transition from ON to OFF nominally indicates the center of each signal element on circuit Receive Data (BB). The MDM provides signals on the Receive Data (BB) circuit in which transitions between signal elements nominally occur at the time of the transitions from OFF to ON on circuit Receive Signal Element Timing (DD).

- Audio Monitor, pin 18, CIM to MDM

  The ON condition on this circuit enables the audio monitor feature of the TI internal modems. If the modem is connected to a 911 CRT with a patch cord (P/N 996373-0001), and the 911 CRT is properly configured, the phone line can be monitored via the speaker in the 911 CRT.

- Data Terminal Ready (CD), pin 20, MDM to CIM

  Signals on this circuit are used to control switching of the MDM to the communication channel. The ON condition prepares the MDM to be connected to the communication channel and maintains the connection established by external means (e.g., manual call origination, manual answering, or automatic call origination). The TI internal modems and most external modems will automatically answer an incoming call if circuit Data Terminal Ready (CD) is ON and a ringing signal is detected. The OFF condition on circuit Data Terminal Ready (CD) causes the MDM to be removed from the communications channel. In switched network applications, after circuit Data Terminal Ready (CD) is turned OFF, it shall not be turned ON again until circuit Data Set Ready (CC) is turned OFF by the MDM.

- Ring Indicator (CE), pin 22, MDM to CIM

  The ON condition of this circuit indicates that a ringing signal is being received on the communication channel. The ON condition appears approximately coincidentally with the ON segment of the ringing signal.

- Transmitter Signal Element Timing External (DA), pin 24, CIM to MDM

  Signals on this circuit are used to provide the MDM with transmitter signal element timing information. The CIM provides signals on the Transmitted Data (BA) circuit in which transitions between signal elements nominally occur at the time of the transitions from OFF to ON condition of this signal. The modem samples the data on circuit Transmitted Data (BA) on the ON to OFF transitions of the circuit Transmitter Signal Element Timing (DB).

- Carrier Detect Reset, pin 25, CIM to MDM

  A one to two millisecond pulse (OFF ON OFF) on this circuit resets the carrier detect circuit on the TI internal asynchronous modem and on the Bell 202S/T modem. This signal is used when the master modem in a multidrop configuration is required to synchronize its receiver to the next slave signal shortly after receiving data from the previous slave modem.

1.2.3 MODEMS. Texas Instruments offers two chassis-mounted modems for use in communications systems incorporating the Texas Instruments Communications Interface Module. These modems are discussed in the following paragraphs.

1.2.3.1 Asynchronous Modem. The asynchronous modem, TI part number 946119-0002, is a printed circuit board that occupies one half-slot location in the computer or expansion chassis. The modem asynchronously performs modulation and demodulation functions to provide a communications link between the CIM (digital interface) and a DAA (analog interface) that provides access to the telephone lines. The asynchronous modem is compatible with the Bell 202 Data Sets at both its digital and analog interfaces. The modem operates in either half- or full-duplex mode and is capable of transferring data at rates up to 1200 bits-per-second. The modem is also capable of operating in conjunction with the TI Auto Call Unit (ACU), TI part number 946110-0001, so that the computer can automatically activate the necessary telephone communications for data transfer.

1.2.3.2 Synchronous Modem. The synchronous modem, TI part number 946120-0001, is a printed circuit board that occupies one half-slot location in the 990 computer or expansion chassis. The modem synchronously performs modulation and demodulation functions to provide a communications link between the CIM (digital interface) and a DAA (analog interface) that provides access to the telephone lines. The synchronous modem is compatible with the Bell 201C Data Set at both its digital and analog interfaces. The modem operates in either half- or full-duplex mode and is capable of transferring data at 2400 bits-per-second. The modem can also operate in conjunction with the TI ACU so that the computer can automatically activate the necessary telephone communications for data transfer.

1.2.4 AUTOMATIC CALLING. Automatic calling is the facility used by a computer to electronically place a telephone call to a remote station without manual intervention. Texas Instruments offers two methods of implementing the automatic calling feature. The first method, illustrated in figure 1-1, involves a computer chassis-mounted ACU that ties into an internal Texas Instruments-supplied modem. The second method, also shown in figure 1-1, consists of a computer chassis-mounted EACUI that ties into an external ACU and modem. Both the ACU and EACUI are discussed in the following paragraphs.

1.2.4.1 Automatic Calling Unit (ACU). The ACU, TI part number 946110-0001, is a single printed circuit board that occupies one half-slot location in the 990 computer or expansion chassis. Depending upon software programming, the ACU provides either tone-dialing or pulse-dialing capabilities. The ACU may be programmed for either noninterrupt or interrupt operation. As directed by the program, the ACU obtains control of the telephone line, detects the dial tone, generates the required tone pairs or dial pulses for the telephone number, detects the answer tone, and transfers control of the telephone line to the data transmitting equipment (internal modem).

1.2.4.2 External Automatic Calling Unit Interface (EACUI). The EACUI, TI part number 2263844-0001, like the ACU, is a single printed circuit board that occupies one half-slot location in the 990 computer or expansion chassis. The EACUI circuit board interfaces with a customer-provided external ACU. The EACUI, coupled with the external ACU, provides the 990 computer with the same dialing capabilities and procedure as the Texas Instruments ACU.

1.2.5 DATA ACCESS ARRANGEMENTS (DAAs). FCC registered DAAs are offered to TI customers who wish to use the Model 990 Computer Communications System on the public switched-telephone network. Texas Instruments obtains the DAAs from two manufacturers: General DataComm Industries, Inc. and Elgin Electronics, Inc. Both companies refer to their DAAs as data couplers. To eliminate confusion, they will be called data couplers throughout the remainder of this manual.

The data couplers are provided to TI customers in kit form with the necessary cables and mounting screws included. Customers may choose to install the data couplers themselves or arrange for a TI representative to do the installation. Site preparations need to be made well in advance of receipt of the data coupler to insure that it can be installed without unnecessary delays or problems. Refer to the Site Requirements paragraph in Section II for further information.

1.2.5.1 FCC Rules Governing Use Of Data Couplers. The FCC requires that the manufacturers of equipment that will interface with the public switched telephone network notify their customers of certain FCC rules governing the installation and use of this equipment. Those rules are presented in Appendix A of this manual and must be read prior to installing or operating a data coupler on the public switched-telephone network.

1.2.5.2 Data Coupler Configurations. The data coupler may be ordered from TI, configured to operate in one of two modes:

Programmable Output Mode. In this configuration, the signal level presented to the telephone network is determined by an external programming resistor which must be installed by the telephone company in the telephone company-provided jack as shown in figure 1-2. The telephone company determines the value of the resistor to be used, based on the loss of the loop facility, from a set of resistor values agreed upon by the industry. This mode of operation provides optimum signal strength to the telephone line.

Permissive Output Mode. This configuration is used for portable data equipment or in applications where signal strength cannot be optimized. In this configuration, the output of the data coupler is internally set so that it cannot exceed -9dBm at the central office. In the majority of installations this will provide a usable signal at the central office.

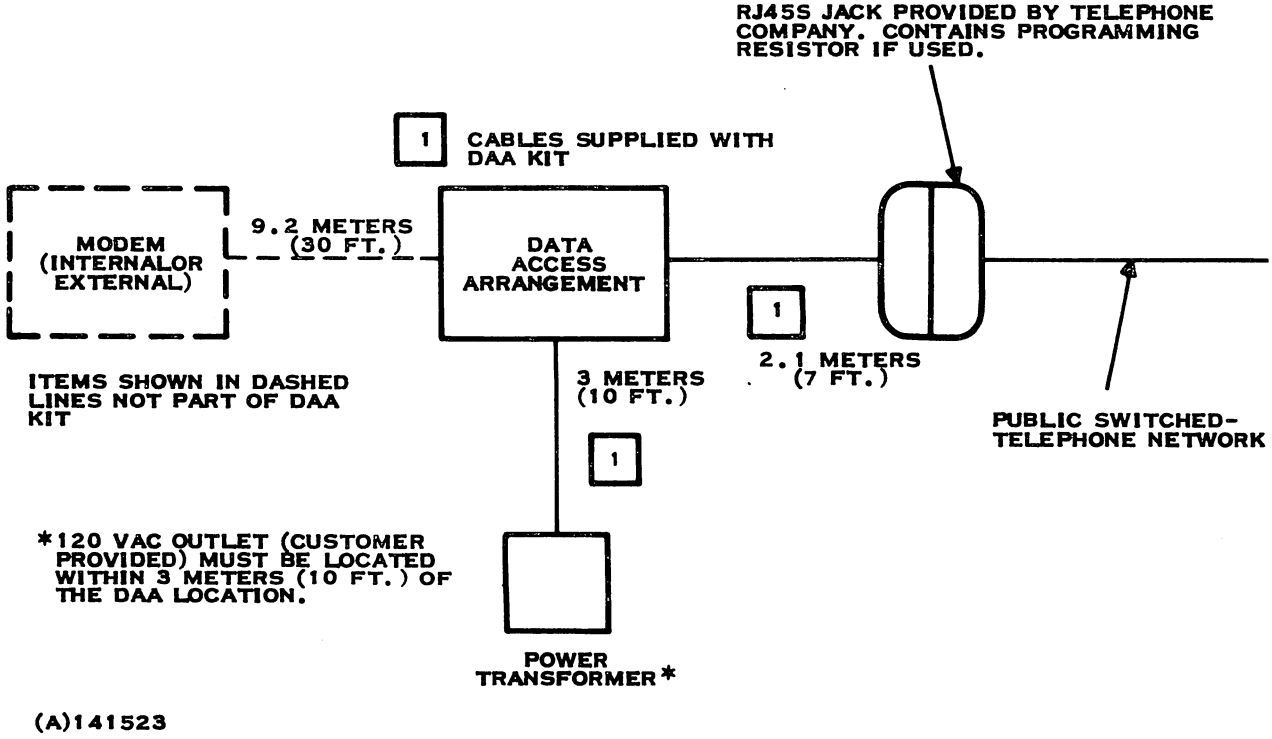


Figure 1-2. Data Access Arrangement Configuration

1.2.5.3 Data Coupler Interfaces. The data coupler provides an interface between the modem on one side and the public switched-telephone network on the other side. The following paragraphs describe the signals involved in each interface.

Modem Interface. The modem interface circuits are designed to meet the requirement of EIA Standard RS-232-C and are defined as follows:

DT (Data Tip) DR (Data Ring)	These circuits provide an analog transmission path between a Model 990 modem (201C or 202) and a telephone line. The data coupler provides transformer coupling of these two leads to the telephone line which also provides an isolated termination for the signals from the modem.
OH (On/Off Hook)	This circuit is generated by the modem and provides control of off-hook and on-hook supervisory signals to the telephone line and associated central office equipment. The ON (Off-Hook) condition of this signal operates a relay which completes a dc path to the serving central office and causes the loop current to flow, establishing a local connection to the communication channel. The ON signal requests dial-tone in originating a call, and on incoming calls, answers the call and trips ringing.
DA (Data Transmission)	This circuit, from the modem, when ON, requests the data transmission path through the coupler be cut through to the telephone line. It is OFF during dial pulsing, but ON for tone addressing. DA turns ON only if OH is ON.
CCT (Coupler Cut-Through)	When this circuit in the data coupler is ON, it indicates to the modem that the data transmission path is connected through the coupler to the telephone line. The ON condition indicates the data coupler status, but not the status of the associated telephone line or channel connection. In the answer mode, CCT responds to the ON condition of circuit OH within 1 to 3 seconds to allow accounting time interval.
RI (Ring Indicator)	This circuit is generated by the data coupler and indicates to the modem that ringing voltage is present on the communications channel. The ON condition is the result of rectifying and integrating the 20Hz-68Hz ringing signals received from the line. The integration protects against false ring detection or transients which may occur during dialing, or when switching transients or impulse noise occur on the telephone line. The ON condition consists of regular transitions which follow the ringing cycle (normally two seconds on, and four seconds off).

SH (Switch Hook)	This circuit is generated by the data coupler to indicate to the modem the status of the handset in the telephone cradle. The ON condition indicates that the operator has gone to the talk mode or is manually originating a call.
SG (Signal Ground)	This is the common reference potential for all interface control signals. All control circuits are referenced to this circuit with RS-232-C voltage controls.

Telephone Network Interface. The following signals interface the data coupler to the public switched-telephone network:

T (Tip) R (Ring)	The T and R circuits are used to provide telephone channel connection of the modem through the coupler. T and R are isolated from the modem and coupler for the protection against hazardous voltage on the telephone line.
PR (Program Resistor) PC (Program Resistor Common)	These circuits provide an indication of the amount of local loop loss encountered in the telephone line from the data jack tip (T) and ring (R) circuits to the serving central office. This indication shall be in the form of a single programming resistor selected by the telephone company at the time of installation and installed in the data jack as per FCC Rules and Regulations Part 68, Section 502.
A and A1	The switch hook indication of the associated telephone is available to the modem on the SH (Switch Hook) circuit where the line switch of the associated telephone is connected to the A and A1 terminals (Mode Indication).
KA and KA1	These terminals indicate coupler On/Off Hook condition.

1.2.6 REMOTE TELEPHONE CONNECTION (RTC) TELEPHONE OPTION. The user may elect to order an optional auxiliary telephone set for use with the communications system. The optional telephone must be ordered (10 weeks in advance of delivery of the data coupler) from the telephone company which will install the telephone on the phone-line side of the communcation system data jack. If the optional telephone set is ordered, the instructions for using it with the communications system may be found in Appendix B of this manual. The following options are available with the telephone set. Texas Instruments recommends ordering options A2 and B4.

1.2.6.1 Option A1. When this option is selected, calls are originated or answered with the telephone (RTC) by lifting the handset off-hook. Operating the exclusion key transfers control of the line to the data set from the telephone (RTC).

1.2.6.2 Option A2. The selection of this option provides control of the line by the data set. The telephone (RTC) remains in its cradle. When the handset is lifted and the exclusion key is operated data transmission is interrupted.

1.2.6.3 Option B3. When this option is selected, aural monitoring is not provided.

1.2.6.4 Option B4. When this option is selected, aural monitoring of data transmission is provided.

1.2.6.5 Option C5. This option provides a Touch Tone Dial.

1.2.6.6 Option C6. This option provides a rotary dial.

1.2.6.7 Option D7. Switch hook indication only. This option provides contacts in the data jack that can be sensed when switch hook on (Off-Hook).

SECTION II

INSTALLATION

2.1 GENERAL

This section provides instructions for unpacking the Communications Interface System, installing the system, and performing initial checkout to ensure proper operation. The instructions in this section require a moderate familiarity with cabling technique but knowledge of digital electronics is not required.

2.2 SITE REQUIREMENTS

Site requirements for the system are separated into requirements for the modular components (printed wiring boards) and requirements for the data coupler.

2.2.1 MODULAR COMPONENT SITE REQUIREMENTS. All components of the communications system with the exception the data coupler and its associated power transformer are individually contained on half-sized printed circuit boards. CRU half-sized slots must be available in either the Model 990 computer mainframe chassis or the expansion chassis to accommodate each component of each configuration. The computer system must also provide the dc power to support the communications interface system. Table 2-1 lists the part numbers, power requirements, and space requirements for the half-sized printed circuit boards.

2.2.2 DATA COUPLER SITE REQUIREMENTS. In preparing a site for installation of the data coupler, the user must select a location where 120 Vac 60 Hz power is available within 3 meters (10 feet). The site must be within 9.2 meters (30 feet) of the location of the modem, the Universal Service Order Code (USOC) jack (for access to the telephone network) must be within 2.1 meters (7 feet) of the data coupler location, and arrangements must be made with the local telephone company to install the USOC jack (or jacks) and any auxiliary telephone sets that may be desired. The following paragraphs describe the various tasks that the user must perform to prepare the site prior to installing the data coupler or arranging for a TI representative to install it. Table 2-2 lists the part numbers of the kits containing the programmable or permissive data couplers. Table 2-3 is a planning checklist to aid the user in planning and completing the installation.

2.2.2.1 Data Coupler Location. The location selected for the data coupler should be a wall surface (wood or sheet-metal) where the data coupler can be mounted in a vertical position using the screws provided in the kit. A wall outlet providing unswitched 120 Vac 60 Hz power must be available within 3 meters (10 feet) of the data coupler. The data coupler must be located within 9.2 meters (30 feet) of the modem to allow the modem cable to reach the data coupler and within 2.1 meters (7 feet) of the USOC jack to allow the data coupler cable to reach the USOC jack. See figure 1-2.

2.2.2.2 Power Requirement. The data coupler requires less than 100 watts of 120 Vac 60 Hz power. The power transformer, included in the data coupler kit, plugs into the wall outlet and supplies power to the data coupler through a 2.1 meter (7 foot) cord.

2.2.2.3 Telephone Line Connection. Before any connections can be made to the local telephone network, the user must notify the local telephone company of the following:

1. The particular line or lines to which the connections are to be made.

2. The type of lines needed. Type 1 lines are rated for less than 300 baud, and type 2 lines are rated for greater than 300 baud. If further detail is desired, see Bell Publication 41005, Section 5.14. Type 2 lines are needed for use with TI internal modems.

3. The FCC registration number and ringer equivalence of the registered data coupler. This information is available on the FCC label on the cover of the data coupler.

4. The USOC jack or jacks that the telephone company is to install. Appendix C contains a listing of the USOC jacks that a local telephone company will install. Detailed information on these jacks and their installation may be found in the Federal Register, Volume 41, Number 34.

   Texas Instruments recommends use of the following two USOC jacks:

   - RJ45S, 8-pin keyed miniature programmable jack for use with the programmable data coupler.

   - RJ11C, 6-position miniature jack for use with the permissive (-9dBm) data coupler.

     NOTE: The telephone company normally requires advance notice of four weeks to ensure that the jacks will be installed when the data coupler is received.

5. Any auxiliary telephone sets and necessary options on these sets to ensure that the telephone company can wire the installation correctly. The options available on the telephone sets and the TI recommendations are listed in Section I. The telephone company also needs to know on which lines to install telephone sets.

NOTE

When auxiliary telephone sets are to be installed, it is good practice to notify the telephone company 10 weeks in advance of the delivery of the data coupler to ensure that preparations for the connection of the data coupler will be complete.

Table 2-1. Power and Space Requirements for the System Modules

Description	Part Number	+5V Amps	+12V Amps	-12V Amps	Space Requirements
990 Communication interface module	946104-0001	-1.5	-0.05	-0.05	1/2 Slot
990 Asynchronous modem kit	945114-0002	-0.1	-0.1	-0.1	1/2 Slot
Bell data set interface kit	946104-0002	-1.5	-0.05	-0.05	1/2 Slot
Pulse/Tone auto calling kit	945163-0001	-1.0	-0.1	-0.1	1/2 Slot
990 Synchronous modem kit	945094-0003	-0.2	-0.2	-0.2	1/2 Slot*
External calling unit interface kit	2263907-0001	-0.5	-0.1	-0.1	1/2 Slot

*Modems must be located adjacent to (above, below, or beside) the communications interface module and the ACU.

Table 2-2. Data Coupler Kits

TI Part Number	Item Description	Vendor's Part No.
2265156-0001* (Kit 1)	Programmable data access arrangement (data coupler)	008M011001 (Note 1) 20025-001(C) (Note 2)
2265156-0002* (Kit 2)	Permissive (-9dBm) data access arrangement (data coupler)	008M011002 (Note 1) 20025-009(C) (Note 2)
945409-9701 (Kits 1 & 2)	*Model 990 Computer Communications System Installation and Operation Manual,* Revision A, May 15, 1979	
972968-18 (Kits 1 & 2)	Sheet metal screws, type AB, #6, panhead, 3 each.	

Note 1. General DataComm, Inc. Part Number
Note 2. Elgin Electronics, Inc. Part Number
*Kit may contain a data coupler manufactured by either vendor depending upon availability when ordered.

A complete data coupler kit (Kit 1 or 2 above, programmable or permissive) from either vendor contains one of the following:

- Data coupler (General DataComm or Elgin)
- Power transformer
- Power transformer to data coupler cable, 3 meters (10 feet) in length
- Data coupler-to-USOC jack cable, 2.1 meters (7 feet) in length
- Manufacturer's installation and operation manual
- Model 990 Computer Communications System I/O Manual, part number 945409-9701
- Three sheet metal screws, part number 972968

Table 2-3. Planning Checklist

Check Off When Completed	Weeks Before Delivery	Responsibility TI	Responsibility Customer	Action
	12		X	Review this planning checklist
	12		X	Arrange for installation of ac power outlet for data coupler if not already available
	12	X	X	Schedule installation date with TI representative if TI is to install.
	12	X	X	Review cable requirements with TI representative
	10		X	Select options for telephone set if needed and place order with local telephone company
	10		X	Notify telephone company of type of lines needed with installation. See recommendation in Section II, Telephone Line Connections
	4		X	Arrange for installation of USOC data jack to be compatible with configuration of data coupler ordered. Local telephone company will install jack and programming resistor if programmable data coupler is ordered
	3		X	Ensure that location is ready for installation of data coupler in all respects

2.2.3 CABLING RESTRICTIONS. Cable lengths affect the positioning of the 990 computer chassis housing the communications interface system, or components of the system. They also affect placement of the system components in the chassis. If a complete communications interface system (communications interface module and a synchronous or asynchronous modem) is installed, the interface module and modem must be installed in the same chassis and in adjacent slots so that they may be interconnected by the short ribbon cable provided with the modem.

If the communications interface module alone is installed for use with an external modem, the chassis where the module is installed must be positioned so that the cable length required to connect the module and the external modem does not exceed 9.2 meters (30 feet).

If either of the Texas Instruments modems is used, the chassis must be positioned so that the cable length required to connect the modem and the data coupler does not exceed 9.2 meters (30 feet). However, the recommended cable for this installation (part number 946091-0002) is 3 meters (10 feet) long and should be used when permitted by the specific configuration. Cabling restrictions for the data coupler with its associated power transformer were discussed under the paragraph entitled Data Coupler Site Requirement earlier in this section.

2.3 UNPACKING

Unless shipped as a part of a Model 990 Computer, each component of the communications interface system (except the data coupler kit) is shipped wrapped in bubble-pack and packaged in a rigid cardboard box. When shipped as a part of a Model 990 Computer, the components are shipped installed in the computer chassis. In that case, unpacking instructions for the computer apply. These instructions are contained in the appropriate Model 990 Computer hardware reference manual or hardware user's manual listed in the preface.

The data coupler kit is shipped separately in a protective carton surrounded by shock-absorbent material.

Unpacking and inspection instructions are separated into two parts: the modular components shown in figure 2-1 and the data coupler kit shown in figure 2-2.

2.3.1 COMMUNICATION INTERFACE MODULAR COMPONENTS. The following instructions apply to each part of the equipment shown and listed in figure 2-1 since each part is shipped separately unless shipped as a part of a computer.

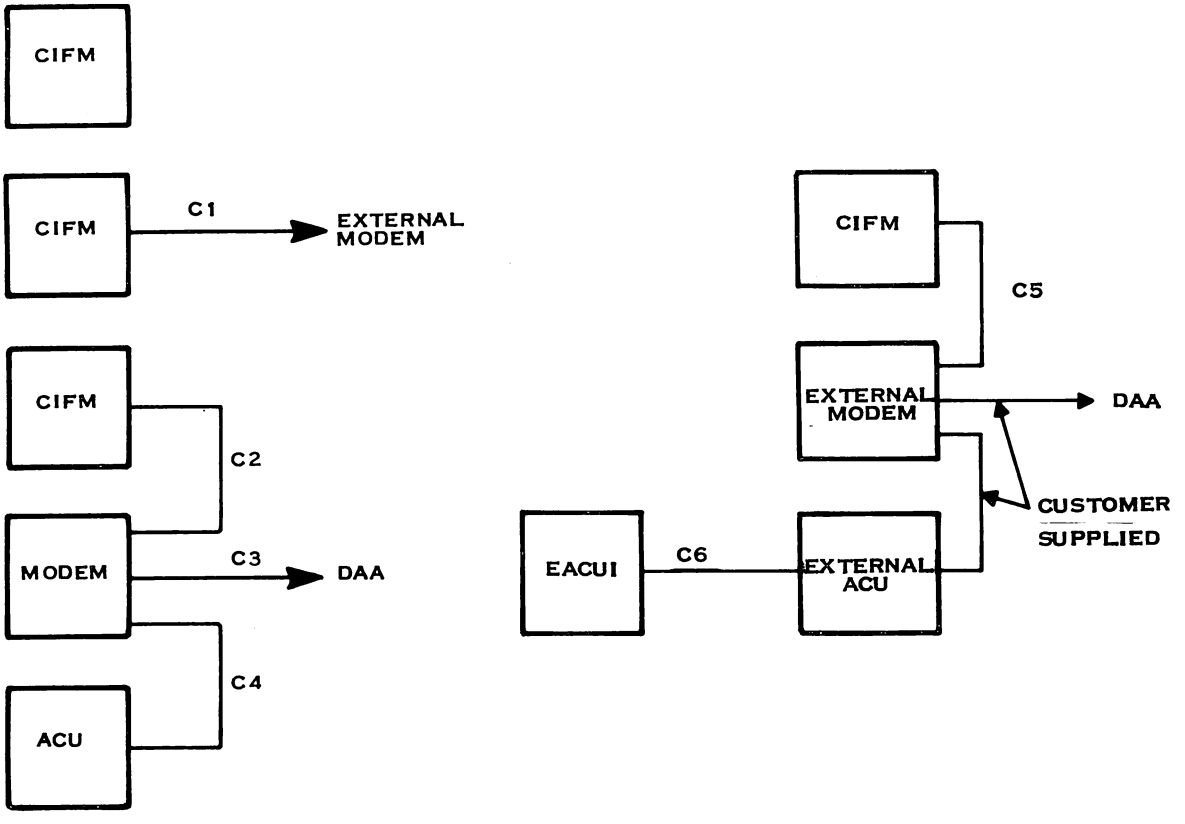
1. Before opening the carton, inspect the carton for signs of possible damage to the contents. Look for such indications as crumpled corners, tears, water stains, loosened packing tape, etc. Notify supervisory personnel of any abnormalities.

2. Open the cardboard box and remove the bubble-pack-wrapped printed circuit wiring board from the box.

3. Carefully remove the bubble-pack wrapping from the board and verify that the part number on the board is correct for the desired assembly. Figure 2-1 lists the assembly part numbers. If the part number is incorrect, notify supervisory personnel.

NOTE

The communications interface module can be ordered with a 9.2 meter (30-foot) cable, TI part number 946117-0001.



	DESCRIPTION	KIT PART NUMBER	SUBASSEMBLY PART NUMBER
INTERFACE PACKAGES	COMMUNICATIONS INTERFACE MODULE (CIFM)	946104-0001	946105-0001
	COMMUNICATIONS INTERFACE MODULE AND CABLE C1	946104-0002	946105-0001 946117-0001
MODEM PACKAGES	ASYNCHRONOUS MODEM CABLE C2 CABLE C3	945114-0002,3	946119-0002,1 946090-0001 946091-0001
	SYNCHRONOUS MODEM CABLE C2 CABLE C3	945094-0003	946120-0001 946090-0001 946091-0001
AUTO CALL UNIT PACKAGE	PULSE/TONE AUTO CALL UNIT CABLE C4	945163-0001	946110-0001 946092-0001
EXTERNAL AUTO CALLING UNIT INTERFACE PACKAGE	EXTERNAL AUTO CALLING UNIT INTERFACE CABLE C5 CABLE C6	2263907-1	2263484-0001 946117-0001 2263477-0001,2

Figure 2-1. Module Configurations and Part Numbers

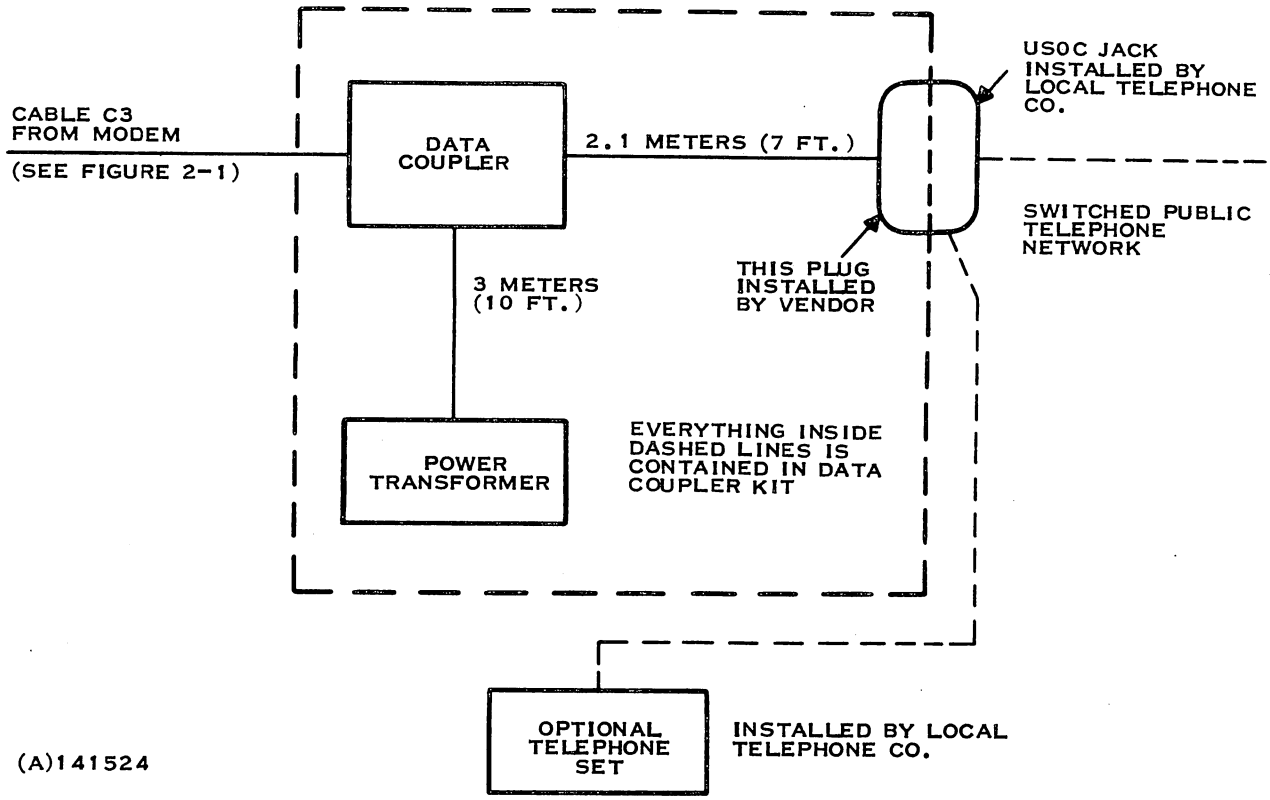


Figure 2-2. Data Coupler Kit Cabling

4. Remove the external cable from the box and verify its part number. Notify supervisory personnel if the proper cable has not been received.

NOTE

Steps 5 and 6 apply only if a modem is shipped with the communications system. A 9.2 meter (30-foot) cable, TI part number 946091-0001, is supplied with both modems. If no TI modem is included, skip to step 7.

5. Remove the intrachassis ribbon cable (wrapped in bubble pack) from the box.

6. Carefully remove the bubble-pack wrapping from the ribbon cable and verify that the part number (946090-0001) on the cable is correct. If the part number is incorrect, notify supervisory personnel.

7. Inspect all printed wiring boards and cables for signs of damage, especially if the box(es) or bubble-pack wrapping showed signs of damage. Look for breaks in the printed wiring board, loose or missing components or connectors, broken wires, corrosion, foreign material lodged between connector pins that might cause short circuits, etc. Notify supervisory personnel of any abnormalities.

2.3.2 DATA COUPLER KIT. The data coupler kit is shipped in one container which contains all of the items listed in table 2-2. Figure 2-2 shows the configuration of a data coupler installation. Cable numbers are not provided as they vary with the vendor of the data coupler; however, both vendors ship their data coupler with the cables connected to the data coupler.

1. Before opening the carton, inspect the carton for signs of possible damage to the contents. Look for such indications as crumpled corners, tears, water stains, loosened packing tape, etc. Notify supervisory personnel of any abnormalities.

2. Open the container and remove each component of the kit. Compare each component of the kit with the part number listed in table 2-2. If the part number is incorrect, notify supervisory personnel.

3. Inspect the cables, power transformer, and data coupler for any signs of damage. Notify supervisory personnel of any abnormalities.

4. Verify that the kit contains three #6 sheet metal screws for mounting the data coupler.

2.4 SYSTEM INSTALLATION

Because the components of the communications interface system can be purchased and used independently, the following paragraphs provide instructions for installing the components of the system separately. The instructions pertaining to installation of printed circuit boards in the computer mainframe or the expansion chassis are presented first, followed by instructions on installing the data coupler, with instructions on cabling the system being presented last.

CAUTION

Before removing or installing any printed circuit boards in the chassis, ensure that computer power is OFF.

2.4.1 DETERMINING PRINTED WIRING BOARD LOCATIONS. The first step in installing the communications interface system is to prepare locations for the printed wiring boards in accordance with the following information.

The physical location of the system component within either the computer or expansion chassis determines the CRU address to which the component responds. Before deciding upon a chassis location for the new circuit board(s), determine the address(es) that system software expects the board(s) to recognize. If the CRU word address is less than or equal to $01E0_{16}$ (byte address $\leq 03C0_{16}$), the circuit board must be installed in the main computer chassis. Refer to the configuration label on the top of the chassis to determine the location in the chassis corresponding to the address. If the base address is greater than or equal to 0200_{16} (byte address $\geq 0400_{16}$) then the circuit board must be installed in one of the expansion chassis in the computer system. Refer to table 2-4 to determine the expansion corresponding to the base address. Figure 2-3 defines the locations within an expansion chassis.

The address for a particular slot in a particular chassis is given by the following formula:

Address (workspace register 12) = chassis address + slot address.

For example, to address slot 9P2 in expansion chassis 6 use the address $1800_{16} + 100_{16} = 1900_{16}$.

The applicable software installation documents should be consulted in deciding the proper chassis location for the modules. For example, the TI-supplied 2780/3780 DX10 and TX990 emulator packages and the DX10 3270 ICS default to use of the chassis address 0040_{16} and interrupt level 4. If no other device that uses this location (such as a card reader) is included in the system configuration, the communications interface should be installed in this location.

Table 2-4. Addresses Assigned to CRU Expansion Chassis

Expansion Chassis	Add to CRU Base Address (Hexadecimal)
1	0400
2	0800
3	0C00
4	1000
5	1400
6	1800
7	1C00

2.4.2 PREINSTALLATION SWITCH SETTINGS. In normal mode, i.e., for communications between the local 990 system and a remote system or terminal via a modem and switched or leased lines, the 8-position rocker DIP switch on the communications interface module should be set as follows:

- Switches 1-7 — Module ID. On a multidrop line these switch settings constitute the seven bits of the Module I.D. (They constitute the line address of the modem.) Switch 1 is the LSB. Switch 7 is the MSB. Setting a switch to "on" represents 1, and setting a switch to "off" represents 0. On single communication line installations, Module I.D. is not needed. Switches 1-7 may be set to OFF in this case.

  Example:

Module I.D.	0	1	0	0	1	1	0	$= 26_{16}$
Switch settings	off	on	off	off	on	on	off	
Switch number	7	6	5	4	3	2	1	

  The Module I.D. may be read by software and compared to an incoming call I.D. word to determine whether the local module is the one being called.

SLOT NUMBER	P1 (CHASSIS FRONT) FIXED CRU BASE ADDRESS	CIRCUIT BOARD	INTER-RUPT LEVEL	P2 (CHASSIS REAR) FIXED CRU BASE ADDRESS	CIRCUIT BOARD	INTER-RUPT LEVEL
1	N/A	USED FOR EXPANDER OR FOR CPU	N/A	N/A	USED FOR EXPANDER OR FOR CPU	N/A
2	02E0			02C0		
3	02A0			0280		
4	0260			0240		
5	0220			0200		
6	01E0			01C0		
7	01A0			0180		
8	0160			0140		
9	0120			0100		
10	00E0			00C0		
11	00A0			0080		
12	0060			0040		
13	0020			0000		

13-SLOT CHASSIS

	FIXED CRU BASE ADDRESS	CIRCUIT BOARD	INTER-RUPT LEVEL	FIXED CRU BASE ADDRESS	CIRCUIT BOARD	INTER-RUPT LEVEL
1	N/A	USED FOR EXPANDER OR FOR CPU	N/A	N/A	USED FOR EXPANDER OR FOR CPU	N/A
2	0120			0100		
3	00E0			00C0		
4	00A0			0080		
5	0060			0040		
6	0020			0000		

6-SLOT CHASSIS

THE ADDRESS FOR A PARTICULAR SLOT IN A PARTICULAR CHASSIS IS GIVEN BY THE FORMULA

ADDRESS (WORKSPACE REGISTER 12) = CHASSIS ADDRESS + SLOT ADDRESS.

FOR EXAMPLE, TO ADDRESS SLOT 9 P 2 IN EXPANSION CHASSIS 6 USE THE ADDRESS $1800_{16} + 100_{16} = 1900_{16}$

(B)133861

Figure 2-3. 990 Chassis Slot Addresses

- Switch 8 — Mode Selection. This switch selects between normal mode and remote test mode:

Switch 8 setting	Mode
ON	Remote test mode
OFF	Normal mode

Normal mode is used for communications. Remote test mode allows testing of the communications system by a different system (remote to the local system).

Each TI internal modem has four 8-pin (4 SPST) DIP switch assemblies which select modem options required for a particular system. The switch assemblies are marked on the modem printed wiring board with the labels S1, S2, S3, and S4. Each switch on an assembly is labeled 1, 2, 3, or 4. In table 2-5 each switch is specified by an assembly number and a switch number. For example, S2-3 is switch 3 on switch assembly 2.

2.4.3 INSTALLING PRINTED WIRING BOARDS. Once the proper locations for the printed wiring boards have been determined and the appropriate switch settings have been made, the boards may be installed in the computer or expansion chassis and connected to the appropriate cables. The following instructions apply for the installation of each printed wiring boards of the Communications Interface System.

1. Prepare the computer or expansion chassis to receive the new printed wiring board(s) in accordance with the instructions in the appropriate Model 990 Computer Hardware Reference Manual.

NOTE

Each printed wiring board has two plastic, pivoted tabs (card ejectors) on one end of the board. This end is the outside edge of the board. The opposite edge of the circuit board is inserted into the connector in the computer chassis.

2. Install a center card guide in the desired location to support each half-size card by using the following procedure:

   a. Disconnect power from chassis before installing center card guide.

CAUTION

SHOCK HAZARD. Do not attempt to install a card guide when power is applied to the chassis.

   b. Examine the card comb located between the two rows of connectors on the front side of the motherboard. If there is a screw between the two connectors in the position where the card guide is to be installed, remove the screw and associated hardware from the motherboard and install in an adjacent (above or below) hole.

Table 2-5. Modem Switch Settings

Switch	Open (Off)	Closed (On)	Remark
S1-1 S1-2 S1-3	No attenuation No attenuation No attenuation	-2dBm -4dBm -8dBm	These switches (in any combination) select the output attenuation relative to one milliwatt. The DAA supplier ordinarily specifies the required attenuation. For private lines select 0 attenuation (all open).
S1-4	ACU connected	No ACU	This switch is closed if a TI Auto Call Unit is not connected.
S2-1 S2-2 S2-3	No action No action No action	8.5 ms RTS-CTS 65 ms RTS-CTS 145 ms RTS-CTS	Only one of these switches should be closed. Select 8.5 for 4-wire lines. Select 65 for short (intra-city) switched lines and 145 for long (inter-city) switched lines.
S2-4	Switched carrier	Continuous carrier	For continuous carrier CTS is always "on". Use continuous carrier only for the host computer in a multi-drop connection or direct modem-to-modem connections.
S3-1	-45dBm sensitivity	-30dBm sensitivity	This switch selects receiver sensitivity. Use -45dBm for switched (DDD) lines and -30dBm for private lines.
S3-2	CCT from DAA	CCT "on"	Use CCT on for private lines.
S3-3	Local copy	Local copy squelched	This selection depends on line protocol.
S3-4	Short line equalizer	Long line equalizer	For asynchronous modems always select short unless the line is marginal. For synchronous systems always select long except for direct connections in the same building.
S4-1 S4-2	24 ms soft carrier Soft carrier	8 ms soft carrier Quick carrier turn off	These switches are defined for asynchronous modems only. Choose soft carrier if the other end modem supports it. 8 ms soft carrier is faster than 24 ms soft carrier.
S4-3	No call turnaround	50 ms call turnaround	This switch selects whether the modem input shuts down for 50 ms following transmission to prevent hearing echoes. Select 50 ms turnaround for 2-wire half duplex operation.
S4-4	2-wire	4-wire	

c. Install the center card guide, Part Number 936404-1, using a flat washer and a screw as in figure 2-4.

NOTE

Determine if one or two half-size cards are to be used with the card guide.

IF two cards are to be used, center the card guide between the connectors as closely as possible.

IF one card is to be used, install the card guide as closely as possible to the side of the chassis in which the card will be installed.

d. Inspect the card guide to ensure that it is not rotated with respect to the card comb. If it is rotated, loosen the screw, rotate the guide and retighten the screw.

3. Insert the printed wiring board into the chassis location corresponding to the desired address. Ensure that the component side of the board is facing upward and that the slots in the circuit board (inside edge) mate properly with the alignment comb on the backplane connector.

NOTE

In some configurations the chassis is mounted sideways. In this case, "upward" means toward slot 1 and away from slot 13 (or 6 in the 6-slot chassis).

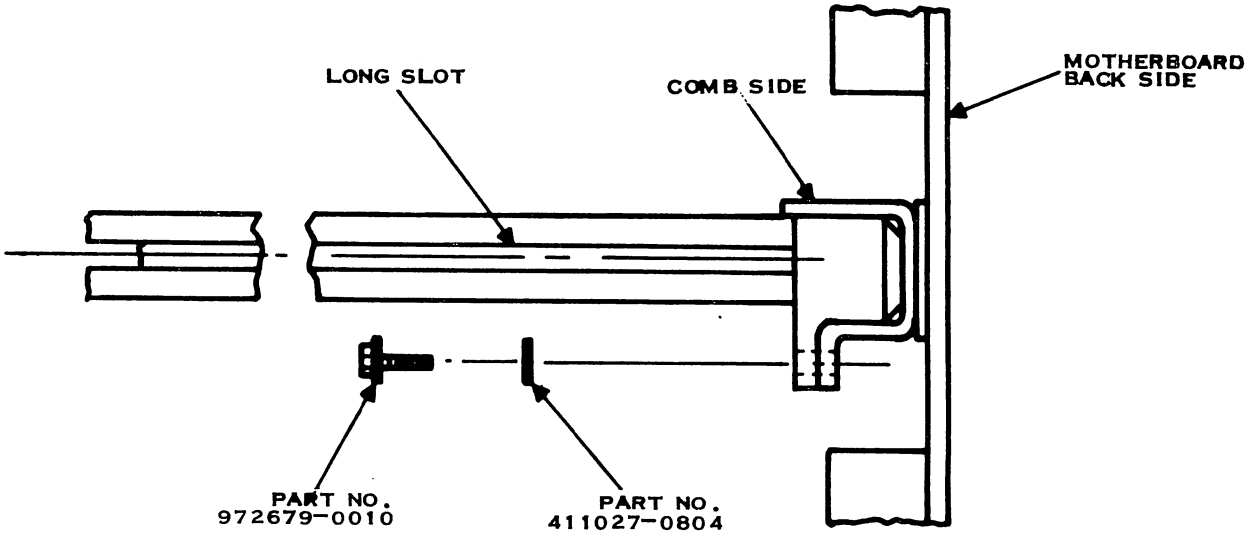


Figure 2-4. Installation of Center Card Guides

2.4.3.1 Interrupt Level Connection. If the system (or system component) is installed in the main computer chassis at the time that the computer system is installed, interrupt level assignments are connected in conjunction with the installation of the computer. Refer to the appropriate *Computer Hardware Reference Manual* or *Computer Hardware User's Manual* for detailed instructions for installing the computer and its associated interrupt level network.

If the system (or system component) is installed in an existing computer system, a new connection must be installed in the computer to allow proper interrupt recognition.

CAUTION

Ensure that ac power to the computer chassis has been disabled before beginning this procedure.

2.4.3.2 Interrupt Level Installation and Modification. Wiring in the backplane of the chassis brings the interrupt lines from each circuit board connector to a pair of jumper plugs located on the backplane adjacent to slot number 1, as shown in figure 2-5. Jumper wires installed in the plugs connect the interrupt outputs from the boards to the CPU interrupt inputs.

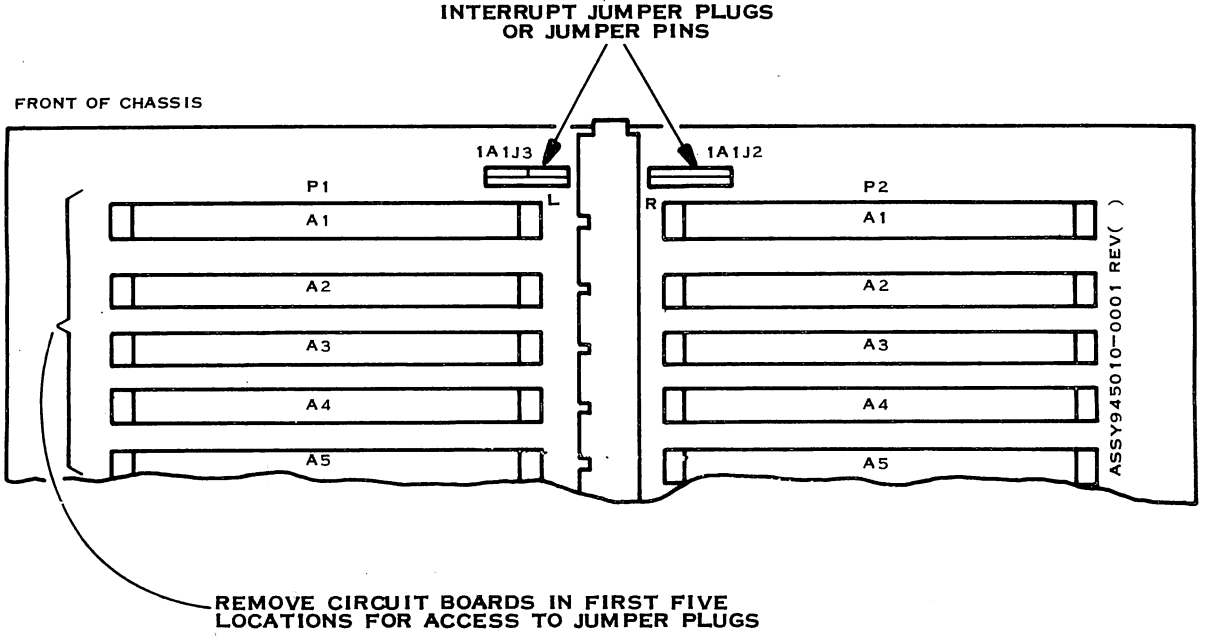


Figure 2-5. Location of Interrupt Jumper Plugs (6- and 13-slot Chassis)

Figure 2-6 is an outline drawing of the jumper plugs for the 6-slot and the 13-slot chassis. CPU input interrupt levels are shown at the right of each connector. Note that the 990/4 does not recognize interrupt levels 8 through 15. Two jumper positions are wired to each chassis interrupt line. This allows multiple interrupts to be connected to one interrupt level, as shown in the example (figure 2-7).

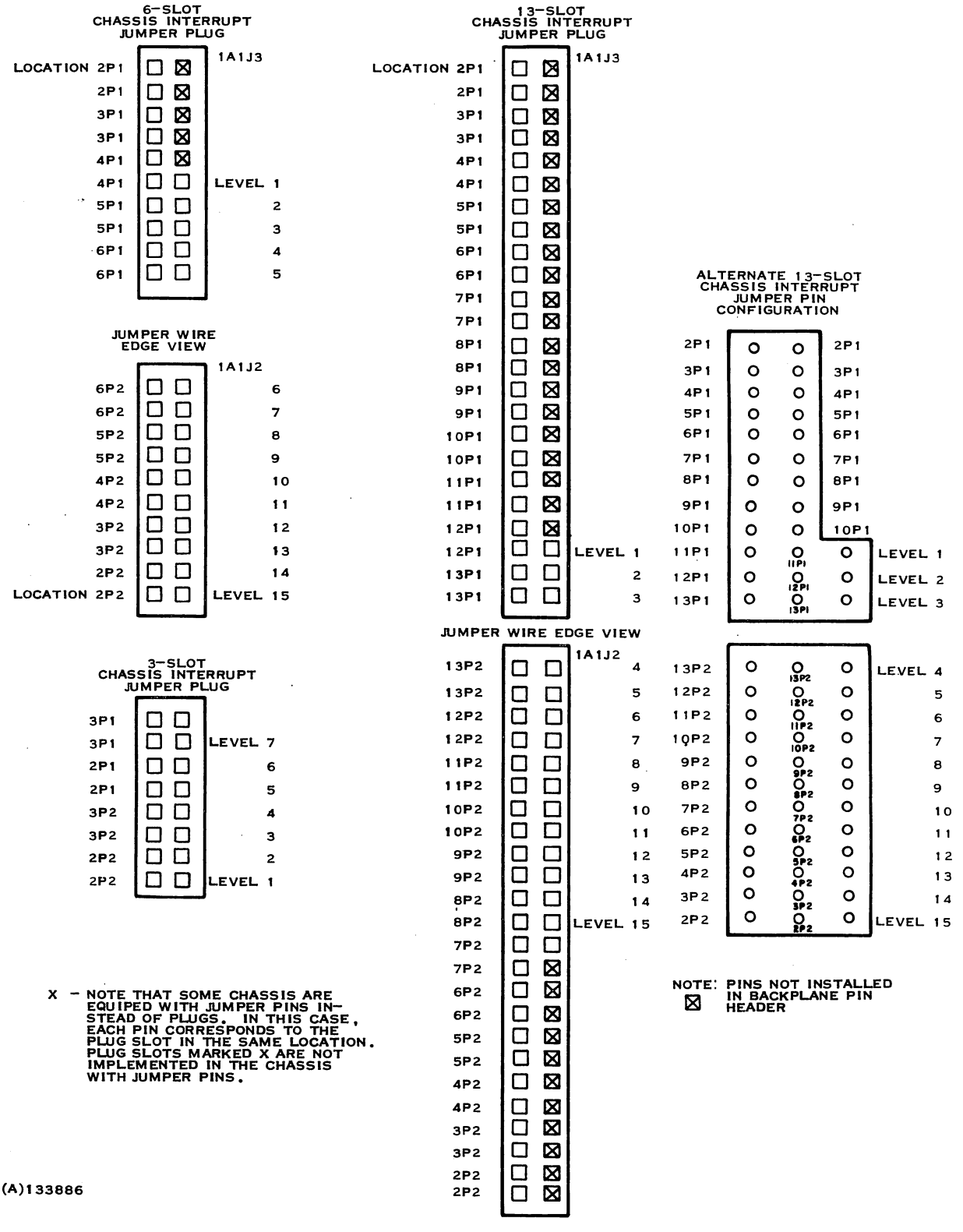


Figure 2-6. 3-, 6- and 13-slot Chassis Interrupt Jumper Plugs

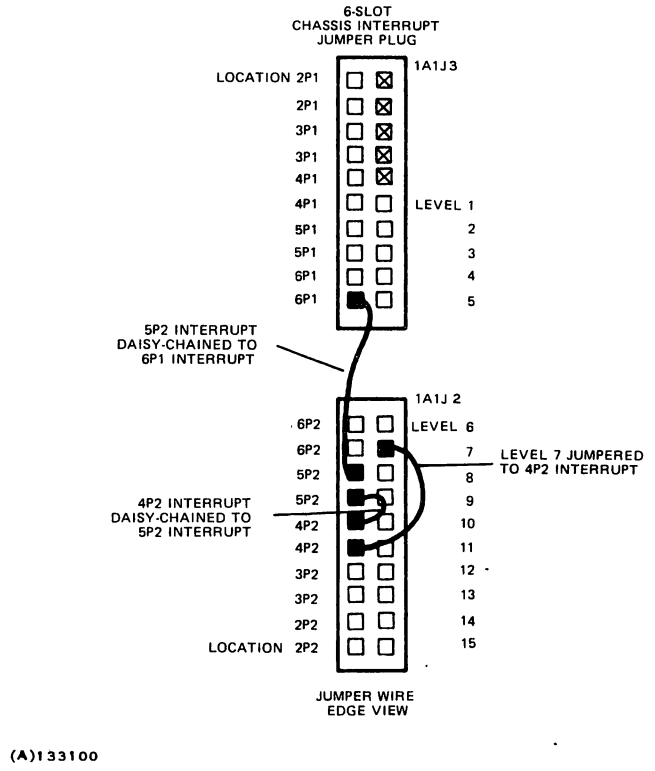


Figure 2-7. Jumper Plug Daisy-Chain Sample Connection

Procedure:

1. Remove the printed wiring boards from the first five slots of the chassis to gain access to the interrupt jumper plugs.

2. Use one of the following steps to connect the jumper wire:

   (a) Pluggable jumpers. Remove the jumper plugs from the chassis. Insert the specially constructed jumper wire to connect the interrupt level to the chassis slot interrupt pin.

   (b) Jumper pins. Connect a jumper wire from the interrupt level pin to the chassis slot interrupt pin.

3. Reinstall the jumper plugs and then the five circuit boards.

2.4.4 DATA COUPLER INSTALLATION. Since the data couplers are supplied by two different vendors, the installation information is separated to provide specific instructions for each vendor's kit. Instructions for installing the cables will be presented later with system cabling information.

CAUTION

Don't forget to read the FCC rules governing the installation and use of the equipment prior to installing or using it. The referenced rules may be found in Appendix A.

2.4.4.1 General DataComm Kit Installation. Installation of the General DataComm data coupler on a vertical wall is recommended. A typical system configuration was shown earlier in figure 2-2. Care should be exercised in locating the site for mounting the data coupler to ensure that all cables will reach their designated termination point. Cable lengths are shown in figure 2-2.

The General DataComm data coupler is mounted by installing two of the screws provided in the kit (Part Number 972968-18) into the wall at the selected location and inserting the screw heads into two keyed holes on the back of the data coupler. Slide the data coupler downward after the screw heads are through the mounting holes to secure it in place. If the data coupler is still loose, remove it from the mounting screws, tighten the screws into the wall surface a little further, and reinstall the data coupler on the screw heads.

2.4.4.2 Elgin Electronics Kit Installation. As with the General DataComm kit, care must be exercised in selecting the location for installing the data coupler to ensure that all cables will reach their termination point. Cable lengths are the same on both kits and are shown in figure 2-2. Vertical mounting is recommended for this data coupler also. Install the data coupler in accordance with the following steps.

1. Remove the four printed circuit mounting screws from the plastic base of the unit to allow access to the mounting holes in the base.

2. Attach the base to the selected location, using one keyed hole and one regular hole provided in the base, with two of the screws provided in the kit (Part Number 972968-18).

3. Replace the board assembly onto the base with the four retaining screws removed earlier.

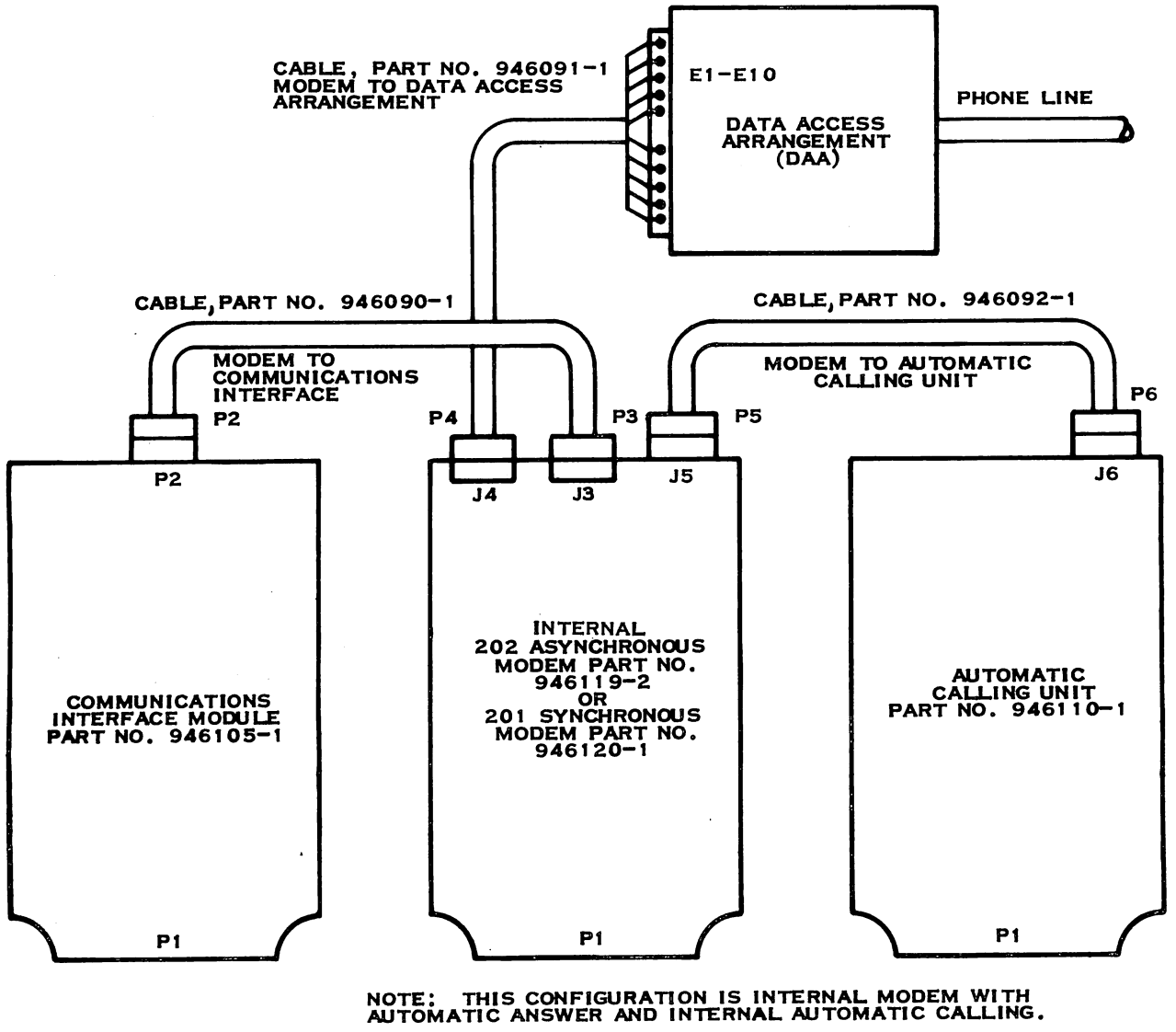
4. Route the cord in the base in the same way as it was when the cover was removed.

5. Replace the snap-on cover on the unit.

2.4.5 SYSTEM CABLING. The instructions for installing system cabling is presented in two parts. The first part covers the cabling in the computer and/or expansion chassis up to the point of connecting the data coupler. The second part covers connection of the two different vendor's data couplers.

2.4.5.1 Printed Circuit Board Connections. The instructions for installing printed wiring boards and connecting interrupt levels should be completed before attaching any cables to the boards. Figures 2-8 and 2-9 illustrate the cabling for the internal and the external communications systems. Refer to these figures as needed in the following procedures.

If the communications interface module is installed for communicating with an external modem, perform the following procedure for connecting the 9.2 meter (30-foot) cable between the module and the modem. All cables are keyed to ensure correct alignment and orientation.



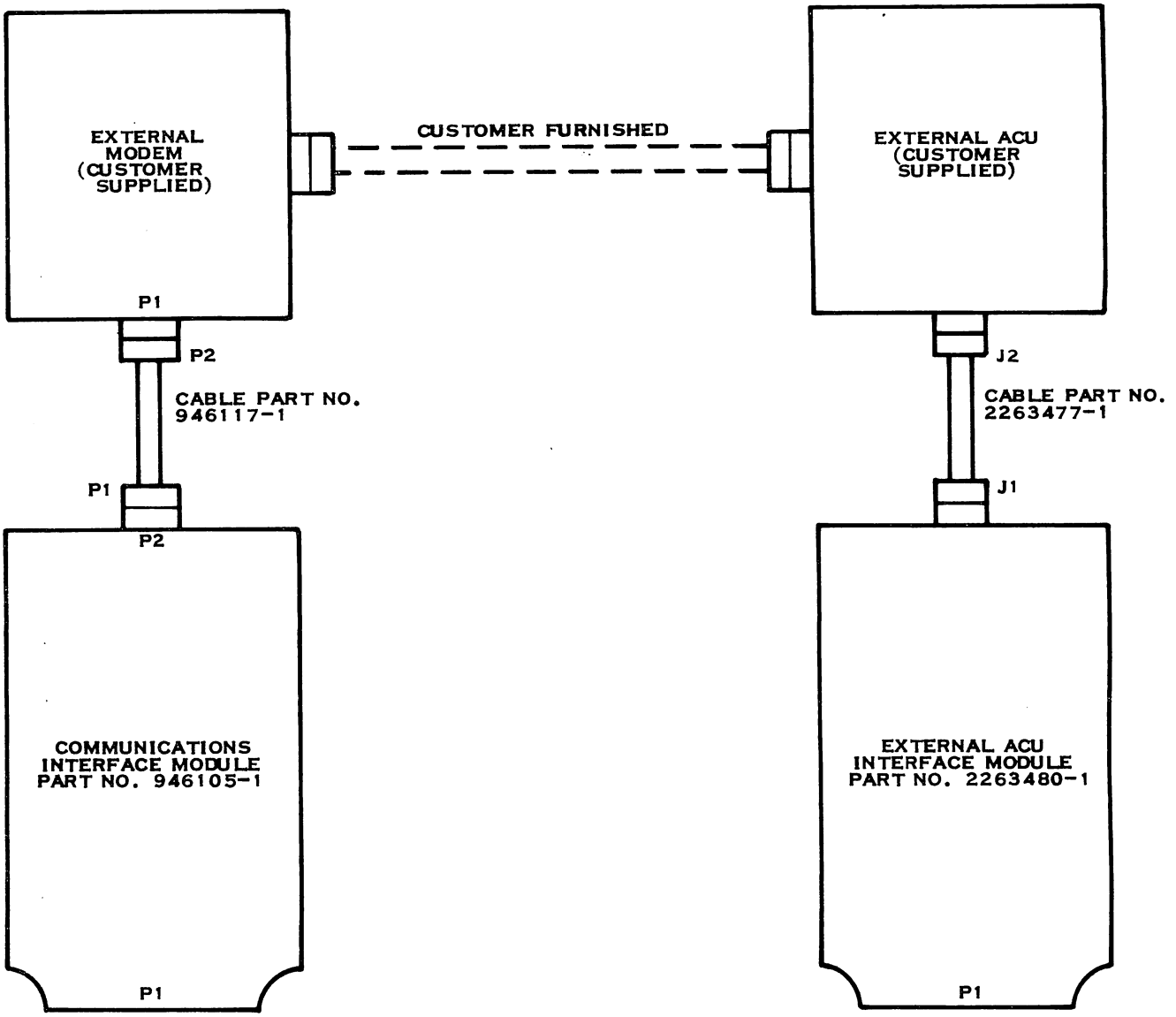
(A) 138169

Figure 2-8. Communications System Cabling with Internal ACU and Modem

NOTE

If the module is intended for this application, it should be ordered as a kit (Part Number 946104-0002) to obtain the cable.

1. Connect the female cable connector to the male connector on the outside edge of the installed communications interface module. Ensure that the cable dresses to the rear of the computer. Engage the cable in one of the cable clamps on the chassis.



(A) 139658

Figure 2-9. Communications System Cabling with External ACU and Modem

2. Route the cable to the modem, ensuring that the cable is placed so that there is no danger of personnel tripping over it.

3. Connect the male cable connector to the female connector on the modem.

NOTE

For operation with the Bell 201A and 201B data sets, the cable connection to pin 24, Transmit Signal Element Timing, must be removed. For operation with Bell 208A and 208B, the cable connection to pin 25 must be removed.

If the module is installed for use with a Texas Instruments modem, the following instructions should be followed to connect the module and the modem.

1. Connect the female ribbon cable connector (P2) to the male connector on the outside edge of the installed communications interface module.

2. Connect the male ribbon cable connector (P3) to the female EIA connector (J3) on the center outside edge of the installed modem. Ensure that the ribbon cable is laid alongside the outside edges of the installed cards out of the way.

3. Connect the female connector (P4) of the 9.2 meter (30-foot) modem-to-data coupler cable (Part Number 946091-0001) to the male connector (J4) on the right outside edge of the modem.

4. Connect the other end of the modem-to-data coupler cable to the data coupler for switched network operation or to the terminal block for private line operation. Connection of the data coupler when the system is used on a switched public telephone network is covered later in this section. To connect the cable for private line operation, proceed as follows:

   Cut off the lugs on the six control leads: RI, OH, CCT, DA, SG*, and SH. Crimp a spare wire cap on each of the six wires. Connect the remaining four wires to the terminal block. They are color coded as follows:

DR1	Brown	DR2	White
DT1	Red	DT2	Black

   *SG is the lead with sleeving, may be black, clear, or violet.

2.4.5.2 General DataComm Data Coupler Connection. If the data coupler in your kit was provided by General DataComm the following instructions for connecting it apply. If it was provided by Elgin Electronics, proceed to paragraph 2.4.5.3.

Power Connection. The data coupler operates on 22 Vac (RMS) supplied by the power transformer included in the kit. The power cable is normally shipped already connected at the data coupler end but the connections are included below in case it is not.

CAUTION

Don't plug the power transformer into the wall outlet until all connections have been made. See paragraph 2.5 later in this section on applying power.

1. Connect the power transformer cable to terminals B and R on the power transformer as shown in figure 2-10. Cable polarity need not be observed.

2. If the power transformer cable is not connected at the data coupler end, connect it to terminals P1 and P2.

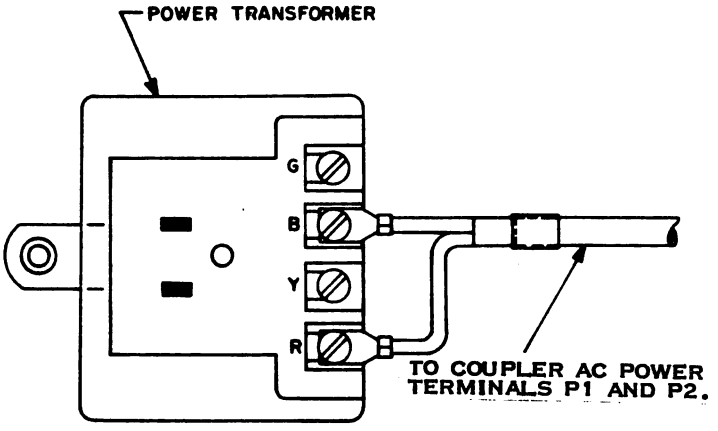


Figure 2-10. Power Transformer Connections

Data Coupler to Telephone Line Connection. Before connecting the data coupler to the USOC jack, verify that the cable provided in the kit is compatible with the coupler output configuration (programmable or permissive) and will mate with the USOC jack installed by the telephone company. This may be verified by referring to Appendix C for definition of the USOC jacks and table 2-6 for definition of the data coupler-to-telephone line cable. After verifying that the cable is correct and the connector provided is compatible with the USOC jack, insert the cable plug into the USOC jack.

Table 2-6. General DataComm Cable Wiring

General DataComm

Cable Part No.	Used For Data Coupler Output Configuration:	Length	Plug Pin No.	Function	Wire Color	
830-025-407	Fixed Loss Loop	2.1 meters (7 ft.)	1	Ring	Blue	Fixed Loss Loop configuration not used with Texas Instruments systems
			2	Tip	Orange	
			3	MI	Black	
			4	Not used	–	
			5	Not used	–	
			6	MIC	Yellow	
			7	Not used	–	
			8	Not used	–	
830-026-407	Permissive	2.1 meters (7 ft.)	1	Not used	–	
			2	MI	Black	
			3	Ring	Red	
			4	Tip	Green	
			5	MIC	Yellow	
			6	Not used	–	
830-025-607	Programmable	2.1 meters (7 ft.)	1	Not used	–	
			2	Not used	–	
			3	MI	Black	
			4	Ring	Red	
			5	Tip	Green	
			6	MIC	Yellow	
			7	PR	Brown	
			8	PC	Slate	

Optional Telephone Connection. If the optional telephone set is ordered from the telephone company, it will be connected to the line side of the data jack by the telephone company as shown in figure 2-11. With option A1, calls are originated or answered with the telephone. When this option is selected, the ringer is connected to the line when the telephone handset is on-hook to provide an audible indication of an incoming call. With option A2, the data set provides control of the line. Instructions for using the optional telephone are included in Appendix B.

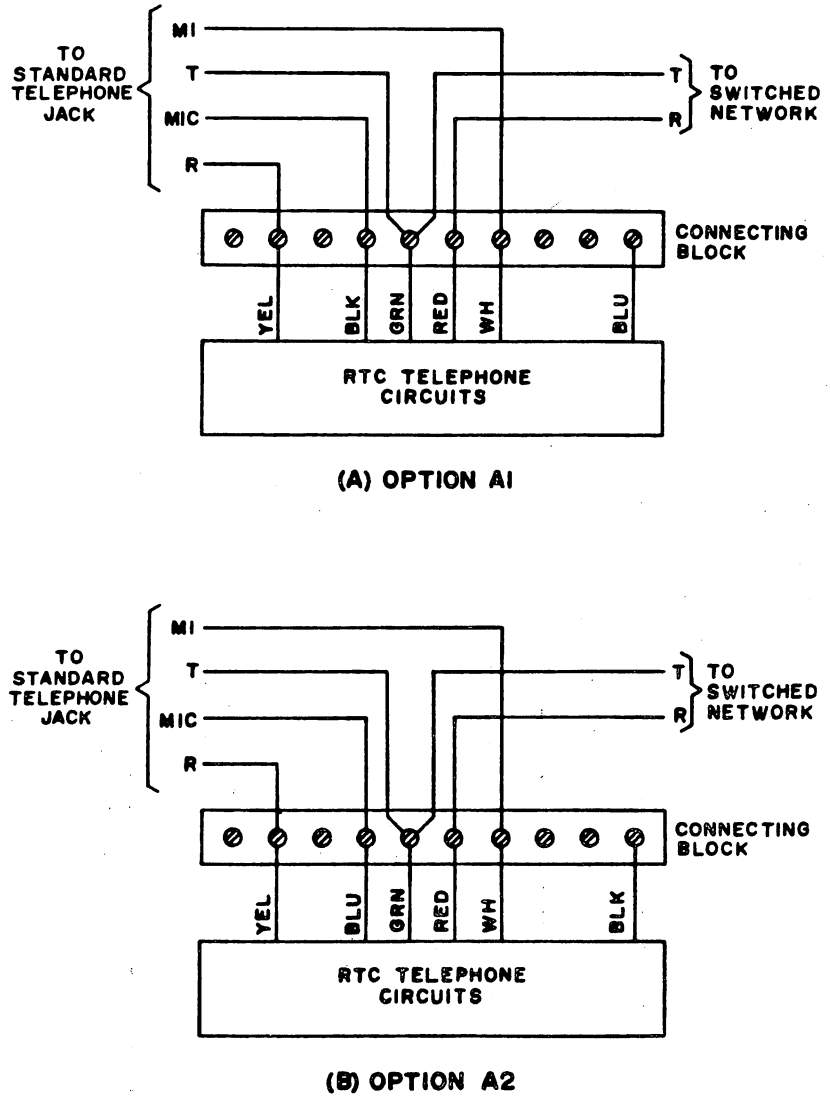


Figure 2-11. Optional Telephone Connections

Modem to Data Coupler Connection. Figure 2-12 illustrates the General DataComm board layout showing location of the terminals where the modem-to-data coupler cable (Part Number 946091-0001) is to be connected. Make the connections for switched network operation as indicated in the following paragraph.

For switched network operation, cut off the lugs on the DT2 (white) and DR2 (black) leads in the cable and crimp a spare wire cap on each of these two wires. Connect the remaining eight lugs to the data coupler terminals. The leads are color coded as follows:

DR1	Brown	CCT	Green
DT1	Red	DA	Blue
RI	Orange	SG	Black, Clear, or Violet
OH	Yellow	SH	Gray

This completes connection of the General DataComm data coupler except for plugging in the transformer. The transformer should be plugged in when power is applied to the rest of the system, as described later in this section.

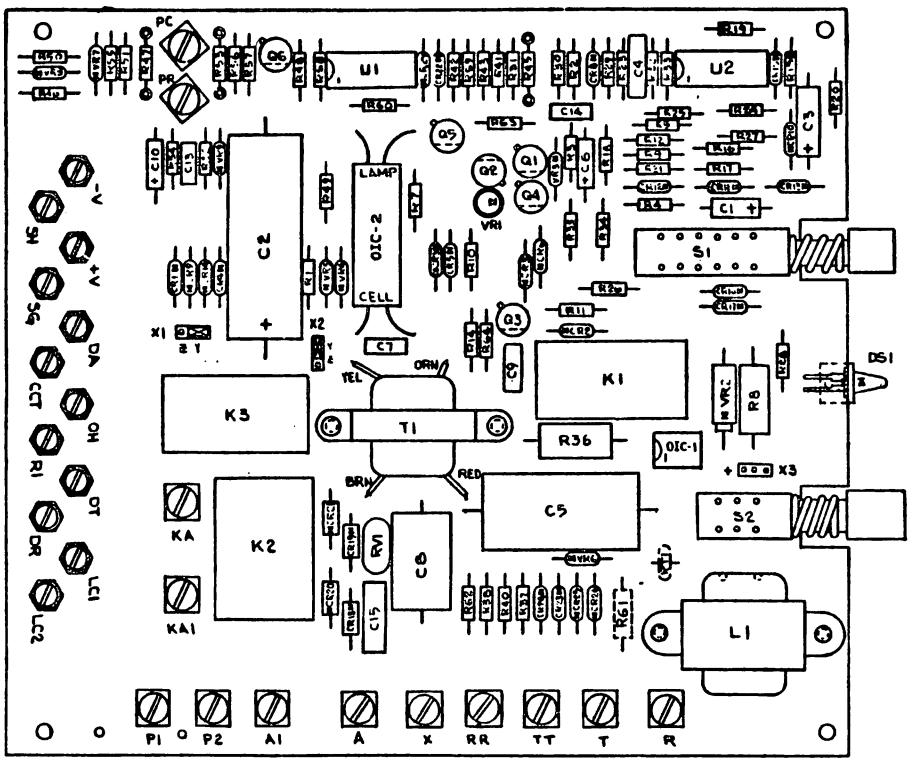


Figure 2-12. GDC Data Coupler Board

2.4.5.3 Elgin Electronics Data Coupler Connection. If the data coupler in your kit was provided by Elgin Electronics, the following procedures for connecting it apply.

Power Connection. The coupler operates on 21.4 to 26.7 Vac provided by the power transformer included in the kit. The power cord is already attached at the data coupler end. Terminals P1 and P3 of the power cord should be connected to the end winding of the power transformer and P2 should be connected to the center tap as shown in figure 2-13.

CAUTION

Don't plug the transformer into the wall outlet until all connections to the data coupler are complete. See paragraph 2.5 on applying power later in this section.

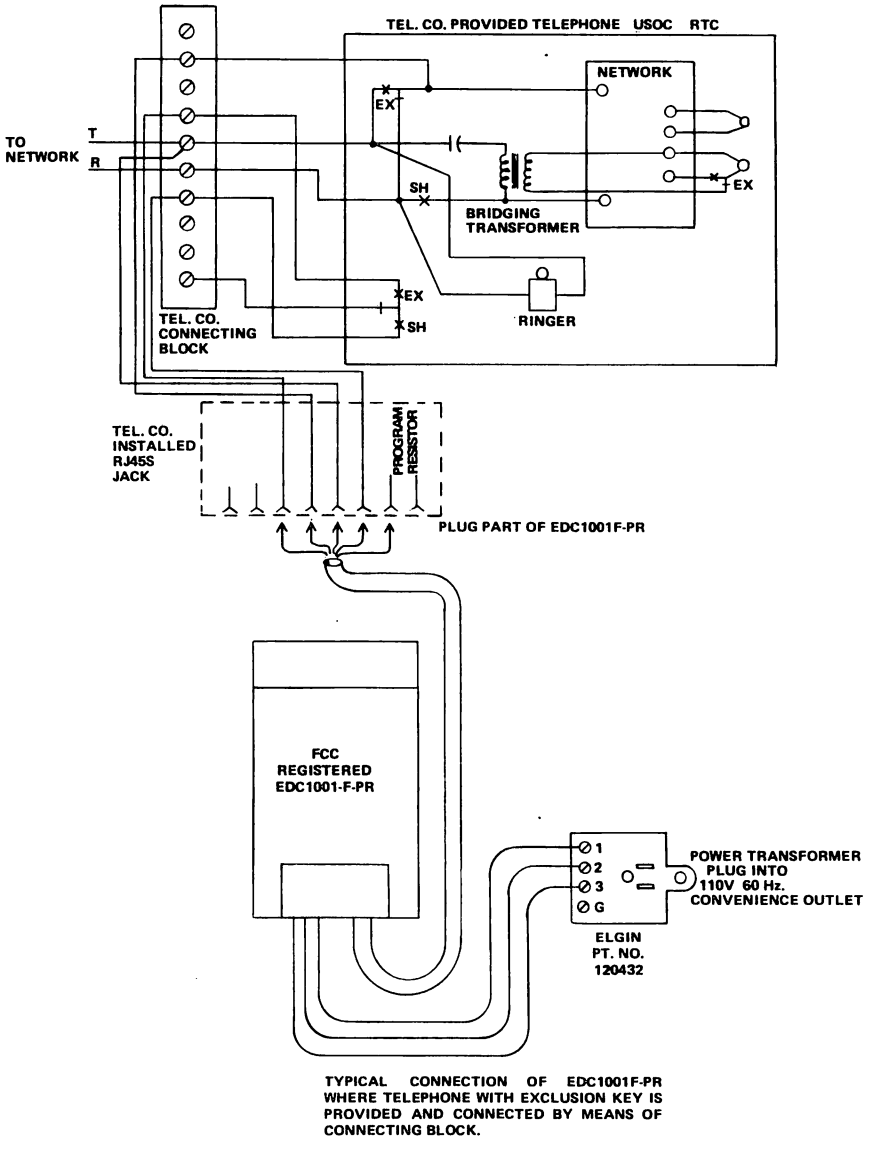


Figure 2-13. Elgin Electronics Data Coupler Connections

Data Coupler to Telephone Line Connection. Before the data coupler is connected to the USOC jack, verify that the coupler output configuration (programmable or permissive) and the cable and plug assembly are compatible with the USOC jack and the switched network. The cable and plug assembly are installed at the factory and do not have separate part numbers to check; however, the permissive configuration will have a miniature 6-pin plug compatible with an RJ11C USOC jack and the programmable configuration will be supplied with a miniature 8-pin keyed plug compatible with an RJ45S USOC jack.

After verifying the compatibility of the equipment, insert the miniature plug into the USOC jack.

To check the installation, perform the following steps:

NOTE

During the following measurements, SG is signal ground. Figure 2-14 shows the arrangement of the terminals on the data coupler printed circuit board.

1. From a remote phone, call the station number of the data coupler. Using a dc voltmeter (1000 ohms/volt or greater), measure the voltage between terminals SG and SH. The meter should read more negative than -5.0 Vdc.

2. Measure the voltage between terminals RI and SG. The meter should read more negative than -5Vdc during the silent interval and greater than +5Vdc during the ringing interval.

3. Jumper terminal A to terminal A1 and measure the voltage between terminals SG and SH. The meter should read greater than +5Vdc. Leave jumper in place for the moment.

NOTE

On the next three steps, it may be necessary to repeat the call to the station more than once to get the measurements made before terminals DT and DR are cut through to the telephone network.

4. Jumper terminal SH to terminal OH and terminal OH to terminal DA. Measure the voltage between terminals CCT and SG. Meter should read more negative than -5Vdc.

5. Quickly measure the voltage between terminals RI and SG. Meter should read more negative than -5Vdc.

6. Move the positive probe of the meter back to the CCT terminal. In approximately 2 seconds, CCT to SG shall read greater than +5Vdc, ringing is tripped, and the DT and DR terminals are cut through to the telephone network. If something was missed in the previous sequence, repeat steps 4, 5, and 6 while making another call to the station number.

7. Remove the jumpers from terminals A to A1, SH to OH, and OH to DA.

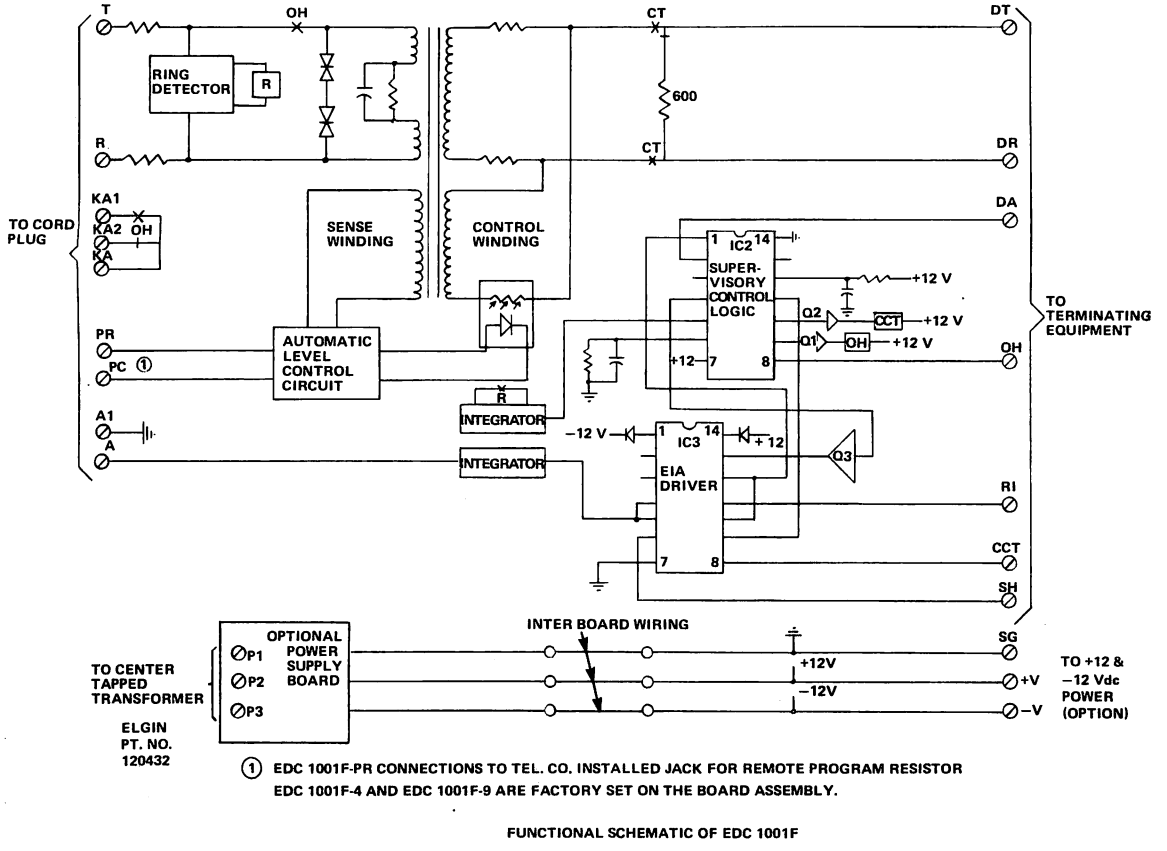


Figure 2-14. Elgin Electronics Data Coupler Terminal Arrangement

Modem to Data Coupler Connection. Figure 2-14 is a functional schematic of the Elgin Electronics data coupler showing the terminals where the modem-to-data coupler cable (Part Number 946091-0001) lugs terminate. Connect the cable for switched operation as indicated in the following paragraph.

For switched network operation, cut off the lugs on the DT2 (white) and DR2 (black) leads in the cable and crimp a spare wire cap on each of these two wires. Connect the remaining eight lugs to the data coupler terminals. The leads are color coded as follows:

DRT	Brown	CCT	Green
DT1	Red	DA	Blue
RI	Orange	SG	Black, Clear, or Violet
OH	Yellow	SH	Gray

Take care to ensure that the DR1 and DT1 leads are not reversed when connecting them.

This completes connection of the Elgin Electronics data coupler except for plugging in the power transformer. The transformer should be plugged in when power is applied to the rest of the system.

2.5 POWERING UP THE SYSTEM

After making all connections necessary to install the Communications Interface System (or any portion of it) in the proper chassis location(s) together with the required cabling and interrupt wiring and installing and connecting the data coupler (for switched network operation), the system is ready to power up. First, set the POWER switch at the rear of the computer chassis to the ON position and then plug the data coupler power transformer into the wall outlet.

2.6 SYSTEM CHECKOUT

Checkout of the system is accomplished by running the Performance Demonstration Test* (PDT), TI part number 2250100, for the Communications Interface Module. The PDT provides the capability of testing the system with or without a TI modem installed. If a TI modem is part of the system, automatic loopback of data for test purposes can be accomplished without need of a loopback connector. If an external customer-provided modem is used in the system, the loopback connector, TI part number 948550-0001 may be needed for use with the PDT. Some customer-provided modems have the capability of analog loopback. If this is the case, the customer provided modem may be placed in the loopback mode for checkout eliminating the need for the loopback connector.

If the system is a four-wire (full-duplex) system, the far-end modem may be placed in analog loopback mode to check both modems and the line between the modems.

The PDT is available on several media for use with any Model 990 computer-based system.

The Model 990 Computer Diagnostics Handbook, TI part number 945400-9701 contains complete information on this and other PDTs available from Texas Instruments.

*The test name for the Communications System checkout is CRCOMM.

SECTION III

PROGRAMMING

3.1 GENERAL

This section contains information about the communications interface system for use in designing a service routine to perform special functions required by specific applications of the system. The information is directed to personnel who are actively involved in programming the Model 990 Computer. Therefore, the section's presentation assumes that the reader is familiar with the programming information contained in *Model 990 Computer TMS 9900 Microprocessor Assembly Language Programmer's Guide,* Part Number 943441-9701.

3.2 COMMUNICATIONS INTERFACE MODULE INTERFACE

The interface between the computer and the communications interface module consists of 16 addressable input bits and 16 addressable output bits.

3.2.1 OUTPUT INTERFACE. The addressable output data (from the computer) includes the character to be transmitted and all the necessary control signals to ensure that the character is transmitted in the proper mode (synchronous or asynchronous) and at the proper baud rate. Also included are all the control signals necessary to direct and control the actual transmission of information over the telephone lines by the modem.

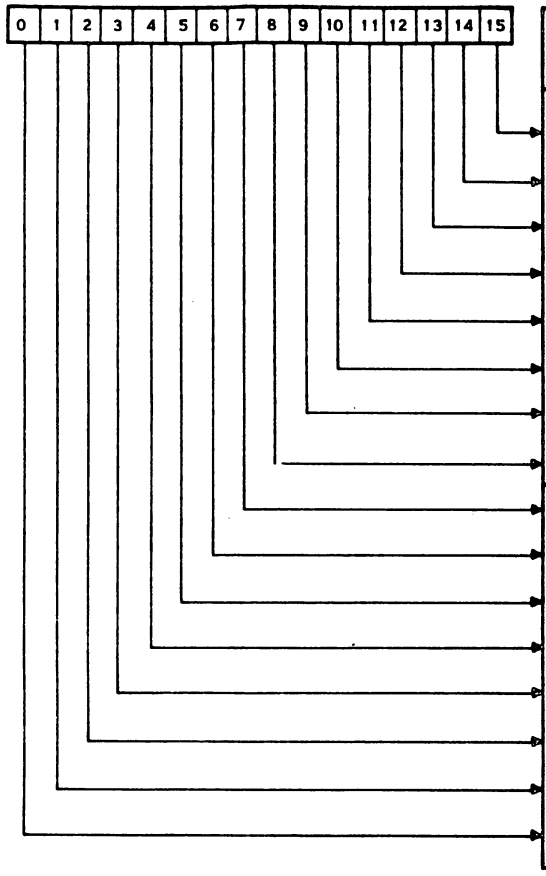
Information on the output interface to the Communications Interface Module from the computer is contained in five module registers, addressed one at a time by a 3-bit CRU addressing scheme: bits 8, 9, and 10 of the 16-bit CRU output register constitute the module register number. Figure 3-1 illustrates the output interface for both synchronous and asynchronous data transmission to the communications interface module, and table 3-1 defines the signals shown in figure 3-1.

3.2.2 INPUT INTERFACE. The addressable input (to the computer) data includes the character received from the modem and all the necessary control and status signals to inform the computer when data is present and the status of the modem and telephone lines.

Information on the input interface from the communications interface module to the computer is contained in five CRU words, addressed one at a time by a 3-bit CRU addressing scheme. Figure 3-2 illustrates the input interface for both synchronous and asynchronous data transmission to the computer, and table 3-2 defines the signals shown in figure 3-2.

3.3 TIMING CONSIDERATIONS

Following any SBO or SBZ of Strobe (CRU output bit 11), neither the least significant byte (data) nor the address portion of the CRU word being accessed should be modified until the Read/Write Busy (R/W Busy) Flag is reset. The time interval from accessing Strobe until the R/W Busy Flag is reset should be no greater than 2.1 microseconds.



ASYNC/SYNC CRU INTERFACE *
OUTPUT

CRU BIT NO.	OUTPUT WORD 0 ADDR 2-0=000 STROBE=0	OUTPUT WORD 1 ADDR 2-0=010 STROBE=1/1	OUTPUT WORD 2 ADDR 2-0=001 STROBE=0	OUTPUT WORD 3 ADDR 2-0=100 STROBE=0	OUTPUT WORD 4 ADDR 2-0=101
0	XMIT DATA 0	SYNC/DLE CHAR 0_2	DTR	CLOCK SEL A0	CLOCK SEL B0
1	1	CHAR 1_2	RTS	CLOCK SEL $A1_1$	CLOCK SEL $B1_1$
2	2	CHAR 2_2	EN RRQ	CLOCK SEL A2	$SRTS_1$
3	3	CHAR 3_2	EN PARITY	ALT CLK/STRIP $SYNC_3$	RES MODEM LD OUT
4	4	CHAR 4_2	ECHO/DLE $STRIP_3$	ODD PARITY	PULSED MODEM LD
5	5	CHAR 5_2	SBS/XMIT PARITY FORCE DLE_4	SYNC MODE	MASTER RESET
6	6	CHAR 6_2 SYNC/DLE	BREAK/$TRNSPRNT_3$	CHAR LENGTH 0	HALF-DUPLEX
7	XMIT DATA 7	CHAR 7_2	$\overline{\text{SELF-TEST}}$	CHAR LENGTH 1	AN L-B REM TEST
8	ADDR 0				
9	ADDR 1				
10	ADDR 2				
11	STROBE				
12	CLR-EN NSF				
13	CLR SET EN TIMER				
14	EN INTERRUPT				
15	EN WRQ				

*ALL BIT DEFINITIONS ARE IN THE POSITIVE LOGIC SENSE:

LOGIC 0 = NOT ASSERTED OR INACTIVE
LOGIC 1 = ASSERTED OR ACTIVE

(B)133863B

1. THIS BIT DEFINED FOR ASYNCHRONOUS MODE COMMUNICATION ONLY.
2. THIS BIT DEFINED FOR SYNCHRONOUS MODE COMMUNICATION ONLY.
3. THIS BIT DEFINED FOR ASYNCHRONOUS/SYNCHRONOUS MODE COMMUNICATION AS INDICATED.
4. SBS DEFINED FOR ASYNCHRONOUS MODE ONLY. XMIT PARITY AND FORCE DLE ARE DEFINED FOR SYNCHRONOUS MODE ONLY.

Figure 3-1. Computer Output Bit Assignments

Table 3-1. Output Bit Assignments

Interface Definition for CRU Output (Write) Operations: Refer to Figure 3-1. An output (write) operation addresses one of five output words as the least significant 8 bits of the 16 bit output word. The most significant 8 bits always refers to output word 0, which contains the address of the lower character.

Word	Bit	Mnemonic	
0	0-7	XMIT DATA	WRITE DATA WORD These 8 bits represent the next data character that will be written to the transmitter holding register. Bit 0 is the LSB, and bit 7 is the MSB. All characters are justified to the LSB with 0-fill.
	8-10	ADDR0-2	These 3 bits represent the address of the CRU interface word being referenced by a read or write operation as described by STROBE (bit 11).
	11	STROBE	The usage of STROBE is defined by the following table.

ADDR 210†	STROBE REF	I/F WORD REFERENCED
000	(none)	*INPUT WORD 1 (Modem leads, etc.)
	SBO	INPUT WORD 0 (RCV Data, errors)
001	SBO	INPUT WORD 2
011	SBO	**INPUT WORD 1 + INPUT WORD 0 (Status Reg, etc.)
100	SBO	INPUT WORD 3
110	(none)	INPUT WORD 4 (Module ID)
000	SBZ	OUTPUT WORD 0 (XMIT DATA)
001	SBZ	OUTPUT WORD 2
010	SBZ	OUTPUT WORD 1 (SYNC)
	SBO	OUTPUT WORD 1 (DLE). First reference to output word 1 with SBZ or SBO STROBE loads SYNC. If DLE is to be loaded, the first reference must be SBO STROBE. The second reference with SBO STROBE loads DLE. SBZ STROBE releases the scanner.
100	SBZ	OUTPUT WORD 3
101	(none)	OUTPUT WORD 4 (AUX REG)

† The module resets ADDR 2-0 to 'OOO' following each access to STROBE, i.e., SBZ or SBO STROBE.

* INPUT WORD 1 is periodically (1μs) updated by the module whenever a read/write operation is not being executed by software. Modem lead bits always reflect the latest read state of the modem leads.

** SBO STROBE to ADDR 2-0 = 011 has the effect of forcing a STATUS SCAN CYCLE.

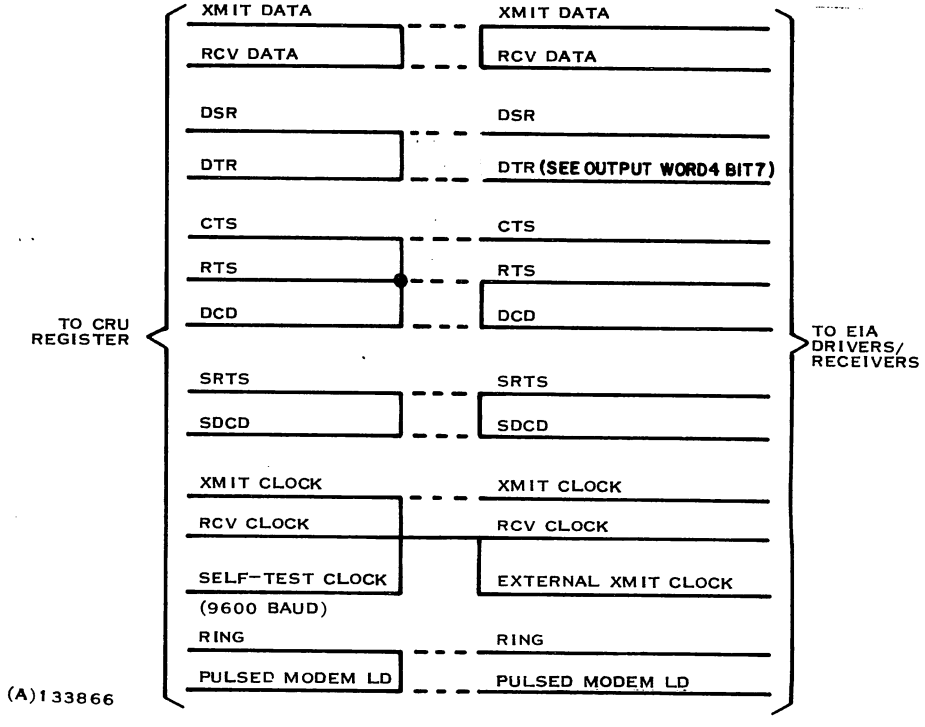
	12	CLR-EN NSF	CLEAR-ENABLE NSF When referenced (SBO or SBZ), this bit clears NSF (INPUT WORD 1, bit 12). When set by SBO, this bit enables NSF to be set upon occurrence of a new status condition from the modem. This bit remains set until reset by software.
0	13	CLR-SET-EN TIMER	Bit 13 — CLEAR-SET-ENABLE TIMER Setting this bit initiates a 250 ms time quantum and enables TIMER EXP (INPUT WORD 1, bit 13) to be set when the period has expired. An SBZ, SBO reference to CLEAR-SET-ENABLE-TIMER preempts an executing quantum and restarts a new one. If the reference is SBZ, no new time quantum is initiated. Once set, this bit remains set until reset by software.

Table 3-1. Output Bit Assignments (Continued)

Word	Bit	Mnemonic	
	14	EN INT	ENABLE INTERRUPT This bit enables INTERRUPT SUMMARY (INPUT WORD 1, bit 14) to interrupt the processor. Interrupts can occur only when this bit is set.
	15	EN WRQ	ENABLE WRQ This bit, when set, enables WRQ (INPUT WORD 1, bit 15), to be set. Once set, EN WRQ remains set until reset by software.
1	0-7	SYNC/DLE	DLE CHARACTER In synchronous mode communication, this byte contains the SYNC or DLE character to be loaded into the SYNC/DLE register as determined by the following sequence of events: The initial write to address 010 loads the SYNC character register and is executed with the instruction SBO STROBE (if DLE is to be loaded) or SBZ STROBE (if DLE is not to be loaded) (OUTPUT WORD 0, bit 11). If the DLE character is also to be loaded to the module, it must be written by the next command cycle by SBO STROBE with ADDR2-0 = 010. If only the SYNC character is to be loaded, ADDR2-0 need not be set = 010 for the next STROBE reference. However, the DLE character cannot be loaded without the preceding SYNC character load. In order to return STROBE to the normal idle state of zero, an SBZ STROBE may be used now to close the SYNC/DLE write sequence.
2	0	DTR	Bit 0 — DATA TERMINAL READY DTR directly drives the CD data set lead (DTR) on pin 20 of the EIA interface, and also enables DSR, DCD, and SDCD changes to be flagged by NEW STATUS FLAG (NSF).
	1	RTS	REQUEST-TO-SEND RTS controls the CA data set lead (RTS) on pin 4 of the EIA interface. Setting RTS combined with CTS ON (INPUT WORD 1, bit 1) enables the transmitter. When RTS is reset, any character in the transmitter register will be completely transmitted before the transmitter is turned off and the CA data set lead is deactivated.
	2	EN RRQ	ENABLE RRQ When set, this bit enables RRQ (INPUT WORD 1, bit 8) to be set, and enables the receiver section of the module. Once set, this bit remains active until deactivated by software. Resynchronization of the receiver is effected by first resetting and then setting EN RRQ (requires STROBE). Additionally, resetting EN RRQ resets the error bits in INPUT WORD 0 (bits 12-15) and resets RRQ (INPUT WORD 1, bit 8).
	3	EN PARITY	PARITY ENABLE For asynchronous communication, setting PARITY ENABLE enables the module for parity checking/generation. For synchronous communication, setting this bit enables parity checking only. When this bit is set, the state of ODD PARITY SELECT (OUTPUT WORD 3, bit 4) determines whether odd or even parity is in effect. If CHAR LENGTH 0, 1, (OUTPUT WORD 3, bits 6-7) is selected to be 8-bits, the parity bit will replace the MSB of the data character.
	4	ECHO/DLE STRIP	ECHO/DLE STRIP In asynchronous communications, setting this bit enables the automatic echo mode, wherein assembled received characters are presented to the transmit data output (data set lead BA) in place of normal transmission through the transmitter register. To allow this echo to occur, the receiver must be enabled by setting EN RRQ (OUTPUT WORD 2, bit 2). Echo will not start until the transmitter is idle. In synchronous communication, setting this bit does not allow assembled receiver register data matching the contents of the DLE register to be transferred to the receiver holding register; also, parity checking is disabled.

Table 3-1. Output Bit Assignments (Continued)

Word	Bit	Mnemonic	
2	5	SBS/ XMIT PARITY/ FORCE DLE	STOP BIT SELECT (SBS)/SYNC TRANSMIT PARITY ENABLE (XMIT PARITY)/FORCE DLE In asynchronous communications, setting this bit causes 1 stop bit to be transmitted at the end of each character. Resetting SBS causes 1.5 or 2 stop bits to be transmitted, depending upon the character length specified. For 5-bit codes (CHARACTER LENGTH 0-1 = 11), 1.5 stop bits will be transmitted, and for 6, 7, or 8-bit codes, 2 stop bits will be selected. In the synchronous mode, setting this bit combined with a logic 0 on bit 6 of Output Word 2 enables Transmit parity; otherwise, no parity is generated. When set with bit 6 also set, the contents of the DLE register is transmitted prior to the next character loaded in the transmitter holding register.
	6	BREAK/ TRANSPARENT	BREAK/TRANSPARENT In asynchronous communications, setting this bit while the transmitter in enabled holds the transmitted data set lead BA in a spacing condition, starting at the end of any current transmitted character. Normal transmitter timing continues so that this break condition can be timed-out by software responding to WRQ interrupts. Character framing is thus maintained during break, and the break condition will be an integral number of character frames long. In synchronous communications, setting this bit conditions the transmitter to transparent transmission. In this mode, a DLE-SYN character sequence will comprise the idle fill, and DLE may be force-transmitted ahead of any character by setting SBS/XMIT PARITY/FORCE DLE (OUTPUT WORD 2, bit 5). NOTE: When entering the transparent mode, the FORCE DLE bit (OUTPUT WORD 2, bit 5) must be set as well as this bit. Thereafter the FORCE DLE bit will function as described by bit 5. The use of transparent requires a half-duplex protocol. If used in a full-duplex mode, unexpected results may occur.
	7	SELF TEST	SELF-TEST Setting this bit causes the module to enter self-test (digital loopback) mode. In this mode, the following logical connections are made with respect to the modem leads:*



* The connections of the modem leads on the output is controlled with the REMOTE TEST (REMTEST) Bit 7 = OUTPUT WORD 4, in conjunction with this SELF-TEST BIT.

Table 3-1. Output Bit Assignments (Continued)

Word	Bit	Mnemonic	
3			CAUTION: This word should be written to the asynchronous/synchronous receiver/transmitter device only while the receiver and the transmitter are idle.
3	0-2	CLOCKSEL	CLOCKSELECT A0-A2 These bits select the transmit and receive clocks. The input clock may be selected as shown:

CLOCKSEL A2-A0	CLOCK	
000	1X clock for Transmit and Receive	(normal state for synchronous mode)
100	32X Async clock input ÷ 1	(normal state for asynchronous mode)
101	32X Async clock input ÷ 2	
110	32X Async clock input ÷ 4	
111	32X Async clock input ÷ 8	

The 1X clock is the synchronous baud clock supplied by the data set, except in self-test mode when it is switched to the 9600 Hz self-test clock.

The 32X Async clock is one of four asynchronous baud clocks selected by CLOCKSEL B0, B1 (ref. OUTPUT WORD 4, bits 0-1).

	3	ALTCLK/ STRIP SYNC	ALTCLK - STRIP SYNC In synchronous mode communication, setting this bit will cause SYNC characters (OUTPUT WORD 1) to be stripped (deleted) from the received, or input, data stream. In asynchronous mode communication, this bit must be set.
	4	ODD PARITY	ODD PARITY SELECT The state of this bit selects either even or odd parity to be checked/sent in the received/transmitted data stream. If this bit is not set, even parity is selected. Setting this bit selects odd parity. Parity must be enabled for this bit to have any effect.
	5	SYNC MODE	SYNC MODE SELECT This bit, when set, selects the synchronous transmission mode; when reset, the asynchronous mode is selected.
	6-7	CHAR LEN	CHARACTER LENGTH SELECT 0-1 These bits select the character length for communication as follows:

Bit 7-6	Character Length (including parity, if enabled)
00	8-bit characters
01	7-bit characters
10	6-bit characters
11	5-bit characters

4	0-1	CLOCKSEL	CLOCKSELECT B0-B1 These bits select one of four 32X clock baud rate ranges, as specified below, and allow, via selection of CLOCKSEL A0 and A1, specification of one of 16 baud rates.

Table 3-1. Output Bit Assignments (Continued)

Word	Bit	Mnemonic	
4			CLOCKSEL B1-B0 BAUD RATE RANGE BAUD RATES (÷ 1,2,4,8)

CLOCKSEL B1-B0	BAUD RATE RANGE	BAUD RATES (÷ 1,2,4,8)
00	200	200,100,50,25
01	600	600,300,150,75
10	880	880,440,220,110
11	9600	9600,4800,2400,1200

NOTE: PN 948625-001 has 134.5 baud rate in place of 200.

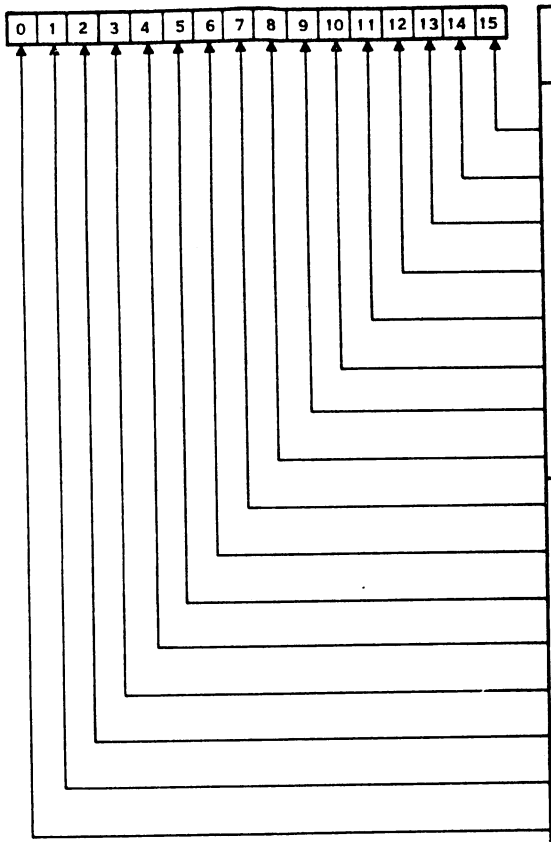
The baud rate selected from the list above may be divided by 1, 2, 4 or 8 as shown in column on right to accommodate a wide range of rates.

When the 1X clock is selected (WORD 3, bits 0, 2 = 000), these bits have no effect.

2	SRTS	SECONDARY REQUEST TO SEND This bit directly drives the SCA data set lead (secondary request to send) in pin 19.
3	RES MODEM-LD OUT	This bit is reserved for customer modem output signal and directly controls the data set lead on pin 18 of the EIA interface. When a Texas Instruments internal modem is employed, this lead has the effect of controlling the audio monitor for use in troubleshooting and/or system assurance.
4	PULSED-MODEM LD	PULSED MODEM LEAD Setting this bit initiates a millisecond signal onto data set leads NS and CDR (pins 14 and 25) of the EIA interface. With a synchronous modem connected to the module, this bit will directly control the NEWSYNC (NS) data set lead. With an asynchronous modem connected, this bit will control the CARRIER DETECT RESET (CDR) data set lead. CAUTION: If an external modem type 208 is employed, the CDR data set lead should be disconnected. Cable PN 946117 does not have CDR connected.
5	MR	MASTER RESET When set MR clears all status and control (except input modem leads) to the reset (inactive) state. MR is a pulse and is automatically returned to the reset state by the module.
6	HALF DUPLEX	HALF DUPLEX When transmitting in half-duplex mode, setting this bit masks the serial receive data line to the module to logic 1, disabling the reception of the transmit data echo (called local copy) provided by many half-duplex (2-wire) modems.
7	ANALOG LB-REM TEST	ANALOG LOOPBACK - REM TEST This bit is combined with SELF-TEST (OUTPUT WORD 2, bit 7) to affect the loopback configuration given by the following table.

SELF TEST	ANALOG LB-REM TEST	LOOPBACK CONFIGURATION
0	0	None (normal comm)
0	1	ANALOG loopback only
1	0	SELF-TEST only (DTR OFF)
1	1	SELF-TEST, REMOTE TEST (DTR ON)

A manually-selected override switch is provided on the module board. When the switch is in the closed position, the remote test mode is selected, regardless of the state of the ANALOG LOOPBACK/REMOTE TEST or SELF-TEST bits. When the switch is in the open position, the state of these bits prevails.



ASYNC/SYNC CRU INTERFACE*
INPUT

CRU BIT NO.	INPUT WORD 0 ADDR 2-0=000 STROBE=1	INPUT WORD 1 ADDR 2-0=000 STROBE =0	INPUT WORD 2 ADDR 2-0=001 STROBE=1	INPUT WORD 3 ADDR 2-0=100 STROBE=1	INPUT WORD 4 ADDR 2-0=110 STROBE=0
0	RCV DATA 0	DSR	DTR	CLOCK SEL $A0_1$	MODEM ID 0
1	1	CTS	RTS	CLOCK SEL $A1_1$	1
2	2	$SDCD_1$	EN RRQ	CLOCK SEL A2	2
3	3	RES MODEM LD OUT	EN PARITY	ALT CLK STRIP $SYNC_3$	3
4	4	RING	$ECHO/DLE\ STRIP_3$	ODD PARITY	4
5	5	DCD	SBS/XMIT PARITY /FORCE DLE_4	SYNC MODE	5
6	6	UNUSED	$BREAK/TRNSPRNT_3$	CHAR LEN 0	MODEM ID 6
7	RCV DATA 7	UNUSED	$\overline{SELF\text{-}TEST}$	CHAR LEN 1	GND (UNUSED)
8	UNUSED	RRQ			
9	SYNC MODE	SYNC MODE			
10	UNUSED	$UNDER\text{-}RUN_2$			
11	R/W BUSY	R-W BUSY			
12	$PE/DLE\ DETECT_3$	NSF			
13	FE/SYNC DETECT	TIMER EXP			
14	OVER-RUN	INTR SUM			
15	RCV ERROR SUM	WRQ			

*ALL BIT DEFINITIONS ARE IN THE POSITIVE LOGIC SENSE (EXCEPT SELF-TEST):

LOGIC 0 = NOT ASSERTED OR INACTIVE
LOGIC 1 = ASSERTED OR ACTIVE
EXCEPT SELF-TEST (REFER TO PARA. 3.5)

1. THIS BIT DEFINED FOR ASYNCHRONOUS MODE COMMUNICATION ONLY
2. THIS BIT DEFINED FOR SYNCHRONOUS MODE COMMUNICATION ONLY
3. THIS BIT DEFINED FOR ASYNCHRONOUS SYNCHRONOUS MODE COMMUNICATION AS INDICATED.
4. SBS IS DEFINED FOR ASYNCHRONOUS MODE ONLY. XMIT PARITY AND FORCE DLE ARE DEFINED FOR SYNCHRONOUS MODE ONLY.

(B)133864B

Figure 3-2. Computer Input Bit Assignments

Table 3-2. Input Bit Assignments

Word	Bit	Mnemonic	Description
0	0-7	RCV DATA	RECEIVE DATA WORD These bits contain the byte input from the asynchronous/synchronous receiver transmitter device to the CRU in response to an SBO STROBE with ADDO-2=000, bit 0 is the LSB, and bit 7 is the MSB. If a character length of less than eight bits has been selected (OUTPUT WORD 3, bits 6-7), the character is justified to the LSB with 0-fill.
	8		Unused
	9	SYNC MODE	SYNC MODE This bit indicates the contents of the SYNC MODE bit (OUTPUT WORD 3, bit 5).
	10		Unused
	11	RW BUSY	READ/WRITE BUSY When set, this bit indicates that the module is busy processing a software-given read or write command, and neither the address bits nor the data bits 0-7 can be modified. Normal read/write referencing can resume when this bit is reset.
	12	PE/DLE DETECT	PARITY ERROR/DLE DETECT PE is a component of RCV ERROR SUM (INPUT WORD 0, bit 15), and is set when PARITY ENABLE (OUTPUT WORD 2, bit 3) is set and a parity error has been detected in the last character received in the receiver register. PE is valid after the access of INPUT WORD 0, while STROBE (OUTPUT WORD 0, bit 11) is set and when STROBE is reset, PE is cleared. In synchronous communications, when STRIP DLE (OUTPUT WORD 2, bit 4) is enabled, the receiver parity check is disabled and this is set if the character previous to the character presently in RECEIVE DATA WORD matched the contents of the DLE register.
	13	FE/SYNC-DETECT	FRAMING ERROR (FE)/SYNC DETECT In asynchronous communications, this error condition is set when the transmitter detects a logic zero stop bit (which should be a logic one). This bit is a component of RCV ERROR SUM (INPUT WORD 1, bit 15), is valid after the access of INPUT WORD 0, while STROBE (OUTPUT WORD 0, bit 11) is set; and is cleared when STROBE is reset. In synchronous communications, this bit is set if the contents of the receiver register match the contents of the SYNC register. This bit is set and cleared as described above. In both modes, this bit is cleared by disabling the receiver.
	14	OVER-RUN	OVER-RUN This error condition is set during reception when a new data character is transferred into the receiver holding register before the previous character is read by the CRU. The previous character in the receiver register will have been lost. OVER-RUN is cleared by the next STATUS SCAN cycle or by disabling the receiver.
	15	RCV ERROR-SUM	RECEIVE ERROR SUMMARY This bit is set when at least one of the following receiver status bits is asserted: PE/DLE DETECT (unless in SYNC, TRANSPARENT mode) FE/SYN DETECT (Unless in SYNC mode) OVER-RUN This bit is cleared by executing SBZ STROBE, as above.
1	0	DSR	DATA SET READY DSR indicates the state of the CC data set lead from the modem (DSR) on pin 6 of the EIA interface. A change in state of this modem lead is indicated as a component of NEW STATUS FLAG (INPUT WORD 1, bit 12) if DTR (OUTPUT WORD 2, bit 0) is active.

Table 3-2. Input Bit Assignments (Continued)

Word	Bit	Mnemonic	Description
1	1	CTS	CLEAR-TO-SEND CTS indicates the state of the CB data set lead from the modem (CTS). When CTS in asserted, the transmitter section of the module is ready for transmission.
	2	SDCD	SECONDARY DATA CARRIER DETECT This bit is defined for asynchronous mode communication only. SDCD indicates the condition of the data set lead SCF on pin 12 of the EIA interface. A change in state of this modem lead is indicated as a component of NEW STATUS FLAG (INPUT WORD 1, bit 12), if DTR (OUTPUT WORD 2, bit 0) is active.
	3	RES MODEM-LD OUT	RESERVED MODEM LEAD OUTPUT (RES MODEM LD OUT) This bit indicates the contents of the RES MODEM LD OUT bit (OUTPUT WORD 4, bit 3).
	4	RING	RING indicates the state of the RING line from the modem (CE). A change in state from inactive to active of RING is indicated as a component of NSF (INPUT WORD 1, bit 12).
	5	DCD	DATA CARRIER DETECT DCD indicates the state of the modem lead (CF). A change in state of DCD is indicated by NSF (INPUT WORD 1, bit 12) if DTR (OUTPUT WORD 2, bit 0) is set.
	6-7		Unused
	8	RRQ	READ REQUEST This bit is set when a receive character is available and EN RRQ (OUTPUT WORD 2, bit 2) is active. RRQ is cleared when the RCV DATA WORD (INPUT WORD 0, bits 0-7) is read. RRQ is a component of INTERRUPT SUMMARY (INPUT WORD 1, bit 14).
	9	SYNC MODE	SYNC MODE This bit indicates the contents of the SYNC MODE bit (OUTPUT WORD 3, bit 5).
	10	UNDER-RUN	UNDER-RUN This bit is defined for synchronous mode communication only. When the transmitter is enabled, the UNDER-RUN error bit is set if the transmitter holding register has remained empty for at least one character time (the time required to transmit one character serially), so that the transmitter has had to insert fill characters into the transmitted data stream. The inserted fill characters are SYNC characters if TRANSPARENT is not set. If TRANSPARENT is set, fill characters are DLE-SYN. Once asserted UNDER-RUN remains asserted until cleared by resetting EN-WRQ (OUTPUT WORD 0, bit 15). UNDER-RUN is defined for 8-bit character lengths, including parity.
	11	R-W BUSY	READ/WRITE BUSY When set, this bit indicates that the module is busy processing a software-given read or write command, and neither of the address bits nor the data bits 0-7 can be defined. Normal read/write referencing can resume when this bit is reset.
	12	NSF	NEW STATUS FLAG This interrupt condition is set when CLR-EN-NSF (OUTPUT WORD 0, bit 12) is set and any of the following modem lines changes state. DSR, SDCD, DCD: $1 \rightarrow 0$ or $0 \rightarrow 1$ RING: $0 \rightarrow 1$ NSF is a component of INTERRUPT SUMMARY (INPUT WORD 1, bit 14), and is cleared by referencing CLR-EN NSF with either SBZ or SBO.

Table 3-2. Input Bit Assignments (Continued)

Word	Bit	Mnemonic	Description
1	13	TIMER EXP	TIMER EXPIRED This interrupt condition is set when the most recent 250-millisecond time priod, started by the (software) assertion of CLR-SET-EN-TIMER (OUTPUT WORD 0, bit 13), expires. This bit is cleared by setting or resetting CLR-SET-EN-TIMER. This bit is a component of INTERRUPT SUMMARY (INPUT WORD 1, bit 14), and can be set only when CLR-SET-EN-TIMER is active.
	14	INTR SUM	INTERRUPT SUMMARY When set, this bit indicates that at least one of the following interrupt bits is set. RRQ (INPUT WORD 1, bit 8) WRQ (INPUT WORD 1, bit 15) TIMER EXPIRED (INPUT WORD 1, bit 13) NSF (INPUT WORD 1, bit 12) This bit will remain set until all interrupting conditions have been cleared, and the setting of this bit will interrupt the processor if ENABLE INTERRUPT (OUTPUT WORD 0, bit 14) is active.
	15	WRQ	WRITE REQUEST This interrupt condition occurs when the transmitter holding register becomes empty while EN WRQ (OUTPUT WORD 0, bit 15), RTS (OUTPUT WORD 2, bit 1), and CTS (INPUT WORD 1, bit 1) are active. WRQ is cleared when a data character is written to the transmitter holding register, or when the transmitter is disabled (RTS reset). This bit is a component of INTERRUPT SUMMARY (INPUT WORD 1, bit 14).
2	0-7	DTR RTS EN RRQ EN PARITY ECHO/DLE STRIP SBS/XMIT PARITY/ FORCE DLE BREAK/ TRANSPARENT SELF-TEST	This word indicates the current contents of OUTPUT WORD 2. NOTE: The sense of the self-test bit is inverted in the input register.
3	0-7	CLOCKSEL ALT CLK/STRIP SYNC ODD PARITY SYNC MODE CHAR LEN	This word indicates the current content of OUTPUT WORD 3.
4	0-6	MODULE ID	These bits contain the Module ID code as set by the low-order 7 bits of the DIP-SWITCH. Bit 0 (switch 1) is the LSB and bit 6 (switch 7) is the MSB.
	7	GROUND	Bit 7 — This bit is tied to ground and will always read as zero.

3.4 SELF-TEST MODE

If data transmission errors occur, placing the system in the self-test mode provides a check on the proper operation of the communications interface module by looping back the data that would normally be transmitted to the modem and onto the telephone lines. The same sequence of events must be performed to operate the system in the self-test mode as is used to normally transmit and receive data.

NOTE

Use of self-test mode requires software capable of full-duplex operation and precludes half-duplex operation.

3.5 SAMPLE ROUTINES

The following paragraphs contain coding examples of routines that perform some of the functions required to interface the computer with the communications interface system. These routines may not meet unique requirements of specific applications and should be used only as guides to designing custom service routines. These routines assume that the CRU base address of the communications interface module is placed in R12 of the executing workspace by assembly of LI R12, CRUADDR. Since SBO or SBZ to Strobe resets ADD2-0 to zeros, it is assumed that all coding examples begin with ADD,2-0 equal 000_2.

Any code which modifies the address selection should always exit with the address selection bits (ADD,2-0) returned to logic zeros and must be protected from another interruption by the same device, since any interruption could yield incorrect address selection. The protection should be provided by disabling the Interrupt Enable CRU bit or by operating at a sufficiently high hardware priority.

Following any Strobe instruction, neither the low-order byte of data nor the address selection bits should be modified until the Busy flag resets. The time interval between access to Strobe and the modification of the address selection bits should be greater than 2.1 microseconds, and will normally be timed out in the examples by the TB BUSY, JEQ sequence of instructions. The following definitions are used in the coding examples in this section.

```
* REGISTER DEFINITIONS
R0      EQU  0          R0
R1      EQU  1          R1
R2      EQU  2          R2
R3      EQU  3          R3
R4      EQU  4          R4
R5      EQU  5          R5
R6      EQU  6          R6
R7      EQU  7          R7
R8      EQU  8          R8
R9      EQU  9          R9
R10     EQU  10         R10
R11     EQU  11         R11
R12     EQU  12         R12
R13     EQU  13         R13
R14     EQU  14         R14
R15     EQU  15         R15
* END OF REGISTER DEFINITIONS
*
```

```
* COM DEVICE CRU DEFINITION
* INPUT STATUS REGISTER-ADDR=0, STROBE=0
DSR         EQU   0       DATA SET READY
CTS         EQU   1       CLEAR TO SEND
SDCD        EQU   2       SECONDARY DATA CARRIER DETECT
RING        EQU   4       RING
DCD         EQU   5       DATA CARRIER DETECT
RRQ         EQU   8       READ REQUEST
SYNCM       EQU   9       READABLE COPY OF SYNC SELECTION
TUNDER      EQU   10      TRANSMIT UNDERRUN
BUSY        EQU   11      SCAN BUSY
NSF         EQU   12      NEW STATUS FLAG-MODEM CHANGE
TIMER       EQU   13      TIMER EXPIRATION
INTSUM      EQU   14      INTERRUPT SUMMARY-NSF/RRQ/WRQ
WRQ         EQU   15      WRITE REQUEST
*           6,7           UNUSED
*
* INPUT DATA REGISTER-ADDR=0, STROBE=1
* RDATA             BITS 0-7  RECEIVE DATA BYTE
PARERR      EQU   12      PARITY ERROR
FRMERR      EQU   13      FRAMING ERROR (BREAK) - ASYNC ONLY
ROVER       EQU   14      RECEIVE OVERRUN-DATA LOST
RCVERR      EQU   15      RECEIVE ERROR SUMMARY
*           8,9,10        UNUSED
*           11            BUSY
*
* OUTPUT WORD ZERO-ADDR=0,STROBE=0
* XDATA             BITS 0-7  TRANSMIT DATA BYTE
*
* OUTPUT STATUS REGISTER-ALL ADDRESSES-ALL STROBES
ADD0        EQU   8       ADDRESS SELECTION BIT 0
ADD1        EQU   9       ADDRESS SELECTION BIT 1
ADD2        EQU   10      ADDRESS SELECTION BIT 2
STROBE      EQU   11      STROBE DATA
ENNSF       EQU   12      ENABLE NSF INTERRUPTS
ENTIME      EQU   13      ENABLE TIMER
ENINT       EQU   14      ENABLE INTERRUPTS
ENWRQ       EQU   15      ENABLE WRITE REQUEST
*
* OUTPUT WORD TWO-ADDR-1,STROBE=0
DTR         EQU   0       DATA TERMINAL READY
RTS         EQU   1       REQUEST TO SEND
ENRRQ       EQU   2       RECEIVER ENABLE
PAREN       EQU   3       PARITY ENABLE
ECHO        EQU   4       ECHO ENABLE- ASYNC ONLY
DLESTR      EQU   4       DLE STRIP- SYNC ONLY
STOPBS      EQU   5       STOP BIT SELECT- ASYNC ONLY
PARXMT      EQU   5       XMIT PARITY ENABLE- SYNC ONLY
TBREAK      EQU   6       XMIT BREAK- ASYNC ONLY
TRNSP       EQU   6       TRANSPARENCY MODE- SYNC ONLY
TEST        EQU   7       SELF TEST MODE
*
```

```
* OUTPUT WORD THREE-ADDR=4,STROBE=0
CLKA0       EQU   0       CLOCK SELECT A0
CLKA1       EQU   1       CLOCK SELECT A1
CLKA2       EQU   2       CLOCK SELECT A2
ALTCLK      EQU   3       ALTERNATE CLOCK SELECT- ASYNC
STRSYN      EQU   3       STRIP SYNC-SYNC
PARODD      EQU   4       ODD PARITY SELECT
SYNC        EQU   5       SYNC MODE SELECTION
CHARL0      EQU   6       CHARACTER LENGTH SELECT 0
CHARL1      EQU   7       CHARACTER LENGTH SELECT 1
*
* OUTPUT WORD FOUR-ADDR=5,STROBE=NONE
CLKB0       EQU   0       CLOCK SELECT B0
CLKB1       EQU   1       CLOCK SELECT B1
SRTS        EQU   2       SECONDARY REQUEST TO SEND
RESOUT      EQU   3       RESERVED MODEM LEAD OUT
PLSOUT      EQU   4       PULSED MODEM LEAD OUT
MR          EQU   5       MASTER RESET
HDUX        EQU   6       HALF DUPLEX
ANLOOP      EQU   7       ANALOG LOOPBACK
*
* OUTPUT WORD ONE-ADDR=2,STROBE=1/0
* SYNC              BITS 0-7   SYNC CHARACTER-FIRST LOAD
* DLE               BITS 0-7   DLE CHARACTER-SECOND LOAD
```

3.6 DATA TRANSFER TO THE COMMUNICATIONS INTERFACE

Data transfer from the computer through the communications interface is accomplished by a four-step process described in the following discussion.

The high-order byte (bits 8 through 15) of any CRU output word are always available for output access. Access to the high-order byte is gained by SBO and SBZ instructions. The following steps are required to access the low-order byte (bits 0 through 7) of the output word:

1. Select the address of the word to be accessed by SBO instructions.
2. Condition the data to be transferred by SBO, SBZ, or LDCR instructions.
3. Strobe the data by SBZ STROBE instructions.
4. Wait until BUSY returns to logic 0.

Example: To select SELF-TEST mode on the device. Other contents of output word 2 are not to be modified.

```
* SELECT ADDRESS
        SBO     ADD0        SELECT ADDRESS 1-001
*
* CONDITION DATA
        SBO     TEST        ASSERT SELF TEST BIT
*
* STROBE DATA
        SBZ     STROBE      STROBE DATA TO DEVICE
*
```

```
* DELAY FOR COMPLETION
WAIT01   TB      BUSY          WAIT FOR ZERO BUSY BIT
         JEQ     WAIT01        LOOP ON BUSY SET
```

Accesses to output word 4 do not require an access to strobe nor any delay; however, the address bits must be reset. For example, assertion of half-duplex selection, with no other contents of output word 4 to be modified, would be done in the following manner.

```
* SELECT ADDRESS
         SBO     ADD2          SELECT ADDRESS 5-101
         SBO     ADD0
*
* CONDITION DATA
         SBO     HDUX
*
* NO STROBE NOR DELAY REQUIRED
* RETURN ADDRESS TO ZERO STATE
         SBZ     ADD2          RESTORE ADDRESS TO ZERO
         SBZ     ADD0
```

Loading of the SYNC and DLE characters requires a somewhat different philosophy since DLE loading requires that it be loaded as the next write following the SYNC load.

```
* SELECT ADDRESS
         SBO     ADD1          SELECT ADDRESS 2-010
*
* CONDITION DATA
         LDCR    @SYNCCH,8     SYNC CHARACTER IS IN SYNCCH
*
* STROBE DATA
         SBO     STROBE        OUTPUT DATA WITH STROBE SET
*
* DELAY
WAITS    TB      BUSY          HANG IN LOOP ON BUSY
         JEQ     WAITS
*
* RESELECT ADDRESS SINCE STROBE ACCESS RETURNS TO ZERO
         SBO     ADD1          SELECT ADDRESS 2-010
*
* CONDITION DATA
         LDCR    @DLECHR,8     DLE CHARACTER IS IN DLECHR
*
* STROBE DATA
         SBO     STROBE        STROBE DATA
*
* DELAY
WAITD    TB      BUSY          HANG IN LOOP ON BUSY
         JEQ     WAITD
*
* THEN RESTORE STROBE TO ZERO
         SBZ     STROBE        RELEASE SCANNER
```

3.7 DATA TRANSFER FROM THE COMMUNICATIONS INTERFACE

Data transfer from the communications interface system is accomplished by a five-step process that is similar to the process for data transfer to the communications interface. The high-order byte of input word 1 is normally available to the program for examination. The following procedure should be observed to read the low-order bytes of the input words and the high-order byte of input word 0.

1. Use SBO instructions to select the address of the word to be read.
2. Strobe the module with an SBO instruction to Strobe.
3. Execute a delay for R/W Busy to Clear.
4. Read the input word by a TB or STCR instruction.
5. Use an SBZ instruction to release the Strobe.

Example: To test the self-test bit.

```
* SELECT ADDRESS
        SBO     ADD0        SELECT ADDRESS 1-001

* STROBE DATA
        SBO     STROBE      READ DATA
*
* WAIT FOR DATA AVAILABLE
WAIT02  TB      BUSY        WAIT FOR BUSY TO RETURN TO ZERO
        JEQ     WAIT02
*
* ACCESS DATA
        TB      TEST        IS SELF TEST MODE SELECTED
        . . .
* RELEASE STROBE
        SBZ     STROBE      SETS ADDRESS AND STROBE TO ZERO
```

Exceptions: To read or test the state of input word 1, no address selection, strobe, or delay is required if the strobe and address are zero.

```
* NO SELECTION, STROBE, NOR DELAY IS REQUIRED
        TB      DSR         ACCESS DATA SET READY
        . . .

* NO RELEASE IS REQUIRED
```

In accessing the module ID no strobe is required and strobe must be zero.

```
* SELECT ADDRESS
        SBO     ADD2        SELECT ADDRESS 6-110
        SBO     ADD1
*
* NO STROBE NOR DELAY IS REQUIRED - ACCESS DATA
        STCR    R0,8        PLACE ID CONTENTS IN R0-HIGH BYTE
*
```

```
* RESTORE ADDRESS - STROBE NOT ALLOWED
        SBZ     ADD2        RESELECT ADDRESS ZERO
        SBZ     ADD1
```

3.8 INITIALIZE COMMUNICATIONS INTERFACE MODULE

Following an RSET instruction, power application, or master reset, the communications interface system must be initialized to its operational (default) parameters. The following code initializes the system for synchronous mode operation.

```
* FIRST LOAD SYNC CHARACTER- DLE IS NOT TO BE LOADED
* REQUIRED ONLY IF SYNC MODE IS TO BE SELECTED
        SBO     ADD1        SELECT ADDRESS 2-010
        LDCR    @SYNCCH,8   SELECT SYNC CHARACTER
        SBZ     STROBE      OUTPUT SYNC CHARACTER
WATSYN  TB      BUSY        WAIT FOR COMPLETION
        JEQ     WATSYN
*
* THEN INITIALIZE OUTPUT WORD 4
* MASTER RESET MUST NOT BE ASSERTED
        SBO     ADD2        SELECT ADDRESS 5-101
        SBO     ADD0
        LDCR    @INITW4,8   LOAD INITIAL OW4 VALUE
*
* THEN INITIALIZE OUTPUT WORD 3 USING PREVIOUS ADDRESS
        SBZ     ADD0        SELECT ADDRESS 4-100
        LDCR    @INITW3,8   LOAD INITIAL OW3 VALUE
        SBZ     STROBE      OUTPUT DATA - RESET ADDRESS
WATOW3  TB      BUSY        AND WAIT FOR COMPLETION
        JEQ     WATOW3
*
* NOW INITIALIZE OUTPUT WORD 2
        SBO     ADD0        SELECT ADDRESS 1-001
        LDCR    @INITW2,8   LOAD INITIAL OW2 VALUE
        SBZ     STROBE      OUTPUT DATA - RESET ADDRESS
WATOW2  TB      BUSY        WAIT FOR OPERATION TO COMPLETE
        JEQ     WATOW2
*
* DEVICE IS INITIALIZED
```

Representative initial values are presented below for three different modes of operation. The first set of values is for full-duplex synchronous mode operation with ASCII SYNC characters with 8-bit characters and no parity selected. The second set of initial values is used for 3780/2780 EBDIC operation. The last set of values is to be used for TI 745 or TI 743 operation at 300 bps with parity to be checked and generated.

Full-Duplex Synchronous Operation

```
INITW2  BYTE    0       ALL BITS 0
INITW3  BYTE    >20     SYNCHRONOUS MODE SELECTION-ALL
                        ELSE ZERO
INITW4  BYTE    0       ALL BITS 0
SYNCH   BYTE    >16     ASCII SYNC CHARACTER
```

3780/2780 EBCDIC Operation

```
INITW2   BYTE   >0
INITW3   BYTE   >20          SYNC MODE
INITW4   BYTE   >48          HALF-DUPLEX ALT CLOCK ENABLE
SYNCH    BYTE   >32
```

TI 745 or TI 743 Operation

```
INITW2   BYTE   >28          EN PARITY, SBS
INITW3   BYTE   >0D          DIVIDE 600 BPS BY 2, ALT CLK
INITW4   BYTE   >01          600 BPS BASE RATE
SYNCH    BYTE   >00          NOT USED
```

3.9 ESTABLISH CONNECTION FOR INCOMING CALL

Assuming that the system has been initialized with no interrupts enabled, the following noninterruptible code sequence establishes the necessary connection for call acceptance.

```
* WAIT FOR RING
WATRNG  TB      RING        WAIT FOR INCOMING RING
        JNE     WATRNG      HANG IN LOOP, IN ZERO
*
* NOW ASSERT DATA TERMINAL READY
        SBO     ADD0        SELECT ADDRESS 1-001 (OW2)
        SBO     DTR         ASSERT DATA TERMINAL READY
        SBZ     STROBE      STROBE IT OUT
WAIT04  TB      BUSY        WAIT FOR COMPLETION
        JEQ     WAIT04
*
* THEN WAIT FOR DATA SET READY, WITH COUNT TIMEOUT
        LI      R0,TIME     INITIALIZE COUNTERS
        CLR     R1
TSTDSR  TB      DSR         COMPLETED?
        JEQ     CONNEC      YES, ASSUME CONNECTION COMPLETE
        DEC     R1          AND TEST FOR TIMEOUT COMPLETE
        JNE     TSTDSR      NO
        DEC     R0          TRY ADDITIONAL LEVEL
        JNE     TSTDSR      NOT YET
*
* THE TIMER HAS EXPIRED, DEASSERT DTR AND LOOK FOR RING
* SAME CODE IS USED FOR DISCONNECTION
DISCON  SBO     ADD0        SELECT ADDRESS 1
        SBZ     DTR         DEASSERT DTR
        SBZ     STROBE      STROBE IT OUT
WAIT05  TB      BUSY        WAIT FOR COMPLETION
        JEQ     WAIT05
        JMP     WATRNG      WAIT FOR ANOTHER RING
*
* THE CALL IS CONNECTED
CONNECT EQU     $
```

NOTE

Different modems may require slightly different code. In particular, some (such as the Bell Type 103) provide additional information (Data Carrier Detect), which provides a more positive indication of connection. For such a case, the code would be modified to test DCD rather than, or in addition to, DSR.

Also, leased line modems may provide noise on the RING lead.Since they are not switched line modems, establishment of a connection does not require waiting for RING, but merely setting DTR and delaying for DSR.

3.10 DATA TRANSMISSION

Transmission of data requires initiation of the system, transfer of the data through the system, and termination of the transfer. In this example, register R6 contains the transfer byte count and R5 contains the buffer address. The routine exits with R6 nonzero if an error occurs. Note that the INITIATION instructions are performed once to initiate the system. The TRANSFER instructions are repeated for each character transferred and then the TERMINATION instructions are performed once to shut down the system.

```
* INITIATE TRANSMISSION (INITIATION)
XMIT    SBO     ADD0        SELECT OUTPUT WORD 2
        SBO     RTS         SET REQUEST TO SEND
        SBZ     STROBE      STROBE THE MODULE
        SBO     ENWRQ       ENABLE TO TRANSMITTER
*
* TRANSMIT DATA CHARACTERS (TRANSFER)
LUPOUT  TB      WRQ         EXAMINE WRITE REQUEST
        JNE     LUPOUT      WAIT FOR WRITE REQUEST
*
* THEN TEST FOR COMPLETION
        MOV     R6,R6       TEST BY IF COUNT
        JEQ     TFINI       TERMINATE TRANSMISSION ON ZERO
*
* OUTPUT ONE CHARACTER SINCE THERE ARE MORE TO XMIT
        LDCR    *R5+,8      LOAD THE CHARACTER
        SBZ     STROBE      STROBE THE MODULE
        DEC     R6          DECREMENT COUNT
        JMP     LUPOUT      CONTINUE TRANSMISSION OF
                            CHARACTERS
*
* SHUTDOWN THE TRANSMITTER (TERMINATION)
TFINI   TB      TUNDER      EXAMINE TRANSMIT UNDER-RUN
        JNE     NOERR       NO ERROR PRESENT IF CLEAR
        INC     R6          INCREMENT COUNT (INDICATES ERROR)
NOERR   SBO     ADD0        SELECT OUTPUT WORD 2
        SBZ     RTS         RESET REQUEST TO SEND
        SBZ     STROBE      STROBE THE MODULE
        SBZ     ENWRQ       STOP TRANSMISSION
```

This example shows one more delay for WRQ than the actual count of characters in the data stream to be transmitted. This is due to the fact that the communications interface module delays resetting RTS until the last character in its serial transmission register has been transmitted. The transfer of a character from the parallel register to the serial register is completed upon the next setting of WRQ following the loading of the character. Certain modems may require additional delays to ensure that the last character is correctly transferred. This may be accomplished by the transmission of extra "pad" characters.

The previous sequence of code does not wait for the presence of clear to send since the necessary delay is performed by the communications interface module. This implies that any modem which is used with the communications interface module must provide an "on" state for Clear To Send when data may be transmitted, since software may not override the absence of Clear To Send.

The error test at the end of the sequence is necessary for synchronous data only.

3.11 DATA RECEPTION

Data reception, like data transmission, requires initiation, data transfer, and termination.[1] The sequences differ slightly for synchronous and asynchronous reception. The coding example which follows is for synchronous data reception. Instructions which would be omitted for asynchronous reception are indicated by * in the first column of the comments. For this example, R0 contains the buffer address, and R1 contains the maximum count of characters to be received. All leading SYNC characters are deleted and any imbedded SYNC characters are treated as data. R2 is used as an indicator to clear the Strip SYNC mode when data is received. If errors are detected, the routine exits with R2 nonzero.

```
* INITIATE RECEPTION (INITIATION)
RECV    SBO     ADD2        *SELECT ADDRESS 4-100
        SBO     STRSYN      *ASSERT STRIP SYNC
        SBZ     STROBE      *THEN STROBE IT OUT
RCVWAT  TB      BUSY        *AND WAIT FOR COMPLETION
        JEQ     RCVWAT      *
        SBO     ADD0        THEN SELECT ADDRESS 1-001
        SBO     ENRRQ       AND ENABLE RECEIVER
        SBZ     STROBE      AND STROBE IT IN
        SETO    R2          * AND SET CLEAR SS FLAG
*
* RECEIVE DATA CHARACTERS (TRANSFER/RECEPTION)
LUPIN   TB      RRQ         WAIT FOR CHARACTER PRESENT
        JNE     LUPIN
*
* A DATA CHARACTER IS PRESENT
        MOV     R2,R2       *TEST FOR STRIP SYNC CLEAR NECESSARY
        JEQ     GETCHR      *NOT REQUIRED
        SBO     ADD2        *SELECT ADDRESS 4-100
        SBZ     STRSYN      *THEN DEASSERT STRIP SYNC
        SBZ     STROBE      *AND STROBE IT OUT
        CLR     R2          *FLAG STRIP SYNC NOT REQD
WATRCV  TB      BUSY        *AND WAIT FOR OPERATION TO COMPLETE
        JEQ     WATRCV      *
*
```

[1] Note that the INITIATION instructions are performed once to initiate the transfer. TRANSFER/RECEPTION instructions are repeated once for each character and then the TERMINATION instructions are performed once to terminate reception.

```
* ACCESS THE DATA REGISTER
GETCHR  SBO     STROBE      STOP THE SCANNER
WATCHR  TB      BUSY        WAIT FOR OPERATION COMPLETE
        JEQ     WATCHR
        STCR    *R0+,8      READ THE CHARACTER AND STORE IT
        TB      RCVERR      TEST FOR ERROR PRESENT
        JEQ     ERRORP      ERROR PRESENT
*
* NO ERROR PRESENT
        SBZ     STROBE      RELEASE SCANNER
        DEC     R1          DECREASE COUNT
        JEQ     RFINI       COUNT COMPLETE
        JMP     LUPIN       CONTINUE TO RECEIVE
*
* AN ERROR IS PRESENT
ERRORP  SETO    R2          INDICATE PRESENCE OF ERROR
```

NOTE

If the type of error were important, code would be included here to detect the type of error.

```
* ERROR SVC COMPLETE
        SBZ     STROBE      RELEASE SCANNER
*
* TERMINATE RECEPTION
RFINI   SBO     ADD0        SELECT OUTPUT WORD 2
        SBZ     ENRRQ       DISABLE RECEIVER
        SBZ     STROBE      TERMINATE RECEPTION
WATFIN  TB      BUSY        EXAMINE BUSY BIT
        JEQ     WATFIN      DELAY FOR COMPLETION
```

A test for error should occur on each character and must be processed before Strobe is reset. The test for error type should be processed only when the RCVERR bit is set and in the following order:

1. Receive overrun.
2. Framing error (asynchronous mode only).
3. Parity error (only when both receive parity is selected, and not in transparent mode).

Other uses of the bits 12 and 13 of input word 0 do not cause assertion of the error summary bit (and would be tested only if the RCVERR bit were zero).

The state of any bit would be tested by the sequence:

```
        TB      X
        JNE     RTN01       (IF BIT IS NOT SET)
        JEQ     RTN02       (IF BIT IS SET)
```

3.12 TIMER SERVICE

The timer on the communications interface module is intended for interval service and is serviced in the following manner:

To activate the timer:

```
        SBO     ENTIME      START THE TIMER
```

To wait for completion:

```
WAITTM  TB      TIMER       AND WAIT FOR EXPIRATION
        JNE     WAITTM
```

To deactivate the timer:

```
        SBZ     ENTIME      DEACTIVATE TIMER
```

To reactivate the timer - whether expired or not:

```
        SBZ     ENTIME      DEACTIVATE TIMER
        SBO     ENTIME      AND RESTART IT
```

3.13 MODEM SERVICE

Modem service can be performed in a timer-driven (or sequential) fashion as in the call connection/disconnection example, or by using the new status flag (NSF):

To enable new status flag service:

```
        SBO     ENNSF       ENABLE NEW STATUS FLAG SERVICE
```

To wait for modem changes:

```
WATCHG  TB      NSF         HAVE ANY CHANGES OCCURRED
        JNE     WATCHG      DELAY UNTIL INDICATION OCCURS
```

To clear NSF and disable new status flag service:

```
        SBZ     ENNSF       CLEAR-DISABLE NSF
```

To clear NSF and continue service:

```
        SBO     ENNSF       CLEAR-ENABLE NSF
```

3.14 DEVICE INTERRUPT SERVICE

All the previous examples have assumed that the code sequences were noninterruptible. In order for interrupts to occur from the communications interface module, the following events must occur:

- Processor priority mask must be numerically greater than, or equal to communications interface module priority.
- Master Interrupt Enable (ENINT) on the communications interface module must be set.

- A flag which will cause an interrupt (NSF, TIMER, WRQ, RRQ) must be set. This implies the requirement of setting ENNSF, ENTIME, ENWRQ and RTS, and ENRRQ:

Interrupt	Enabling Mask(s)
NSF	ENNSF
TIMER	ENTIME
WRQ	ENWRQ and RTS
RRQ	ENRRQ

Figure 3-3 shows the sequence that may be used to write the interrupt service code.

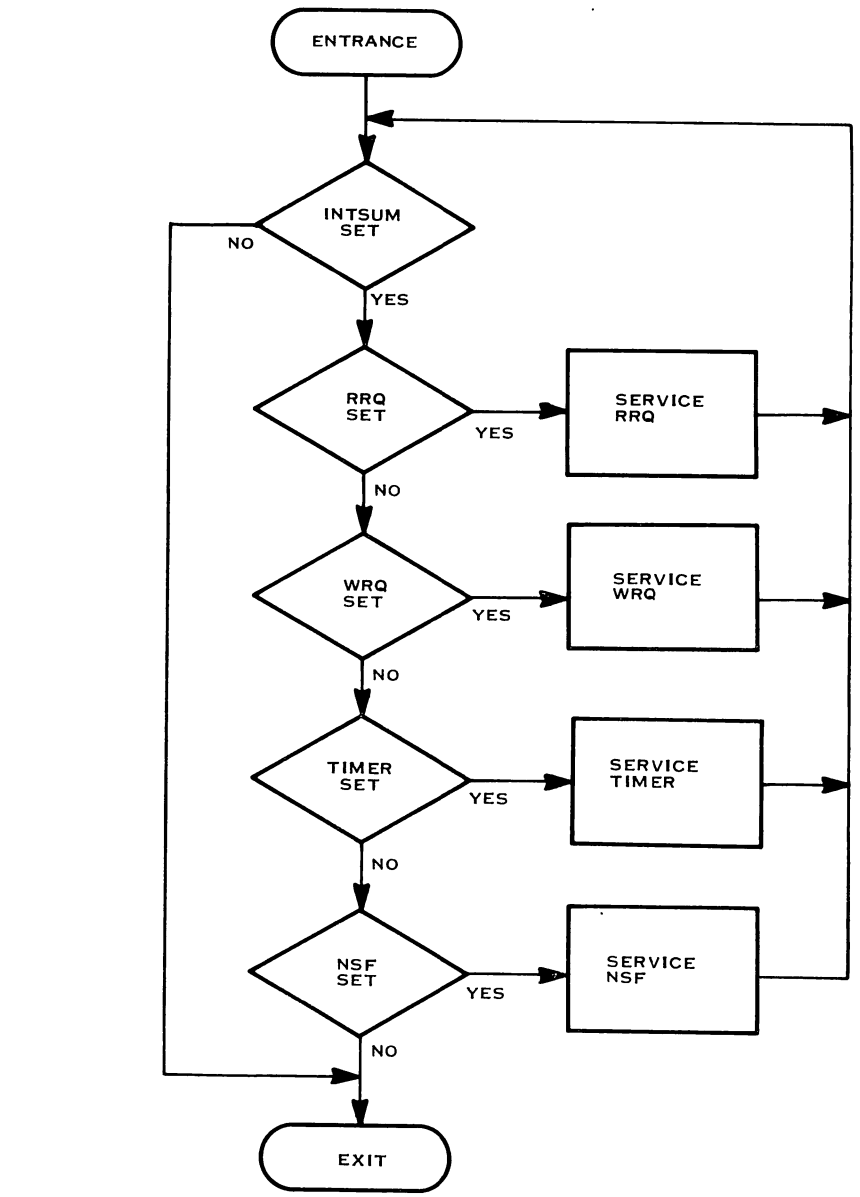


Figure 3-3. Interrupt Service Routine Flowchart

APPENDIX A

FCC RULES AND REGULATIONS

A.1 GENERAL

The Rules of the Federal Communications Commission (FCC) specify that the manufacturer/grantee must notify customers who are required to use FCC-registered equipment of certain provisions of Part 68 of the FCC Rules, and of certain instructional material which is contained in the attached technical manual. The paragraphs that follow contain excerpts from the FCC Rules.

A.2 FCC RULES SECTION 68.104 — MEANS OF CONNECTION

"(a) General

Except for telephone company-provided ringers and except as provided in subsection (c), all connections to the telephone network shall be made through the standard plugs and standard telephone company-provided jacks, or equivalent, described in Subpart F, in such a manner as to allow for easy and immediate disconnection of the terminal equipment. Standard jacks shall be so arranged that, if the plug connected thereto is withdrawn, no interference to the operation of equipment at the customer's premises which remains connected to the telephone network, shall occur by reason of such withdrawal.

(b) Data Equipment

Where a customer desires to connect data equipment which has been registered in accordance with Section 68.308(a) (4) (i) or (ii), he shall notify the telephone company of each telephone line to which he intends to connect such equipment. The telephone company, after determining the attenuation of such telephone line between the interface and the telephone company central office, will make such connections as are necessary in each standard data jack which it will install, so as to allow the maximum signal power delivered by such data equipment to the telephone company central office to reach but not exceed the maximum allowable signal power permitted at the telephone company central office."

A.3 STANDARD DATA JACKS

The Standard Data Jacks with which the FCC-registered model(s) of the coupler covered in the attached technical manual will connect are listed and briefly described in the manual.

A.4 FCC RULES SECTION 68.106 — NOTIFICATION TO TELEPHONE COMPANY

"Customers connecting terminal equipment to the telephone network shall, before such connection is made, give notice to the telephone company of the particular line(s) to which such connection is to be made and shall provide to the telephone company the F.C.C. Registration Number and the Ringer Equivalence Number of the registered terminal equipment or registered protective circuitry."

A.5 FCC REGISTRATION NUMBER AND RINGER EQUIVALENCE NUMBER

The FCC Registration Number and Ringer Equivalence Number are contained on the label on the registered equipment.

A.6 FCC RULES SECTION 68.108 — INCIDENCE OF HARM

"Should terminal equipment cause harm to the telephone network, the telephone company shall, where practicable, notify the customer that temporary discontinuance of service may be required; however, where prior notice is not practicable, the telephone company may temporarily discontinue service forthwith, if such action is reasonable in the circumstances. In case of such temporary discontinuance, the telephone company shall (1) promptly notify the customer of such temporary discontinuance, (2) afford the customer the opportunity to correct the situation which gave rise to the temporary discontinuance, and (3) inform the customer of his right to bring a complaint to the Commission pursuant to the procedures set out in Subpart E of this Part."

A.7 FCC RULES SECTION 68.110 — COMPATIBILITY OF THE TELEPHONE NETWORK AND TERMINAL EQUIPMENT

"(b) Changes in Telephone Company Facilities, Equipment, Operations or Procedures

The telephone company may make changes in its communications facilities, equipment, operations or procedures, where such action is reasonably required in the operation of its business and is not inconsistent with the rules and regulations in this Part. If such changes can be reasonably expected to render any customer's terminal equipment incompatible with telephone company communications facilities, or require modification or alteration of such terminal equipment, or otherwise materially affect its use or performance, the customer shall be given adequate notice in writing, to allow the customer an opportunity to maintain uninterrupted service."

A.8 FCC RULES, SECTION 68.218 (b) — INSTRUCTION TO USER

"(2) . . . registered terminal equipment or protective circuitry may not be used with party lines or coin lines.

(3) . . . when trouble is experienced the customer shall disconnect the registered equipment from the telephone line to determine if the registered equipment is malfunctioning and . . . if the registered equipment is determined to be malfunctioning, the use of such equipment shall be discontinued until the problem has been corrected.

(4) . . . the user must give notice to the telephone company in accordance with the requirements of Section 68.106."

APPENDIX B

USE OF RTC TELEPHONE

B.1 GENERAL

This appendix contains instructions for use of the Remote Telephone Connection (RTC) telephone set for users who order the set(s) as optional equipment. The instructions cover use of the telephone set regardless of the options ordered: however, certain instructions are only valid for use with a specific option. Those particular instructions are identified to avoid confusion.

B.2 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).

B.3 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).

B.4 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.

APPENDIX C

USOC JACKS

C.1 GENERAL

This appendix contains a table showing the Universal Service Order Code (USOC) jacks that a local telephone company will install to allow a user access to the public switched telephone network. Texas Instruments recommends use of the following two jacks listed in the table:

- For programmable data coupler configurations, TI recommends use of the RJ45S USOC jack.
- For permissive data coupler configurations, TI recommends use of the RJ11C USOC jack.

Table C-1. USOC Jacks

USOC	CONNECTION	MECHANICAL ARRANGEMENT	USEAGE
		SINGLE LINE PERMISSIVE (-9.0 dB max. signal output)	
RJ11W	Bridged Tip and Ring	6 position miniature jack	Non-key Tel. System portable wall mount
RJ11C	Same as RJ11W	6 position miniature jack	Non-key Tel. System all others
RJ12W	Tip & Ring ahead of line ckt., A-Al	6 position miniature jack	Key Tel. System portable
RJ12C	Same as RJ12W	6 position miniature jack	Key Tel. System all others
RJ13W	Tip & Ring behind line ckt., A-Al	6 position miniature jack	Key Tel. System portable
RJ13C	Same as RJ13W	6 position miniature jack	Key Tel. System all others
RJ16X	Same as RJ11 except provides MI-MIC	6 position miniature jack	Single line system allows connection of RJ36X
		SINGLE LINE FLL (3) AND PROGRAMMABLE	
RJ41S	Bridged Tip and Ring	(2) Universal Jack-8 pin, Keyed	FLL or Programmable
RJ42S	T & R ahead of line ckt., A-Al uses MI-MIC	Universal Jack-8 pin, Keyed	Key Tel-System-FLL or Programmable
RJ43S	T & R behind line ckt., A-Al uses MI-MIC	Universal Jack-8 pin, Keyed	Key Tel-System-FLL or Programmable
RJ51X(5)	T & R ahead of line ckt., A-Al & MI-MIC	50 position ribbon jack	Key Tel-System-FLL or Programmable
RJ52X(5)	Same as RJ53X except behind line	50 position ribbon jack	Key Tel-System-Programmable

Table C-1. USOC Jacks (Continued)

USOC	CONNECTION	MECHANICAL ARRANGEMENT	USEAGE
		SINGLE LINE PROGRAMMABLE ONLY	
RJ45S	Bridged Tip and Ring	8 pin Keyed miniature Prog. jack	Programmable only
RJ46S	T & R ahead of line ckt., A-Al	8 pin Keyed miniature Prog. jack	Key Tel-System-Programmable
RJ47S	T & R behind line ckt., A-Al	8 pin Keyed miniature Prog. jack	Key Tel-System-Programmable
		MULTI LINE PERMISSIVE (-9.0 dB max. signal output)	
RJ53X(5)	T & R ahead or line ckt., A-Al, MI-MIC(4)	50 position ribbon jack	Key Tel-System Prog. & MI
RJ54X(5)	Same as RJ53X except behind line	50 position ribbon jack	Key Tel-System Prog. & MI
		MULTI LINE FLL (3) AND PROGRAMMABLE	
RJ41M	Up to 8 lines T & R bridged	up to 8-Universal Jacks	FLL or Prog.
RJ42M	8 lines T & R ahead of line ckt., A-Al	up to 8-Universal Jacks	Key Tel-System FLL or Prog.
RJ26X	8 lines T & R bridged	one 50 pin pos. ribbon jack	FLL or Prog.
		MULTI LINE PROGRAMMABLE ONLY	
RJ45M	Up to 8 lines T & R bridged	up to 8 program jacks	Program only
RJ46M	Up to 8 lines T & R ahead of line A-Al	up to 8 program jacks	Key Tel-System for Prog.
RJ27X	8 lines T & R bridged	one 50 pin ribbon jack	Program only

Notes:

(1) Chart C is a listing of Universal Service Order Codes (USOC) for jacks which will be installed by local telephone companies. For detailed information on these jacks and installation refer to Federal Register Vol. 41, No. 134.

(2) Universal Jack can be used for both FLL and Programmable Data Access Arrangements.

(3) Fixed Loss Loop — Maximum signal output -4.0 dBm.

(4) MI-MIC are Mode Indication used for Hook switch status of an attached station telephone set.

(5) This configuration will normally use, in addition to the specified jack, a series jack designated *RJ36X*. For use with an associated telephone set having mode indication (EXCLUSION KEY).

ALPHABETICAL INDEX

INTRODUCTION

HOW TO USE THE 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 – References to Sections of the manual appear as "Section x" with the symbol x representing any numeric quantity.
- Appendixes – References to Appendixes of the manual appear as "Appendix y" with the symbol y representing any capital letter.
- Paragraphs – References 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 is 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 are preceded by the word "See" followed by the referenced entry.

USER'S RESPONSE SHEET

Manual Title: Model 990 Computer Communications System

Installation and Operation (945409-9701)

Manual Date: 15 May 1979 **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.

CUT ALONG LINE

Location in Manual	Comment/Suggestion
_____	_____
	_____
	_____
	_____
_____	_____
	_____
	_____
	_____
	_____
_____	_____
	_____
	_____
	_____

NO POSTAGE NECESSARY IF MAILED IN U.S.A.
FOLD ON TWO LINES (LOCATED ON REVERSE SIDE), TAPE AND MAIL

FOLD

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 7284 DALLAS, TX

POSTAGE WILL BE PAID BY ADDRESSEE

TEXAS INSTRUMENTS INCORPORATED
DIGITAL SYSTEMS GROUP
ATTN: TECHNICAL PUBLICATIONS
P.O. Box 2909 M/S 2146
Austin, Texas 78769

FOLD

TEXAS INSTRUMENTS
INCORPORATED
DIGITAL SYSTEMS DIVISION
POST OFFICE BOX 2909 AUSTIN, TEXAS 78769