Systems

**IBM 3704 and 3705
Communications Controllers
Original Equipment
Manufacturers' Information**

IBM

Preface

This reference publication provides information to assist OEM engineers and IBM engineers in designing compatible interfaces that can be attached to the IBM 3704 and 3705 Communications Controllers. The reader should have a knowledge of teleprocessing and telecommunications, and should be familiar with the terminology and concepts presented in the prerequisite publications:

Introduction to the IBM 3704 and 3705 Communications Controllers, GA27-3051

IBM 3704 and 3705 Communications Controllers Principles of Operation, GC30-3004

A related publication is:

Planning and Installation of a Data Communications System Using IBM Line Adapters, GA24-3435

This publication is divided into four sections:

- Section 1 is the introduction.
- Section 2 describes the IBM 3704 and 3705 communication interfaces.
- Section 3 contains charts showing examples of interface sequences between the IBM 3704 and 3705 Communications Controllers and the communication line.
- Section 4 describes the interface cables for the IBM 3704 and 3705 Communications Controllers.

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Abbreviations

ACK	acknowledge character
ACO	Automatic Call Originate
ACR	Abandon Call and Retry
ACU	Automatic Calling Unit
AGC	automatic gain control
BCC	block check character
BCD	binary coded decimal
bps	bits per second
CCITT	International Telephone and Telegraph Consultive Committee
char	character
chg	change
clk	clock
conn	connector
COS	Call Origination Status
CPU	central processing unit
CRQ	Call Request
ctrl	control
CTS	Clear to Send
DLE	data link escape
DLO	Data Line Occupied
DOS	Disk Operating System
DPR	Digit Present
DSR	Data Set Ready
DTR	Data Terminal Ready
EBCDIC	Extended Binary Coded Decimal Interchange Code
EIA	Electronic Industries Association
ENQ	enquiry
EP	Emulation Program
EPO	emergency power off
ETX	end of text
ICW	interface control word
IPL	initial program load
LCD	line control definer
LIB	line interface base
mA	milliampere
max	maximum
MIL-STD	Military Standard
min	mimimum
ms	millisecond
N/A	not available
No.	number
OEM	Original Equipment Manufacturers
OS	Operating System
opt	optional
osc	oscillator
P/N	part number
PCF	primary control field
PDF	parallel data field
pF	picofarad
PND	Present Next Digit
PWI	Power Indication
rcv	receive
req	request
RS	Recommended Standard
SCR	Serial Clock Receive
SCT	Serial Clock Transmit
SD	Send Data
SDF	serial data field
sec	second
sel	select
SR	Send Request
std	standard
STX	start of text
svc	service
SYN	synchronous idle character
µs	microsecond

Summary of Amendments for GA27-3053-2

Information that describes LIBs 5, 6, 7, 8, and 9 with associated Line sets 1H, 5A, 5B, 6A, 8A, 8B, and 9A has been added.

Information has been added about the IBM 3704 and references to the IBM 3704 have been incorporated where applicable.

Summary of Amendments for GA27-3053-1

Three sections have been added that describe new interfaces to the 3704 and 3705 Communications Controllers:

MIL STD 188C Interface
CCITT V.35 Interface
Low-Speed Full-Duplex Interface

Line sets 1B, 1J, and 1K have been added to the line sets available with the 3704 and 3705 Communications Controllers.

Other minor additions and corrections have also been added with this edition.

Introduction

The IBM 3704 and 3705 Communications Controllers are transmission control units with a resident control program. Because of the many variations that can be obtained with different programs, the information contained in this manual is valid only when using the IBM-supplied Emulation Program or Network Control Program. Alteration of these programs can affect these specifications.

The IBM 3704 and 3705 provide for the connection and control between a variety of local or remote input/output devices and a system processor. A control program, residing in the IBM 3704 and 3705, performs many of the functions previously performed by the transmission control unit hardware.

For a description of the IBM 3704 and 3705 hardware and program capabilities, refer to *Introduction to the IBM 3704 and 3705 Communications Controllers,* GA27-3051.

Channel Interface

Two types of channel adapters are available for the IBM 3705; only one type is available for the 3704. The Type 1 Channel Adapter provides attachment to an IBM System/360 or System/370 byte-multiplexer channel. The Type 2 Channel Adapter (available only on the 3705) provides attachment to an IBM System/370 selector channel, byte-multiplexer channel, or block-multiplexer channel.

Channel Interface Signal Lines. Except for 'select out' and 'select in', the maximum allowable internal resistance (including all contact resistance) for every signal line is less than 1.0 ohms. The combined 'select out' and 'select in' maximum resistance is less than 1.5 ohms. For a detailed description of the channel interface, refer to *IBM System/360 and System/370 Interface Channel to Control Unit—Original Equipment Manufacturers' Information,* GA22-6974.

Communication Interfaces

This section describes the interfaces between the IBM 3704 and 3705 Communications Controllers and the external communication facilities.

Line Set Descriptions

Line sets provide for the attachment of communication lines to the IBM 3704 and 3705. The types of line sets are as follows:

Line Set 1A (Low–Speed External Modem Attachment). This line set provides for the attachment of two start-stop lines at speeds up to 1,200 bps, each line having an EIA RS-232C/CCITT V.24 interface for attachment to an external modem.

Line Set 1B (Low–Speed Full–Duplex Data External Modem Attachment). This line set provides for attaching one full-duplex data start-stop leased or switched line at speeds up to 1,200 bps. The line set has an EIA RS232C/CCITT V.24 interface for attachment to a single external modem. The 3704 and 3705 control program must condition this line interface for business machine clock control.

This line set consists of two addresses. The low-order address is the transmit address and the high-order address is the receive address.

Line Set 1C (Low–Speed Local Attachment). This line set provides for the local attachment of two IBM start-stop terminals at speeds up to 1,200 bps via IBM-provided cables. Modems are not required. Total cable length may not exceed 200 feet.

Line Set 1D (Medium–Speed External Modem Attachment). This line set provides for the attachment of two start-stop or synchronous lines at speeds up to 7,200 bps, each line having an EIA RS-232C/CCITT V.24 interface for attachment to an external modem. Speeds above 2,400 bps require modem clocking.

Line Set 1E (Auto Call Adapter). This line set provides two EIA RS-366 interfaces for the attachment of two external calling units. These automatic calling units can be associated with any switched-network lines attached through Line Sets 1A, 1B, 1D or 1G. Line Set 1E is available only in the United States and Canada.

Line Set 1F (Medium–Speed Local Attachment). This line set provides for the local attachment of two IBM synchronous terminals at speeds up to 2,400 bps via IBM-provided cables. Modems are not required. Total cable length may not exceed 100 feet. The attached terminal must provide its own clocking.

Line Set 1G (High–Speed External Modem Attachment). This line set provides for the attachment of one synchronous line for operation at speeds up to 50,000 bps. This line set has an interface for attachment to a switched or private-line wideband external modem.

Line Set 1H (Medium–Speed Duplex External Modem). This line set provides for the attachment of one duplex synchronous communication line at speeds up to 7,200 bps. The Line Set has an EIA RS-232C interface for attachment to an external modem.

Line Set 1J (MIL-STD-188C Interface). For a description of this line set, see "MIL-STD-188C Interface" in this chapter.

This line set differs from other IBM 3704 and 3705 line sets because it does not include an external cable.

Line Set 1K (CCITT V.35 Interface). For a description of this line set, see "CCITT V.35 Interface" in this chapter.

This line set cannot be used if the type 1 communication scanner is installed on the IBM 3704 and 3705.

Line Set 2A (Telegraph Single Current). This line set provides for the attachment of two single-current leased telegraph lines that can operate at speeds up to 100 bps. Each line can be wired for 20 mA, 40 mA, or 62.5 mA single current termination.

Line Set 3A (Limited Distance Type 1 Line Adapter, 2-wire). This line set provides for the attachment of two start-stop lines at speeds up to 134.5 bps. The line set includes two IBM Limited Distance Type 1 (2-wire) line adapters. No external modems are required.

Line Set 3B (Limited Distance Type 1 Line Adapter, 4-wire). This line set provides for the attachment of two start-stop lines at speeds up to 134.5 bps. This line set includes two IBM Limited Distance Type 1 (4-wire) line adapters. No external modems are required.

Line Set 4A (Limited Distance Type 2 Line Adapter, 2-Wire). This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. The line set includes two IBM Limited Distance Type 2 line adapters. No external modems are required.

Line Set 4B (Leased Line Adapter, 2-wire). This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. The line set includes two IBM Leased Line (2-wire) line adapters. No external modems are required.

Line Set 4C (Leased Line Adapter, 4-wire). This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. This line set includes two IBM Leased Line (4-wire) line adapters. No external modems are required.

Line Set 5A (2400 bps Leased Line Integrated Modem, Point to Point--IBM 3705 only). This line set provides for the attachment of one synchronous leased line at 2400/1200 bps. The line set includes an IBM 2,400 bps, integrated modem with receive equalization. No external modem is required.

Line Set 5B (2400 bps Leased Line Integrated Modem, Multipoint Control--IBM 3705 only). This line set provides for the attachment of one synchronous leased line at 2400/1200 bps. The line set includes an IBM 2,400 bps integrated modem with no equalization. No external modem is required.

Line Set 6A (2400 bps Switched Network Integrated Modem--IBM 3705 only). This line set provides for the attachment of one half-duplex synchronous switched line at 2400/1200 bps. The line set includes an IBM 2,400 bps integrated modem with automatic answering and automatic equalization. No external modem is required. Line Set 6A is available only in the United States and Canada.

LIB Type 7 (2400 bps Switched Network Integrated Modem with Automatic Call Originate--IBM 3705 only). This LIB provides a single line set for the attachment of one half-duplex synchronous switched line at 2400/1200 bps with Automatic Call Originate (ACO). This line set includes an IBM 2,400 bps integrated modem with automatic answering, automatic call originate (under proper control), and automatic equalization. No external Modem or automatic calling unit is required. LIB Type 7 is available only in the United States and Canada.

Line Set 8A (1200 bps Leased Line Integrated Modem--IBM 3705 only). This line set provides for the attachment or two synchronous leased lines at speeds up to 1,200 bps. This line set includes two IBM 1,200 bps integrated modems. No external modems are required.

Line Set 8B (1200 bps Switched Network Integrated Modem--IBM 3705 only). This line set provides for attachment of two half-duplex synchronous switched lines at speeds up to 1,200 bps. This line set includes two IBM 1,200 bps integrated modems with automatic answering. No external modems are required. Line set 8B is available only in the United States and Canada.

Line Set 9A (1200 bps Switched Network Integrated Modem with Automatic Call Originate--IBM 3705 only). Line Set 9A provides for attachment of one half-duplex synchronous switched line at speeds up to 1200 bps. This line set includes an IBM Integrated Modem with automatic answering and automatic call origination. No external modem or automatic calling unit is required. Line Set 9A is available only in the United States and Canada.

EIA RS-232C/CCITT V.24 Interface

The IBM 3704 and 3705 Communications Controllers provide an EIA Recommended Standard 232C and CCITT Recommendation V.24 type interface for attachment to external modems. The following list shows the interface lines that are used by the IBM 3704 and 3705.

Pin Number	EIA/CCITT Circuit	Line Description	Line Set 1A or 1B	1D or 1H
2	BA/103	Transmitted Data	STD	STD
3	BB/104	Received Data	STD	STD
4	CA/105	Request to Send	STD	STD
5	CB/106	Clear to Send	STD	STD
6	CC/107	Data Set Ready	STD	STD
7	AB/102	Signal Ground	STD	STD
8	CF/109	Received Line Signal Detector	OPT	OPT
14	Special**	New Sync	N/A	OPT
15	DB/114	Transmitter Signal Element Timing	N/A	OPT
17	DD/115	Receiver Signal Element Timing	N/A	OPT
18	Special**	Modem Wrap (Local Test)	N/A	OPT
20	CD/108*	Data Terminal Ready	STD	STD
22	CE/125	Ring Indicator	N/A	OPT
23	CH/111	Data Signal Rate Selector	N/A	OPT

*Circuit CD/108 is available in the Connect-Data-Set-to-Line option (CCITT 108.1) or the Data-Terminal-Ready (CCITT 108.2) option. Connect Data Set to

Line (CCITT 108.1) can be used only with Line Set 1D because circuit CE/125 is required to use this option.

**Special—These circuits are not defined by RS-232C or CCITT V.24.

STD signals are those signals that the line set always presents to or expects to receive from the external modem or autocall unit.

OPT signals are those signals that the line set is capable of presenting to or receiving from the external modem or autocall unit, but whose use depends upon the type of modem, communication facility, program support, etc., used.

N/A are those signals not available on the line set.

Line Descriptions

Transmitted Data (BA/103). This circuit transfers data from the IBM 3704 and 3705 to the modem for transmission on the communication channel. The IBM 3704 and 3705 holds circuit BA/103 in the Mark condition when no signals are to be transmitted, or when any of the following circuits is in an OFF condition:

Request to Send	CA/105
Clear to Send	CB/106
Data Set Ready	CC/107
Data Terminal Ready	CD/108

Received Data (BB/104). The modem generates signals on this circuit in response to data signals received from the communication channel.

Request to Send (CA/105). The IBM 3704 and 3705 generate signals on this circuit to condition the local modem for data transmission and, on a half-duplex channel, to control the direction of data transmission of the local modem.

Clear to Send (CB/106). The modem must present signals on this circuit to the IBM 3704 and 3705, indicating whether or not the modem is ready to transmit data.

The ON condition, together with the ON condition on interchange circuits CA/105, CC/107, and CD/108, indicates to the IBM 3704 and 3705 that signals presented on circuit BA/103 (Transmitted Data) will be transmitted to the communication channel.

The ON condition of circuit CB/106 is a response to a concurrent ON condition of circuit CC/107 (Data Set Ready) and circuit CA/105 (Request to Send), delayed as may be appropriate to the modem. This delay is used to establish a data communication channel to remote data equipment, and includes the removal of the MARK HOLD clamp from the Received Data interchange circuit of the remote modem.

Data Set Ready (CC/107). The modem generates signals on this circuit to indicate its status.

The ON condition on this circuit must be presented to the IBM 3704 and 3705 when:

a) The local modem is connected to a communication channel ('OFF HOOK' in switched service).

AND b) The local modem is not in test (local or remote), talk (alternate voice), or dial mode.

AND c) The local modem has completed, where applicable:

1. Any timing functions required by the switching system to complete call establishment, and
2. The transmission of any discrete answer tone, the duration of which is controlled solely by the local modem.

If the local modem does not transmit an answer tone, or if the duration of the answer tone is controlled by some action of the remote modem, the ON condition must be presented as soon as all the other above conditions (a, b, and c-1) are satisfied.

Signal Ground (AB/102). This conductor establishes the common ground reference for all interface lines.

Received Line Signal Detector (CF/109). The modem generates signals on this circuit. The ON condition on this circuit is present when the modem is receiving a signal that meets its suitability criteria. These criteria are established by the modem manufacturer.

New Sync (Pin 14). To allow for faster receiver bit synchronization for subsequent messages, the IBM 3704 and 3705 may provide signals on this circuit that may be used by the modem to squelch the receiver signal element timing clock.

Transmitter Signal Element Timing (DB/114). Signals on this circuit, when generated by synchronous modems, are used to provide the IBM 3704 and 3705 with 'signal element timing' information. The IBM 3704 and 3705 change the transmitted data signals simultaneously with *OFF to ON* transitions of this circuit. The modem must sample bits with the *ON to OFF* transitions on circuit DB/114. The *ON to OFF* transitions should occur in the center of each signal element. The Transmitter Signal Element Timing pulses must have an accuracy of 0.01%. This timing signal must be a square wave form with a duty cycle of 50% ±10%. Transmitter Signal Element Timing pulses, when provided by a modem, must be continuous whenever circuit CC/107 (Data Set Ready) is ON.

Receiver Signal Element Timing (DD/115). Signals on this circuit, when generated by synchronous modems, are used to provide the IBM 3704 and 3705 with 'received signal element timing' information. The transition from ON to OFF must indicate the center of each signal element on circuit BB/104 (Received Data). This signal, when provided to the IBM 3704 and 3705, must be continuous during a receive operation.

Modem Wrap (Local Test Pin 18). The IBM 3704 and 3705 may provide signals on this circuit. An active level indicates that diagnostic mode has been set in the IBM 3704 and 3705 line interface and that the modem should go into local test.

Connect Data Set to Line (CD/108.1). The IBM 3704 and 3705 generate signals on this circuit to control the switching of the modem to the communication channel. The ON condition must cause the modem to connect to the communication channel and to maintain this connection.

The OFF condition must cause the modem to be removed from the communication channel following the completion of any "in process" transmission. The OFF condition must not disable the operation of circuit CE/125 (Call Indication).

When circuit CD/108.1 is turned OFF, it is not turned ON again until circuit CC/107 is turned OFF.

Data Terminal Ready (CD/108.2). The IBM 3704 and 3705 generate signals on this circuit to control the switching of the modem to the communication channel. The ON condition must (1) prepare the modem to be connected to the communication channel, and (2) maintain an established connection.

If the station is equipped for automatic answering of received calls and is in the automatic answering mode, connection to the line occurs only in response to a combination of a ringing signal and the ON condition of circuit CD/108.2 (Data Terminal Ready). The IBM 3704 and 3705 may present an ON condition on circuit CD/108.2 (1) whenever it is ready to transmit or receive data, or (2) in response to an ON condition on circuit CE/125 (Ring Indicator).

The OFF condition must cause the modem to be removed from the communication channel following the completion of any "in process" transmission. The OFF condition must not disable the operation of circuit CE/125 (Ring Indicator).

In switched network applications, when circuit CD/108.2 is turned OFF, it *is not* turned ON again until circuit CC/107 (Data Set Ready) is turned OFF by the communication equipment.

Ring Indicator (CE/125). The modem generates signals on this circuit to indicate to the IBM 3704 and 3705 that a ringing signal is being received by the modem.

Data Signal Rate Selector (CH/111). The IBM 3704 and 3705 may generate signals on this circuit that may be used by the modem to select between two operating speeds, if the modem is equipped to operate at more than one speed.

Electrical Characteristics

The IBM 3704 and 3705 modem interfaces comply with the electrical requirements of RS-232C and CCITT V.24 as highlighted in the following paragraphs.

All voltages are measured at the connector with respect to Signal Ground (AB). The output line delivers between 5 volts and 15 volts into a resistance of at least 3,000 ohms, but not more than 7,000 ohms. The input circuit responds to a voltage between 3 volts and 25 volts. The polarity of the signals depends on the following:

Polarity	Data	Logic	Control
+	Space	0	ON
−	Mark	1	OFF

The terminating impedance of the receiving end of the interchange circuit must be at least 3,000 ohms but not more than 7,000 ohms. The capacitance measured at the interface connector should not exceed 2,500 pF. The open-circuit voltage of the input circuits should not exceed 2 volts of either polarity. A short circuit between any two conductors (including ground) must not result in a current in excess of one-half ampere.

For the data and timing circuits, the rise and fall time through the +3 volt to -3 volt range should not exceed one millisecond or three percent of the nominal bit time, whichever is less. Conversely, the maximum instantaneous rate of change (skew rate) through the transition region, +3 volts to -3 volts, must not exceed 30 volts/microsecond.

The following control lines, when used, are considered 'failsafe' lines:

Request to Send (CA/105)
Data Set Ready (CC/107)
Data Terminal Ready (CD/108)

The power-off source impedance of the sending end of the 'fail-safe' lines should be at least 300 ohms, measured at an applied voltage not greater than ±2 volts.

Local Attachment Interfaces

The local attachment interfaces allow local attachment of IBM terminals through IBM-provided cables. Modems are not required, and the total cable length may not exceed 200 feet for Line Set 1C or 100 feet for Line Set 1F. The signal lines are described in "EIA RS-232C/CCITT V.24 Interface" and are shown in Figures 1 and 2. Although the Line Set 1C signal lines are as described in "EIA RS232C/CCITT V.24 Interface", the electrical characteristics at the end of 200 feet of cable differ from the standard.

Line Set 1F electrical characteristics differ from the standard at the end of 100 feet of cable.
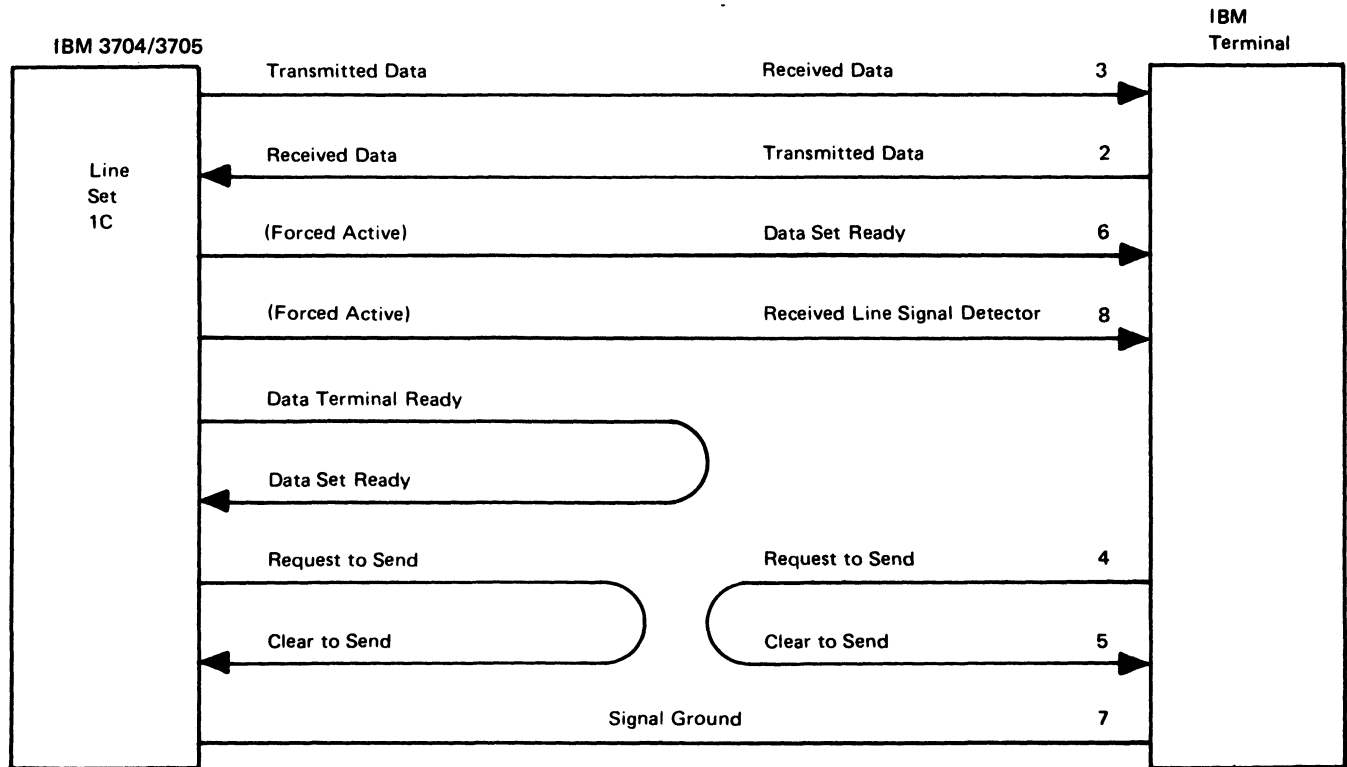
Figure 1. Local Attachment Interface—Line Set 1C

IBM 3704/3705 ... IBM Terminal

Line Set 1F

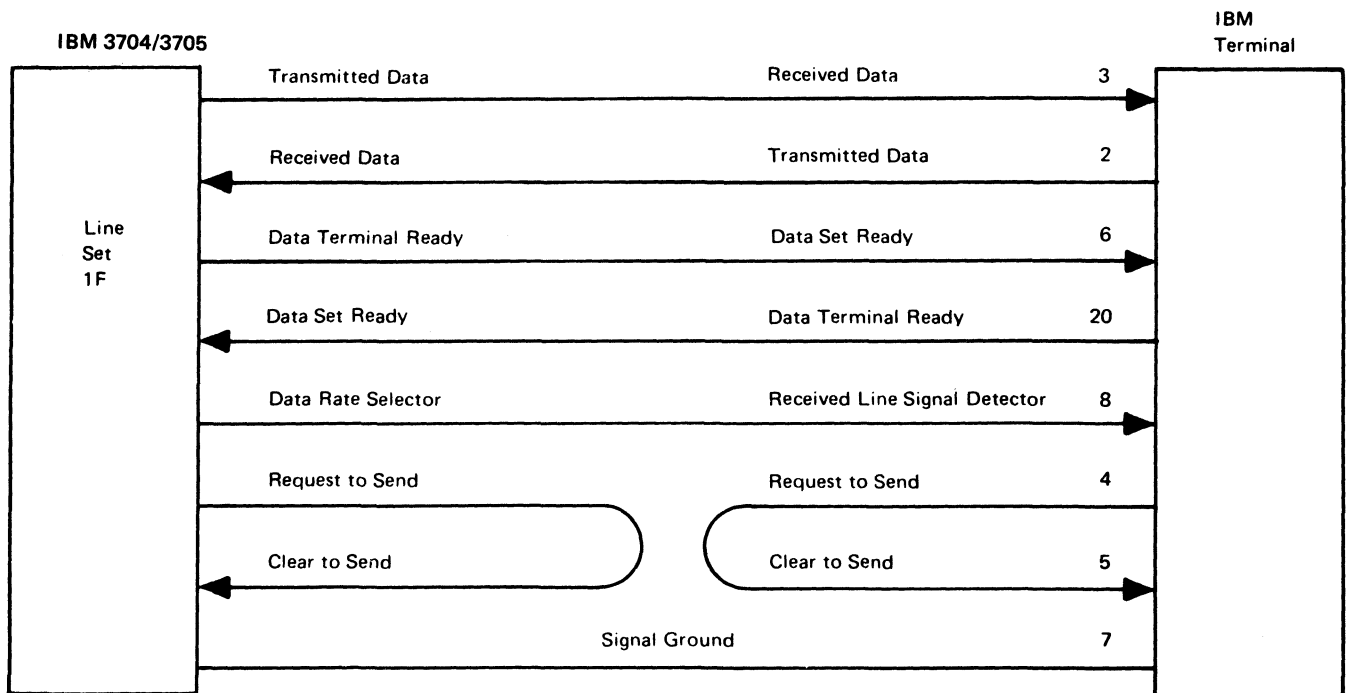| Transmitted Data | Received Data | 3 |
Received Data	Transmitted Data	2
Data Terminal Ready	Data Set Ready	6
Data Set Ready	Data Terminal Ready	20
Data Rate Selector	Received Line Signal Detector	8
Request to Send	Request to Send	4
Clear to Send	Clear to Send	5
Signal Ground		7

Figure 2. Local Attachment Interface—Line Set 1F

Low-Speed Full-Duplex Interface

The low-speed full-duplex interface provides an EIA RS 232C/CCITT V.24 interface for simultaneous transmit and receive operations. The interface (Line Set 1B) lines are described in "EIA RS 232C/CCITT V.24 Interface" and are shown in Figure 3.

IBM 3704/3705   Modem

Line Set 1B

        B02   Transmitted Data   Received Data   2
        B05   Clear to Send   5
        B06   Request to Send   4
        B08   Data Set Ready
Transmit Line
Low-Order Address
        D03   Data Terminal Ready
        D08   Signal Ground   7
        J03   Data Terminal Ready   Data Set Ready   20

Line Set 1B
        J02   Receive Signal Detector   8
        G04   Received Data   Transmitted Data   3
Receive Line
High-Order Address
        G08   Data Set Ready   Data Terminal Ready   6
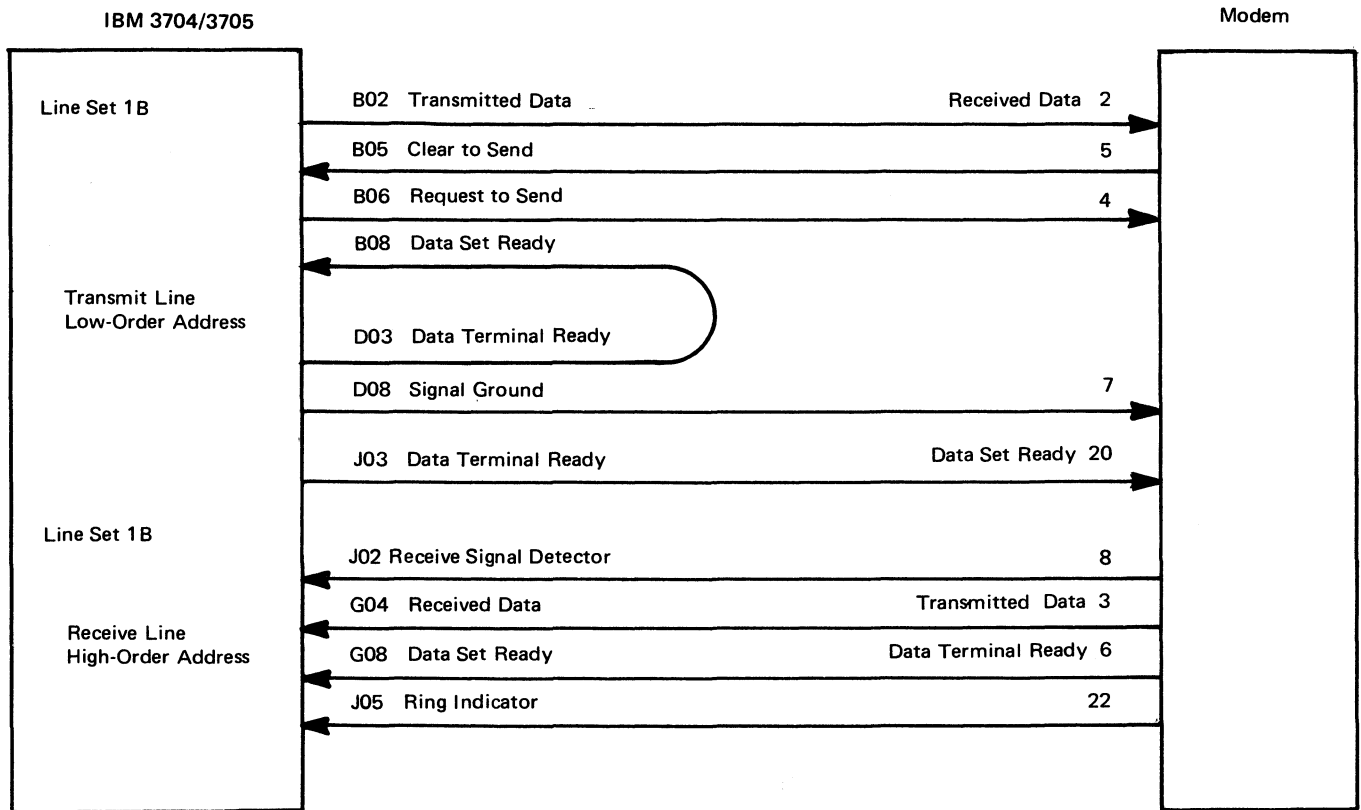   J05   Ring Indicator   22

Figure 3. Low-Speed Full-Duplex—Line Set 1B

Medium-Speed Full-Duplex Interface

The medium-speed full-duplex interface provides an EIA RS-232C/V.24 CCITT interface for simultaneous transmit and receive operations at speeds up to 7200 bps. The interface lines (Line Set 1H) are described in "EIA RS-232C/V.24 Interface" and are shown in Figure 4.
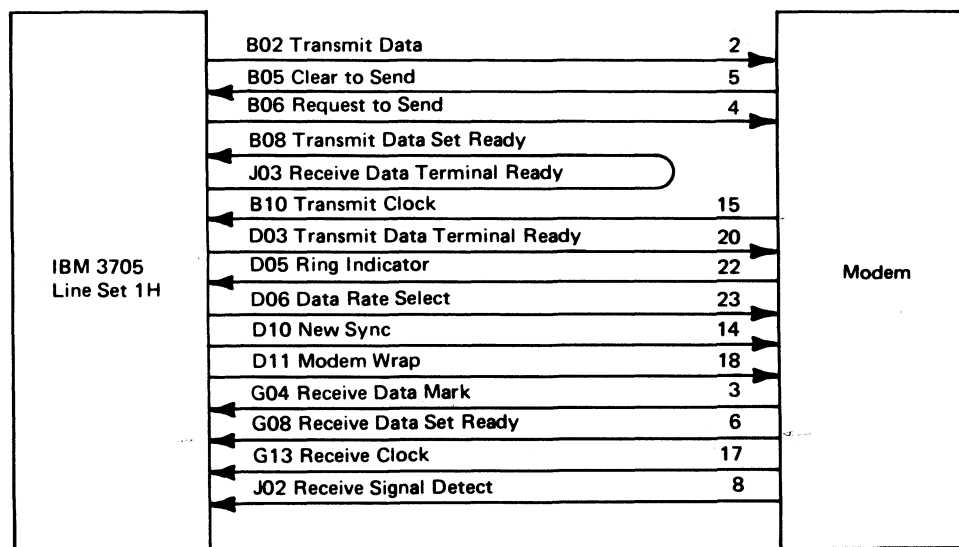
                B02 Transmit Data   2
                B05 Clear to Send   5
                B06 Request to Send   4
                B08 Transmit Data Set Ready
                J03 Receive Data Terminal Ready
                B10 Transmit Clock   15
                D03 Transmit Data Terminal Ready   20
IBM 3705   D05 Ring Indicator   22   Modem
Line Set 1H   D06 Data Rate Select   23
                D10 New Sync   14
                D11 Modem Wrap   18
                G04 Receive Data Mark   3
                G08 Receive Data Set Ready   6
                G13 Receive Clock   17
                J02 Receive Signal Detect   8

Figure 4. Medium-Speed Full-Duplex Line Set 1H

Automatic Calling Unit (ACU) Interface

The IBM 3704 and 3705 Communications Controllers provide an EIA RS-366 type interface for attachment of external automatic calling units (ACU). The following list shows the interface lines used by the IBM 3704 and 3705.

Pin Number	EIA/CCITT Circuit	Line Description
2	DPR/211	Digit Present
3	ACR/205	Abandon Call and Retry
4	CRQ/202	Call Request
5	PND/210	Present Next Digit
6	PWI/213	Power Indication
7	AB/201	Signal Ground
13	COS/204	Call Origination Status
14	NBI/206	Digit Signal Circuit
15	NB2/207	Digit Signal Circuit
16	NB4/208	Digit Signal Circuit
17	NB8/209	Digit Signal Circuit
22	DLO/203	Data Line Occupied

Line Descriptions

Digit Present (DPR/211). The IBM 3704 and 3705 generate signals on this circuit in response to an ON condition on the Present Next Digit (PND) line. Digit Present (DPR) indicates to the ACU that the digit, as presented, is valid. Once the DPR line is turned ON, it stays ON until the Present Next Digit (PND) line goes OFF, or until the IBM 3704 and 3705 terminate the call. When PND goes OFF, the DPR line is immediately turned OFF and is not turned ON again until the PND line has been turned ON and the next digit is valid.

Abandon Call and Retry (ACR/205). The ACU generates signals on this circuit to indicate that the call was not completed within a preset time limit. The IBM 3704 and 3705 abort the call in response to and ON condition on this line.

Call Request (CRQ/202). The IBM 3704 and 3705 generate signals on this circuit to request the ACU to originate a call. Call Request remains ON throughout the dialing procedure; it is turned OFF either after the ACU turns ON Call Origination Status, or when the IBM 3704 and 3705 terminate the call attempt.

Present Next Digit (PND/210). The ACU generates signals on this circuit which must be turned ON when the ACU is ready to accept a digit and when the DPR line is OFF. The PND line must remain ON until (1) the DPR line is activated, and the digit has been accepted by the ACU, or (2) the IBM 3704 and 3705 terminate the call.

Power Indication (PWI/213). The ACU generates signals on this circuit which must be ON as long as power is available in the ACU. The ACU should indicate that it is inoperative by presenting an OFF signal on PWI.

Signal Ground (AB/210). This conductor establishes the common ground reference for all interface lines.

Call Orgination Status (COS/204). The ACU generates signals on this circuit to indicate the status of the automatic call origination procedures. The ON condition, during an automatic call procedure, indicates that (1) the ACU has completed its calling function and (2) control of the communication channel has been transferred to the modem interface.

Note: *If Data Terminal Ready is not ON when COS comes ON, the call should be disconnected immediately.*

Digit Leads (NB1/206, NB2/207, NB4/208, NB8/209). The IBM 3704 and 3705 generate signals on these circuits to present the dialing digit in binary form to the ACU. (The low-order position is NB1.)

Data Line Occupied (DLO/203). The ACU generates signals on this circuit to indicate the condition of the communication channel. The ON condition indicates that the communication channel is in use for calling, data communication, voice communication, or testing. The OFF condition indicates that that the ACU may originate a call if PWI is active.

Electrical Characteristics

The IBM 3704 and 3705 interfaces to external automatic calling units complies with the electrical requirements of EIA RS-366 as highlighted in the following paragraphs.

All voltages are measured at the connector with respect to Signal Gound (AB). The output line delivers between 5 volts and 15 volts into a resistance of at least 3,000 ohms but not more than 7,000 ohms. The input circuit responds to voltage between 3 volts and 25 volts. The polarity of the signals depends on the following:

Polarity	Data (Dial Digits)	Logic	Control
+	Space	0	ON
−	Mark	1	OFF

The terminating impedance of the receiving end of the interchange circuit must be at least 3,000 ohms but not more than 7,000 ohms. The capacitance measured at the interface connector should not exceed 2,500 pF. The open-circuit voltage of the imput circuits should not exceed 2 volts of either polarity. A short circuit between any two conductors (including ground) must not result in a current in excess of one-half ampere.

For the data and timing circuits, the rise and fall time through the +3 volt to −3 volt range should not exceed either one millisecond or three percent of the nominal bit time, whichever is less. Conversely, the maximum instantaneous rate of change (skew rate) through the transition region, +3 volts to −3 volts, must not exceed 30 volts/microsecond.

The following control lines, when used, are considered 'failsafe' lines:

  Call Request (CRQ/202)
  Power Indication (PWI/213)

The power-off source impedance of the sending end of the 'failsafe' lines should be at least 300 ohms, measured at an applied voltage of not greater than ±2 volts.

High-Speed Interface

The IBM 3704 and 3705 Communications Controllers high-speed interface provides for the attachment of an external high-speed modem for operation on wideband services at speeds up to 50,000 bps.

The interface is a cable terminated with a Burndy MD 12 MXP-17TC (or equivalent) coaxial plug, which interfaces to a Burndy MD 12 MXR-8T coaxial connector. The cable consists of 12 coaxial circuits and has a maximum length of 50 feet. The interface lines and pin assignments are as follows.

Pin	Circuit
A	Not Used
B	Not Used
C	Clear to Send
D	Send Request
E	Send Data
F*	Data Set Ready
F**	Ring Indicator (see note)
G	Local Test
H	Not Used
J	Serial Clock Transmit
K	Receive Data
L	Serial Clock Receive
M*	AGC Lock
M**	Data Terminal Ready (see note)

* Denotes center pin
** Denotes shield

Note: *These leads are EIA RS-232 voltage mode circuits.*

Line Descriptions

Signal Ground. The signal ground connection is completed between the IBM 3704 and 3705 and the modem through the coaxial shield leads (with the exception of Ring Indicator—Pin F, and Data Terminal Ready—Pin M). This line is used to establish the reference potential for all signal lines and is connected to 0 volts in the IBM 3704 and 3705 power supply.

Clear to Send (CTS). The modem generates signals on this circuit, that indicate to the IBM 3704 and 3705 that the modem is transmitting the information presented on the Send Data line. The modem must turn ON the Clear to Send line in response to an ON condition on the Request to Send line.

Send Request (SR). The Send Request line from the IBM 3704 and 3705 is a request for the modem to transmit data, presented on the Send Data line, to the remote terminal. When the IBM 3704 and 3705 brings up Send Request, the modem must respond with a Clear to Send signal and must then transmit the data presented on the Send Data line.

Send Data (SD). The IBM 3704 and 3705 generate data signals on this circuit to be transmitted by the modem, as controlled by the Serial Clock Transmit signal. The IBM 3704 and 3705 changes the signal element during the positive-going transitions of the Serial Clock Transmit signal. The modem must sample the signal element during the negative transitions, which are normally in the center of the signal element.

Data Set Ready. The modem generates signals on this circuit to indicate that it is ready to operate. The OFF condition indicates one of the following.

a. A local or remote test
b. Power off condition
c. Inoperative voice channel (if so equipped)

The ON condition appears at all other times.

Ring Indicator. The modem generates signals on this circuit when it is receiving a ringing signal from the communication channel. This circuit is independent of the condition of the Data Terminal Ready circuit. Ring Indicator is an EIA RS-232 voltage mode circuit.

Local Test. The IBM 3704 and 3705 generate signals on this circuit to provide for control of looping both the wideband modem (and the voice-band modem, if provided). When the IBM 3704 and 3705 turn ON this circuit, the modem must go into local test mode. This allows the IBM 3704 and 3705 to send to itself through the wideband modem. The Local Test lead is controlled by the Diagnostic Mode condition in the IBM 3704 and 3705.

Serial Clock Transmit (SCT). The modem generates signals on this circuit to be used by the IBM 3704 and 3705 for timing. The IBM 3704 and 3705 change the data on the Send Data line coincidentally with the positive-going transition of Serial Clock Transmit. The modem must sample the Send Data line on every negative transition of this signal, which occurs in the center of the signal element. This timing signal must be a square wave with a duty cycle of 50% ±1%.

Receive Data. The modem generates signals on this circuit in response to data signals received from the communication channel. The IBM 3704 and 3705 sample the Receive Data circuit on the negative transition of the Serial Clock Receive.

Serial Clock Receive SCR. The modem generates timing signals on this circuit that are used by the IBM 3704 and 3705 for sampling the received data. Any change in the Receive Data line must be made coincidentally with the positive transitions of the signal. The IBM 3704 and 3705 sample the Receive Data line during the negative transition of the signal. This signal must be a square wave with a duty cycle of 50% ±1%.

AGC Lock. The modem generates signals on this circuit that indicate the quality of the received signal. The ON condition indicates that the quality of the received signal is acceptable to the modem.

Data Terminal Ready. The IBM 3704 and 3705 generate signals on this circuit to control the switching of the modem to the communication channel if communication is over a switched facility. Data Terminal Ready must be ON to allow the modem to answer calls and must remain ON to maintain an established connection. The OFF condition should cause the modem to disconnect from the communication channel. Data Terminal Ready is an EIA RS-232 voltage mode circuit.

Line Characteristics

The interface circuits associated with the signal lines consist of cable drivers and terminators that operate into a coaxial cable that has a characteristic impedance of 90 to 120 ohms. The terminator impedance should be 100 ohms resistive. Any open circuit or driver power OFF should be identified by a terminator as OFF.

The sleeve of each interface line's coaxial lead is connected to Signal Ground, except those sleeves designated as EIA RS-232 circuits.

Logic and Control Definitions

1. Logical 1 and Control OFF, or Mark: In this condition, the driver output current must be less than 5.0 mA into 100 ohms.
2. Logical 0 and Control ON, or Space: Driver output current will be greater than 23 mA, when terminated by 100 ohms and biased negative at least -0.8 volts (but less than -1.3 volts). The IBM 3704 and 3705 terminator open circuit input voltages will be between -0.8 volts and -1.3 volts.

Telegraph Interface

The IBM 3704 and 3705 Communications Controllers can be connected to a telegraph line through a cable that provides two twisted pairs of wires for connection to two separate telegraph circuits. The maximum cable length is 50 feet.

Figure 4 shows the IBM 3704 and 3705 protective input network for a telegraph line. The interface can be used for 20 mA, 40 mA, or 62.5 mA single current telegraph line termination. Card jumpers are used to select the proper circuitry for detecting signals on 20 mA, 40 mA, or 62.5 mA telegraph loops.

Notes: *1. When transmitting, the distortion generated by the IBM 3704 and 3705 does not exceed 2%.*
2. The maximum allowable receive distortion is 40%.
3. An echo check is signaled as a modem error.

Logic Definitions

1. Logical 1 or Mark: Current (nominal 20 mA, 40 mA, or 62.5 mA; to be adjusted by common carrier).
2. Logical 0 or Space: No current.

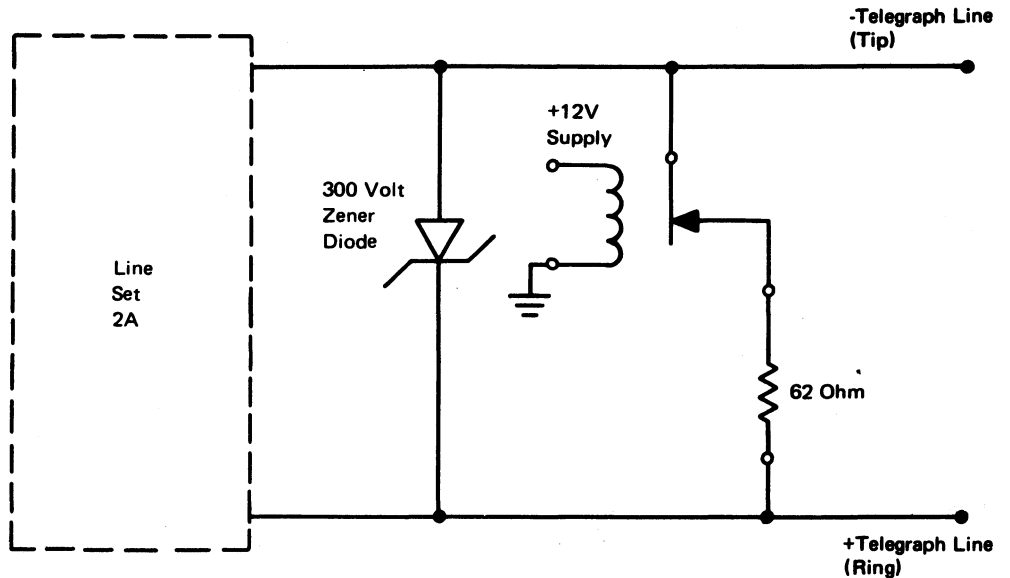A 300 volt Zener diode limits the surge voltage across the telegraph line to 300 volts maximum.

Figure 5. IBM 3704 and 3705 Protective Input Network

IBM Line Adapters

IBM Line Adapters are devices internal to specific IBM 3704 and 3705 line sets. These line adapters eliminate the need for external modems, and they interface directly to customer-supplied cable facilities or common-carrier facilities. For information about IBM Line Adapters, refer to *Planning and Installation of a Data Communications System Using IBM Line Adapters,* GA24-3435.

IBM Integrated Modems

The IBM 2400/1200 bps integrated modem can communicate with another properly equipped IBM 2400/1200 bps integrated modem or a properly equipped IBM 3872 Modem. For information about IBM 2400/1200 bps integrated modems, refer to the *IBM 3872 User's Guide* Section 3, GA27-3058.

MIL-STD-188C Interface

The IBM 3704 and 3705 provide a MIL-STD-188C interface for attaching an external modem with one half-duplex line to operate at speeds up to 56,000 bps. The interface conforms to section 7.2.1 of MIL-STD-188C dated 24 November 1969, which describes the electrical parameters for low-level signaling. The 3704 and 3705 control program may condition this line interface for either external clock control or business machine clock control if the line speed does not exceed 2,400 bps. At speeds above 2,400 bps, external clock control must be used.

No cable is provided with this interface.

The following shows the interface lines used and the I/O gate connector pins at which they terminate.

Line Description	I/O Gate Connector Pin	Active Voltage Level
Transmit Clock	D02	+MIL188
Signal Return Transmit Clock	B13	−MIL188
Receive Clock	B05	+MIL188
Signal Return Receive Clock	B02	−MIL188
Mark Receive Data	D06	+MIL188
Signal Return Receive Data	D07	−MIL188
Mark Send Data	D10	+MIL188
Ground Send Data	B11	−MIL188

Line Descriptions

Transmit Clock and Signal Return Transmit Clock. The modem generates MIL-STD-188C voltage signals on this circuit to be used by the IBM 3704 and 3705.

Receive Clock and Signal Return Receive Clock. The modem generates MIL-STD-188C voltage signals on this circuit to be used by the IBM 3704 and 3705.

Mark Receive Data and Signal Return Receive Data. The modem generates MIL-STD-188C voltage signals on this circuit when a data bit is received from the communication channel.

Mark Send Data and Ground Send Data. The IBM 3704 and 3705 generate MIL-STD-188C voltage signals on this circuit to indicate that a bit is to be transmitted over the communication channel.

Electrical Characteristics

All MIL-STD-188C signals are balanced with respect to ground and should be measured differentially.

For the IBM 3704 and 3705 terminator circuits, the voltage levels are:

	Minimum	Maximum
Logical 1 or Mark	+0.5 V	+7.0 V
Logical 0 or Space	−0.5 V	−7.0 V

For the IBM 3704 and 3705 driver circuits, the voltage levels are:
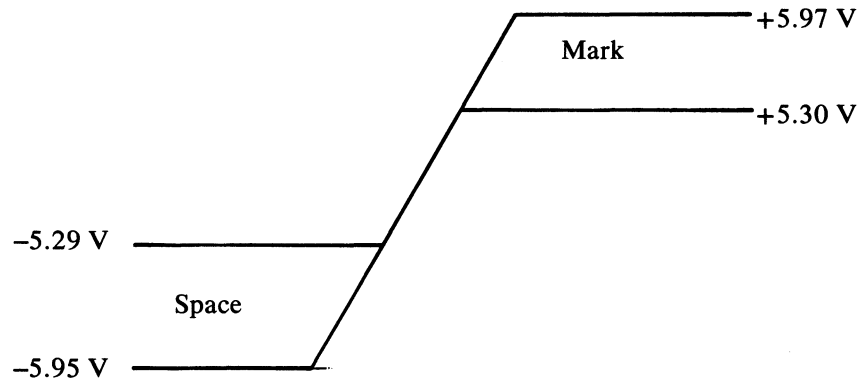
CCITT V. 35 Interface

The IBM 3704 and 3705 provide CCITT Recommended V.35 interfaces for attaching one half-duplex line to an external data set that can handle up to 56,000 bps. The 3704 and 3705 control program must condition this line interface for external clock control.

The following shows the interface lines used by the 3704 and 3705.

Pin	Line Description
A	+Transmit Clock
C	Request to Send
D	Clear to Send
E	Data Set Ready
F	Receive Signal Detector
P	−Transmitted Data
R	−Receive Data
S	+Transmitted Data
T	+Receive Data
V	+Receive Clock
X	−Receive Clock
Y	−Transmit Clock

The cable provided by the IBM 3704 and 3705 line sets terminates at the modem end with a Winchester Electric connector (part number XAC34PD3300), or equivalent.

Line Descriptions

+Transmit Clock. The modem generates differential voltage levels on this circuit to be used by the IBM 3704 and 3705.

Request to Send. The Request to Send line is a request for the modem to transmit the data presented on the Transmitted Data line. When the 3704 and 3705 bring up Request to Send, the modem must respond with Clear to Send and transmit the data presented on the Transmitted Data line.

Clear to Send. The modem generates EIA voltage signals on this circuit that indicate to the IBM 3704 and 3705 that the modem transmitting the information presented on the Transmitted Data line. Clear to Send must be turned ON in response to Request to Send.

Data Set Ready. The modem generates EIA voltage signals on this circuit to indicate to the IBM 3704 and 3705 that the modem is ready to operate.

Receive Signal Detector. The modem generates EIA voltage signals on this line to indicate to the IBM 3704 and 3705 that the modem is receiving signals on its Receive Data line that meet the modem's suitability criteria.

– Transmitted Data. The IBM 3704 and 3705 generate differential voltage signals on this circuit. The modem transmits these signals over the communication channel. The modem transmits these signals over the communication channel.

–Receive Data. The modem generates signals on this circuit in response to data signals received from the communication channel. The IBM 3704 and 3705 receives the data as differential voltage level signals.

+Transmitted Data. The IBM 3704 and 3705 generate differential voltage signals on this circuit. The modem transmits these signals over the communication channel.

+Receive Data. The modem generates signals on this circuit in response to data signals received from the communication channel. The IBM 3704 and 3705 receive the data as differential voltage level signals.

+Receive Clock. The modem generates differential voltage level signals on this circuit to be used by the modem.

–Receive Clock. The modem generates differential voltage level signals on this circuit to be used by the IBM 3704 and 3705.

–Transmit Clock. The modem generates differential voltage levels on this circuit to be used by the IBM 3704 and 3705.

Electrical Characteristics

The electrical characteristics meet the requirements of CCITT Recommendation V.35, Appendix 4.

Examples of Interface Sequences between the IBM 3704 and 3705 and the Communication Line

Figures 6-10 show *examples* of timings and sequences which can be used to communicate with a sampling of IBM terminals, connected through typical modems to the IBM 3704 and 3705. Timings depend upon the IBM 3704 and 3705 program activity, the type of scanner, the number of lines being serviced, the type of line set, the line speed, the type of modem, and the remote terminal type.

Loss of Data Set Ready or Clear to Send

Loss of Data Set Ready (in PCF state 5, 7, 8, 9, A, B, C, or D) or loss of Clear to ·Send (in PCF state 9, A, B, or D) causes the Modem Error bit (bit 3) to be set in the ICW. This bit is set in the ICW either at bit service scan time or at character service queue reset time.

If the modem error is detected before the Normal Service Request bit is set, the Modem Error bit will be ON, and the Normal Service Request bit will be OFF at L2 interrupt time (for character service). If the Normal Service Request bit is ON when the Modem Error bit is set, the Normal Service Request bit is turned OFF. If the line is idle, or a switched line disconnects without a break or space detected, then a character service interrupt will not be taken. Under these conditions, the program has to interrogate the ICW periodically to detect a modem error.

The minimum time to detect loss of Data Set Ready or Clear to Send as a modem error is variable and depends on the line speed. The minimum time to detect a down level as an error varies from 50 ns to the bit period of the line plus 0.153 ms.

The maximum time to detect loss of Data Set Ready or Clear to Send as a modem error is as follows:

Line Speed	Maximum Time To Detect Loss
110.00 bps	9.2 ms
134.49 bps	7.6 ms
600.00 bps	1.7 ms
1200.00 bps	987.0 us
2000.00 bps	653.0 us
2400.00 bps	570.0 us
4800.00 bps	362.0 us
7200.00 bps	215.0 us

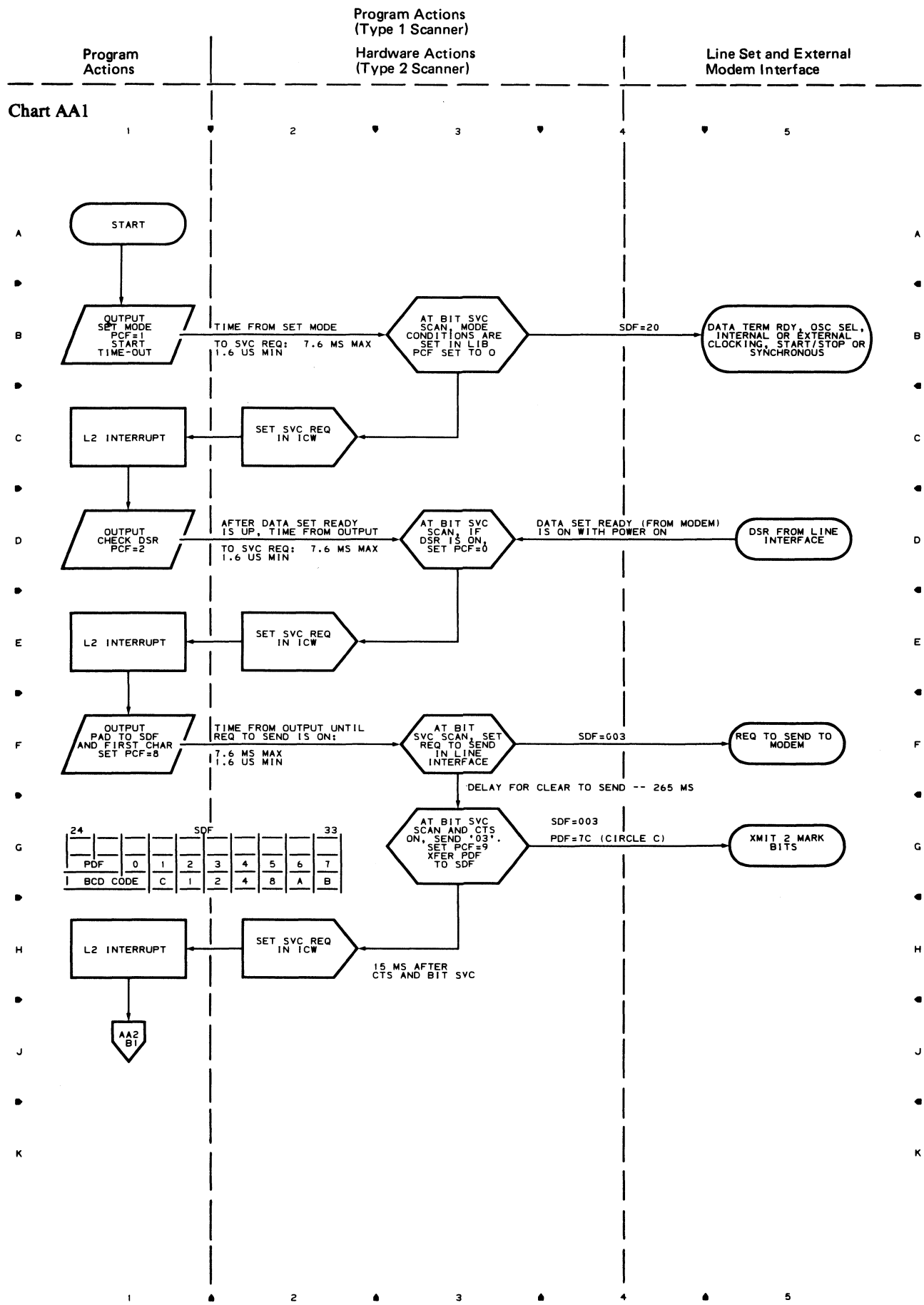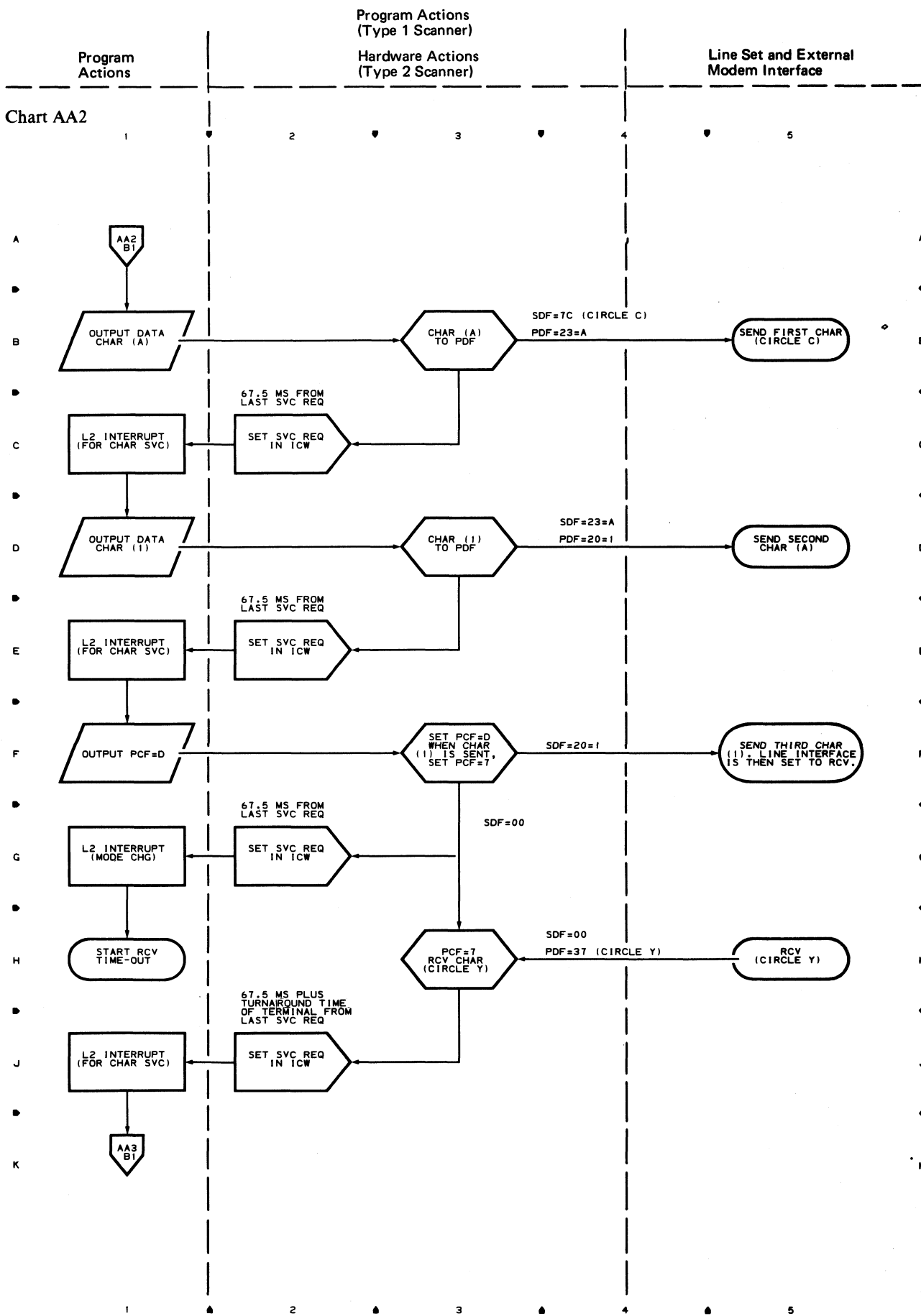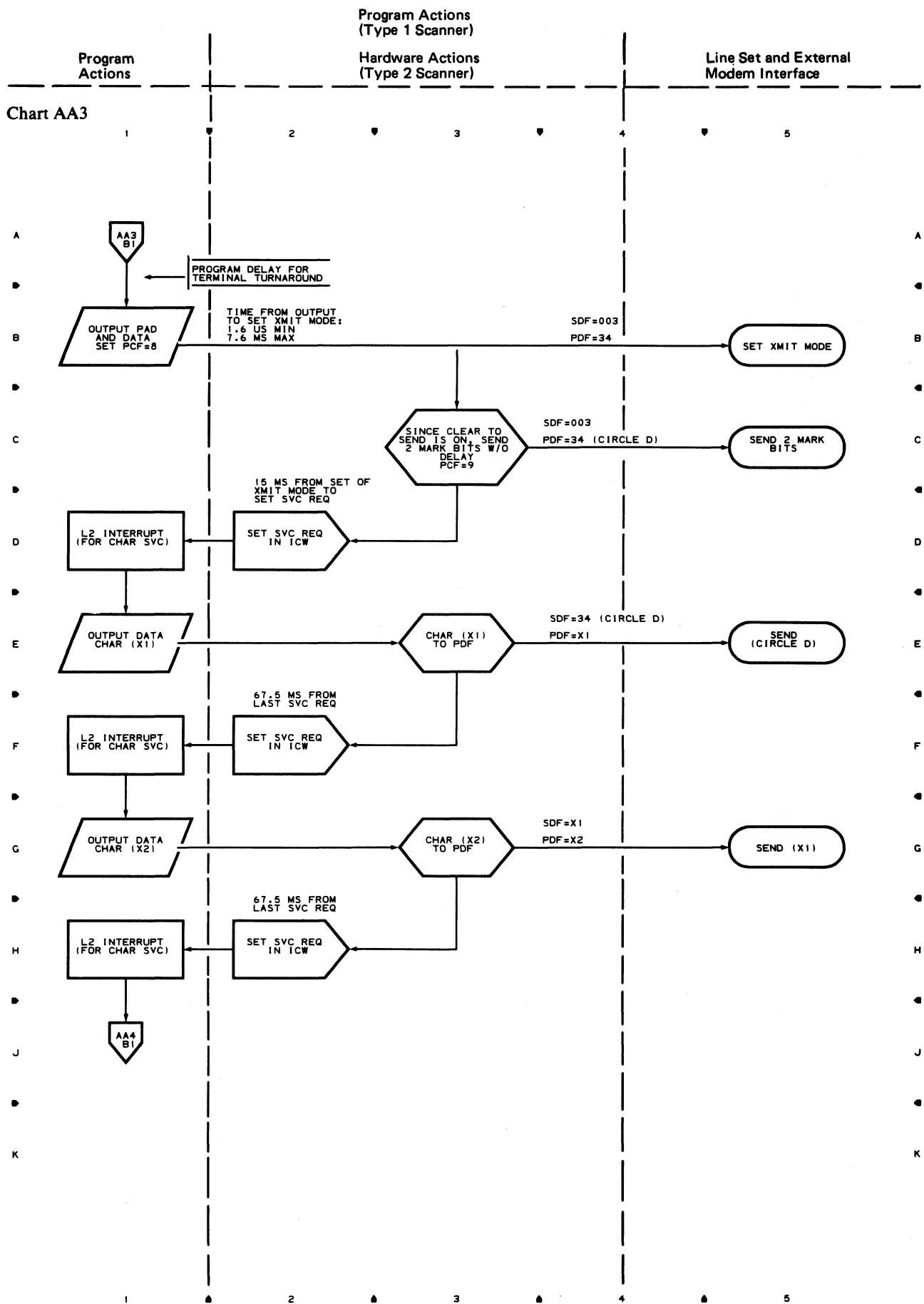Figure 6. *Example* of Dedicated-Duplex Service—Programmed for the IBM 1050 Communication System (Part 1 of 4)

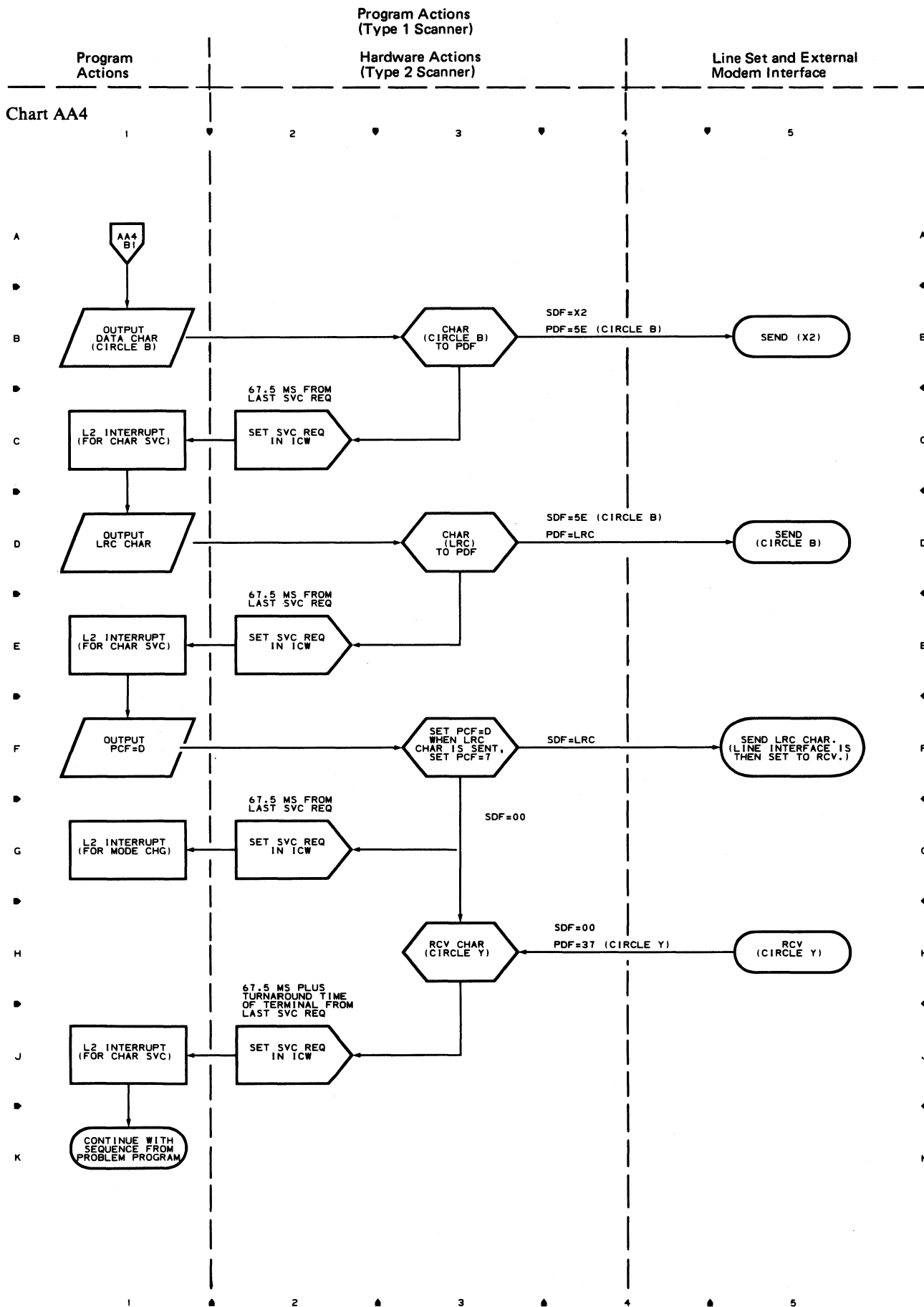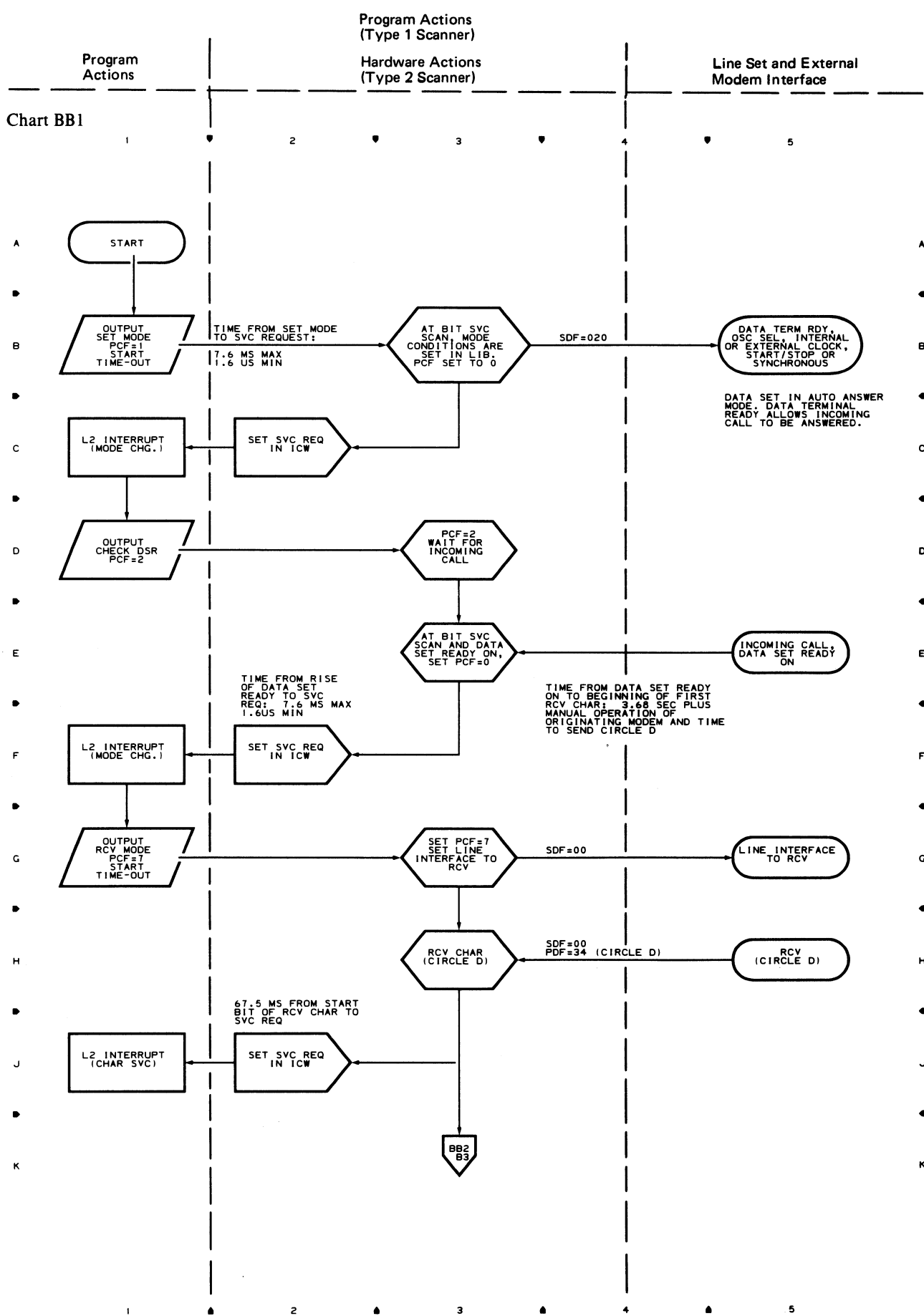| Program Actions		Program Actions (Type 1 Scanner) Hardware Actions (Type 2 Scanner)		Line Set and External Modem Interface
1	2	3	4	5

A

AA2 B1

B

OUTPUT DATA CHAR (A) → CHAR (A) TO PDF

SDF=7C (CIRCLE C)
PDF=23=A

SEND FIRST CHAR (CIRCLE C)

C

L2 INTERRUPT (FOR CHAR SVC) ← SET SVC REQ IN ICW

67.5 MS FROM LAST SVC REQ

D

OUTPUT DATA CHAR (I) → CHAR (I) TO PDF

SDF=23=A
PDF=20=I

SEND SECOND CHAR (A)

E

L2 INTERRUPT (FOR CHAR SVC) ← SET SVC REQ IN ICW

67.5 MS FROM LAST SVC REQ

F

OUTPUT PCF=D → SET PCF=D WHEN CHAR (I) IS SENT, SET PCF=7

SDF=20=I

SEND THIRD CHAR (I). LINE INTERFACE IS THEN SET TO RCV.

G

L2 INTERRUPT (MODE CHG) ← SET SVC REQ IN ICW

67.5 MS FROM LAST SVC REQ

SDF=00

H

START RCV TIME-OUT

PCF=7 RCV CHAR (CIRCLE Y)

SDF=00
PDF=37 (CIRCLE Y)

RCV (CIRCLE Y)

J

L2 INTERRUPT (FOR CHAR SVC) ← SET SVC REQ IN ICW

67.5 MS PLUS TURNAROUND TIME OF TERMINAL FROM LAST SVC REQ

K

AA3 B1

| 1 | 2 | 3 | 4 | 5 |

Figure 6. *Example* of Dedicated-Duplex Service—Programmed for the IBM 1050 Communication System (Part 2 of 4)

Program Actions
(Type 1 Scanner)

Program
Actions

Hardware Actions
(Type 2 Scanner)

Line Set and External
Modem Interface

Chart AA3

1   2   3   4   5

A

```
AA3
B1
```

PROGRAM DELAY FOR
TERMINAL TURNAROUND

B

OUTPUT PAD
AND DATA
SET PCF=8

TIME FROM OUTPUT
TO SET XMIT MODE:
1.6 US MIN
7.6 MS MAX

SDF=003

PDF=34

SET XMIT MODE

C

SINCE CLEAR TO
SEND IS ON, SEND
2 MARK BITS W/O
DELAY
PCF=9

SDF=003

PDF=34 (CIRCLE D)

SEND 2 MARK
BITS

D

L2 INTERRUPT
(FOR CHAR SVC)

15 MS FROM SET OF
XMIT MODE TO
SET SVC REQ

SET SVC REQ
IN ICW

E

OUTPUT DATA
CHAR (X1)

CHAR (X1)
TO PDF

SDF=34 (CIRCLE D)

PDF=X1

SEND
(CIRCLE D)

F

L2 INTERRUPT
(FOR CHAR SVC)

67.5 MS FROM
LAST SVC REQ

SET SVC REQ
IN ICW

G

OUTPUT DATA
CHAR (X2)

CHAR (X2)
TO PDF

SDF=X1

PDF=X2

SEND (X1)

H

L2 INTERRUPT
(FOR CHAR SVC)

67.5 MS FROM
LAST SVC REQ

SET SVC REQ
IN ICW

J

```
AA4
B1
```

K

1   2   3   4   5

Figure 6. **Example** of Dedicated-Duplex Service—Programmed for the IBM 1050 Communication System (Part 3 of 4)

Program Actions
(Type 1 Scanner)

Program
Actions

Hardware Actions
(Type 2 Scanner)

Line Set and External
Modem Interface

Chart AA4

1   2   3   4   5

A

AA4
B1

B

OUTPUT
DATA CHAR
(CIRCLE B)

CHAR
(CIRCLE B)
TO PDF

SDF=X2

PDF=5E (CIRCLE B)

SEND (X2)

C

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

D

OUTPUT
LRC CHAR

CHAR
(LRC)
TO PDF

SDF=5E (CIRCLE B)

PDF=LRC

SEND
(CIRCLE B)

E

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

F

OUTPUT
PCF=D

SET PCF=D
WHEN LRC
CHAR IS SENT,
SET PCF=7

SDF=LRC

SEND LRC CHAR.
(LINE INTERFACE IS
THEN SET TO RCV.)

G

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR MODE CHG)

SET SVC REQ
IN ICW

SDF=00

H

RCV CHAR
(CIRCLE Y)

SDF=00

PDF=37 (CIRCLE Y)

RCV
(CIRCLE Y)

J

67.5 MS PLUS
TURNAROUND TIME
OF TERMINAL FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

K

CONTINUE WITH
SEQUENCE FROM
PROBLEM PROGRAM

1   2   3   4   5

Figure 6. **Example** of Dedicated-Duplex Service—Programmed for the IBM 1060 Communication System (Part 4 of 4)

Figure 7. *Example* of Switched-Duplex Service—Programmed for the IBM 2741 Communications Terminal (Part 1 of 4)

Chart BB2

Figure 7. **Example** of Switched-Duplex Service—Programmed for the IBM 2741 Communications Terminal (Part 2 of 4)

Program Actions	Hardware Actions (Type 2 Scanner)	Line Set and External Modem Interface

Chart BB3

1   2   3   4   5

A

BB3
B1

B

OUTPUT DATA
CHAR (X1)

CHAR (X1)
TO PDF

SDF=34 (CIRCLE D)
PDF=X1

SEND
(CIRCLE D)

C

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(CHAR SVC)

SET SVC REQ
IN ICW

D

OUTPUT
DATA CHAR
(CIRCLE C)

CHAR
(CIRCLE C)
TO PDF

SDF=X1
PDF=7C (CIRCLE C)

SEND (X1)

E

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(CHAR SVC)

SET SVC REQ
IN ICW

F

OUTPUT
SET PCF=D

SET PCF=D
AFTER (CIRCLE
C) CHAR IS
SENT, SET
PCF=7

SDF=7C

SEND (CIRCLE C)
LINE INTERFACE IS THEN
SET TO RCV (RTS IS LEFT
ON, AND XMIT MODE IS
RESET)

G

67.5 MS FROM
LAST SVC REQ

L2 INTERRUPT
(CHAR SVC)

SET SVC REQ
IN ICW

SDF=00

H

START
TIME-OUT

PCF=7
RCV MODE

SDF=00

RCV MODE

MESSAGES MAY
CONTINUE, OR TERMINAL
MAY DISCONNECT LINE

J

BB4
B1

K

1   2   3   4   5

Figure 7. **Example** of Switched-Duplex Service—Programmed for the IBM 2741 Communications Terminal (Part 3 of 4)

Chart BB4

1   2   3   4   5

```
        ┌─────┐
        │ BB4 │
        │ B1  │
        └──┬──┘
```

A

```
B    ┌──────────────┐        ⬡ BIT SVC AND          ( DISCONNECT OF  )
     │   OUTPUT     │◄───────  DATA SET      ◄───────( LINE DROPS DATA )
     │ CHECK ICW FOR│          READY OFF, SET        (   SET READY    )
     │ MODEM ERROR  │          MODEM ERROR
     └──────┬───────┘
```

DISCONNECT OF TERMINAL, WITH
RESULTANT LOSS OF CARRIER TO
THE IBM 3705 MODEM, MAY

```
C        ◇ MODEM ERROR ◇──YES       RESULT    IN THE RCV DATA LINE
          ◇           ◇             AT A SPACE TO THE LINE
             │                      INTERFACE LONG ENOUGH TO BE
            NO                      CLOCKED AS A START BIT.
             │                      THIS WILL RESULT IN A CHAR SVC
     ┌──────────────┐               INTERRUPT 67.5 MS AFTER THE RCV
D    │RETURN TO CHECK│              SPACE IS DETECTED.   THE MODEM
     │   LINE AT    │               ERROR BIT WILL BE ON IN THE ICW.
     │  INTERVALS   │
     └──────────────┘               IF A CHAR SVC IS NOT GENERATED,
                                     THE PROGRAM MUST INTERROGATE THE
                                     ICW       PERIODICALLY TO DETECT
                                     THE MODEM ERROR THAT IS
                                     SIGNALING THE DISCONNECT.
```

```
E    ┌──────────────┐        ◄─┐MODEM ERROR ◄─┐
     │ L2 INTERRUPT │          │ IN ICW       │
     │ (ERROR SET)  │          └──────────────┘
     └──────┬───────┘
```

```
F    ┌──────────────┐  TIME FORM OUTPUT    ⬡ SET PCF=F,          ( RESET ALL CTRL )
     │   OUTPUT     │  TO SVC REQ:           RESET LINE          (  LATCHES, DROP )
     │  SET PCF=F   │◄──────────────────── INTERFACE (BIT SVC ──►( DATA TERM READY)
     │ (DISABLE THE │  7.6 MS MAX           AND DATA SET RDY)
     │    LINE)     │  1.6 US MIN            SET PCF=0
     └──────┬───────┘
```

```
G    ┌──────────────┐        ◄─┐ MODE CHANGE ◄─┐
     │ L2 INTERRUPT │          └──────────────┘
     │ (MODE CHG)   │
     └──────┬───────┘
```

H

```
     ( RETURN TO      )
     ( BEGINNING, TO  )
     ( ENABLE LINE FOR)
     ( ANOTHER CALL   )
```

J

K

1   2   3   4   5

Figure 7. *Example* of Switched-Duplex Service—Programmed for the IBM 2741 Communications Terminal (Part 4 of 4)

Figure 8. Start-Stop Mode with a Switched-Duplex Modem and Automatic Answering
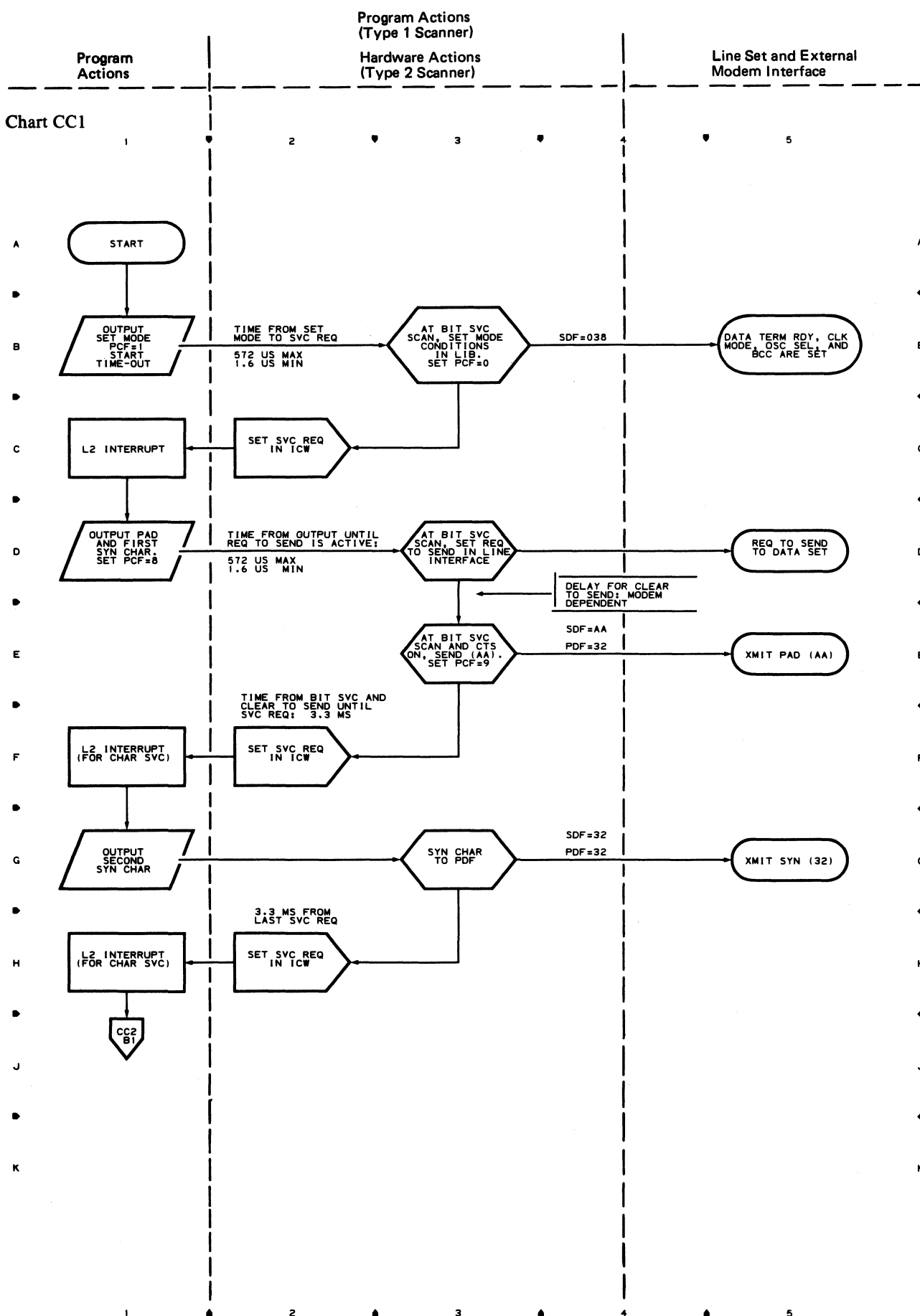
Figure 9. *Example* of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal
(Part 1 of 6)
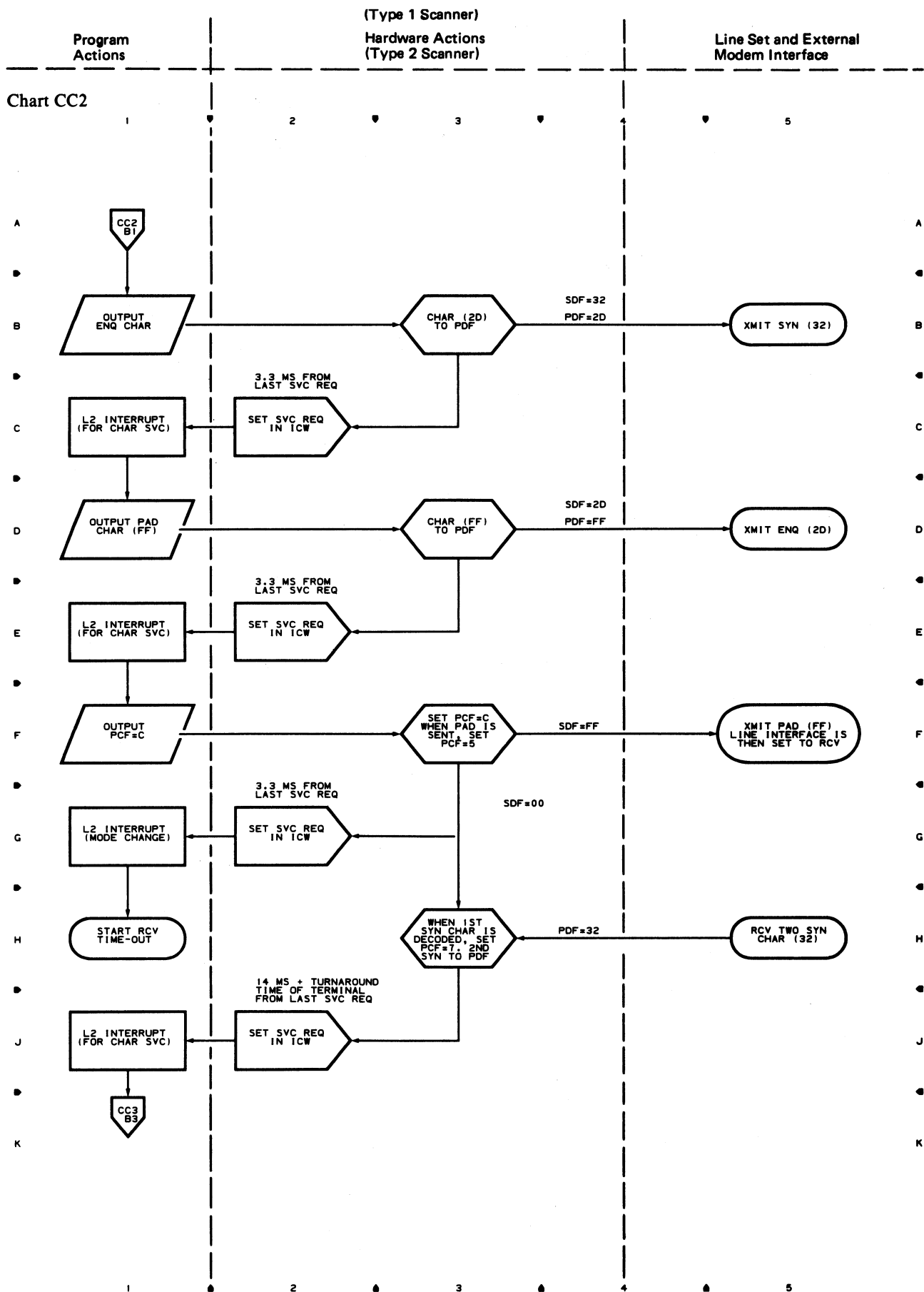
Chart CC2

Figure 9. **Example** of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal
(Part 2 of 6)

Chart CC3

1   2   3   4   5

CC3
B3

RCV
DLE (10) — PDF=10 — RCV DLE (10)

SEE NOTE

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC) ← SET SVC REQ
IN ICW

RCV
ACK 0 (70) — PDF=70 — RCV ACK 0 (70)

SEE NOTE

NOTE: ACK 0 IS A
TWO CHARACTER
SEQUENCE CONSISTING
OF X'10' AND X'70'.

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC) ← SET SVC REQ
IN ICW

RCV
PAD (XF) — PDF=XF — RCV PAD (XF)

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC) ← SET SVC REQ
IN ICW

OUTPUT PAD
AND FIRST
SYN CHAR.
SET PCF=8 → AT BIT SVC
SCAN WITH
CTS ON, SEND
(AA).
SET PCF=9 — SDF=0AA
PDF=32 — SET XMIT
SEND PAD (AA)

TIME FROM OUTPUT
UNTIL SVC REQ: 3.8 MS
MAX, 3.3 MS MIN

L2 INTERRUPT ← SET SVC REQ
IN ICW

CC4
B1

1   2   3   4   5

Figure 9. **Example** of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal
(Part 3 of 6)

Figure 9. *Example* of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal
(Part 4 of 6)

Chart CC5

Program Actions
(Type 1 Scanner)

Program
Actions

Hardware Actions
(Type 2 Scanner)

Line Set and External
Modem Interface

1   2   3   4   5

CC5
B1

OUTPUT
BCC-1 CHAR

CHAR
(BCC-1)
TO PDF

SDF=03
PDF=YY

XMIT
ETX (03)

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

OUTPUT
BCC-2 CHAR

CHAR
(BCC-2)
TO PDF

SDF=YY
PDF=ZZ

XMIT
BCC-1 (YY)

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

OUTPUT
PAD CHAR
(FF)

CHAR (FF)
TO PDF

SDF=ZZ
PDF=FF

XMIT
BCC-2 (ZZ)

3.3 MS FROM
LAST SVC REQ

L2 INTERRUPT
(FOR CHAR SVC)

SET SVC REQ
IN ICW

OUTPUT
SET PCF=C

WHEN PAD
CHAR IS SENT,
SET PCF=5
SET LINE
INTERFACE
TO RCV

SDF=FF

XMIT PAD (FF)
LINE INTERFACE IS
THEN SET TO RCV

SDF=00

CC6
B1

1   2   3   4   5

Figure 9. *Example* of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal
(Part 5 of 6)

Chart CC6

Program Actions	Program Actions (Type 1 Scanner)		Line Set and External
	Hardware Actions (Type 2 Scanner)		Modem Interface

| 1 | 2 | 3 | 4 | 5 |

CC6 B1

3.3 MS FROM LAST SVC REQ

L2 INTERRUPT (FOR CHAR SVC) ◄─── SET SVC REQ IN ICW

START RCV TIME-OUT

WHEN 1ST SYN CHAR IS DECODED, SET PCF=7 2ND SYN TO PDF ◄─── PDF=32 ◄─── RCV SECOND SYN CHAR (32)

14 MS PLUS TURNAROUND TIME OF TERMINAL FROM LAST SVC REQ

L2 INTERRUPT (FOR CHAR SVC) ◄─── SET SVC REQ IN ICW

RCV DLE (10) ◄─── PDF=10 ◄─── RCV DLE (10)

SEE NOTE

3.3 MS FROM LAST SVC REQ

L2 INTERRUPT (FOR CHAR SVC) ◄─── SET SVC REQ IN ICW

RCV ACK 1 (61) ◄─── PDF=61 ◄─── RCV ACK 1 (61)

SEE NOTE

NOTE: ACK 1 IS A TWO CHARACTER SEQUENCE CONSISTING OF X'10' AND X'61'

3.3 MS FROM LAST SVC REQ

L2 INTERRUPT (FOR CHAR SVC) ◄─── SET SVC REQ IN ICW

SEND ANOTHER DATA BLOCK, OR SEND EOT AND TURNAROUND TO MONITOR FOR ENQ FROM TERMINAL

| 1 | 2 | 3 | 4 | 5 |

Figure 9. *Example* of Dedicated Half-Duplex Service—Programmed for an IBM Binary Synchronous Communication Terminal (Part 6 of 6)

Figure 10. Synchronous Mode with a Switched Half-Duplex Modem

Dial Operation

Figures 11 and 12 show an *example* of an automatic call operation. Timings depend upon the IBM 3704 and 3705 program activity, the type of scanner, the number of lines being serviced, the line speed, and the automatic calling unit (ACU).

A set mode state (PCF=1) is invalid to an auto dial interface, and results in a feedback error (LCD=F).

During an auto dial operation, error conditions are not checked by the hardware. Failures in the automatic calling unit, such as PWI inactive, must be detected by the program.

If Data Line Occupied (DLO) is active before the IBM 3704 and 3705 raise Call Request (CRQ), an auto dial operation cannot be initiated. Therefore, the program must examine the ICW for an auto dial line before beginning an auto dial operation.

Chart DD1

Program Actions	Program Actions (Type 1 Scanner) / Hardware Actions (Type 2 Scanner)	Line Set and External Modem Interface

START

OUTPUT DISABLE PCF=F

TIME FROM OUTPUT TO SVC REQ IS ACU DEPENDENT

AT BIT SVC, TEST FOR DLO, ACR, PND, AND COS OFF.

DLO, ACR, PND, AND COS

SET PCF=0

L2 INTERRUPT ← SET SVC REQ IN ICW

OUTPUT MONITOR ACU PCF=4

TIME FROM OUTPUT TO SVC REQ IS ACU DEPENDENT

AT BIT SVC SCAN, CRQ IS SENT TO LIB. PCF=4

CRQ ACTIVE TO ACU

AT BIT SVC SCAN, (AFTER PND IS ACTIVE), SET INTERRUPT

PND FROM ACU

DD1 H1

L2 INTERRUPT ← SET SVC REQ IN ICW

OUTPUT DIAL DIGIT. SET PCF=8 OUTPUT TO RESET INTERRUPT REMEMBER

TIME FROM OUTPUT TO SVC REQ IS ACU DEPENDENT

AT BIT SVC SCAN, DIAL DIGIT AND DPR SET IN LIB. PCF=8

PDF='XX'
'XX' IS DIAL DIGIT

DIAL DIGIT AND DPR ARE SENT TO ACU

DD2 A3

Figure 11. **Example** of Dial Operation with an External Automatic Calling Unit (Part 1 of 2)

Chart DD2

Program
Actions

Program Actions
(Type 1 Scanner)

Hardware Actions
(Type 2 Scanner)

Line Set and External
Modem Interface

DD2
A3

AT BIT SVC
SCAN (AFTER
PND IS DOWN),
SET PCF=4

PND DOWN
FROM ACU

AT BIT SVC
SCAN (AFTER
PND IS
ACTIVE), SET
INTERRUPT

PND ACTIVE
FROM ACU

L2 INTERRUPT ← SET SVC REQ
IN ICW

IS LAST
DIAL DIGIT
SENT? — NO → DD1
H1

YES

OUTPUT MONITOR
ACU W/O PND
PCF=5
OUTPUT TO RESET
INTERRUPT REMEMBER

TIME FROM OUTPUT
TO SVC REQ IS ACU
DEPENDENT

SET PCF=5 AT
BIT SVC SCAN
(AFTER ACR OR COS
IS RCVD), SET
INTERRUPT

ACU RETURNS COS
(CALL COMPLETE) OR
ACR (TIME-OUT)

L2 INTERRUPT ← SET SVC REQ
IN ICW

OUTPUT
DISABLE
PCF=F

TIME FROM OUTPUT
TO SVC REQ IS ACU
DEPENDENT

AT BIT SVC
SCAN, RESET
CRQ IN LIB.
PCF=F

RESET CRQ
TO ACU

AT BIT SVC
SCAN (WHEN DLO,
ACR, COS, AND PND
INACTIVE), SET
INTERRUPT
PCF=0

DLO, ACR, COS,
AND PND INACTIVE
FROM ACU

L2 INTERRUPT ← SET SVC REQ
IN ICW

END

Figure 11. *Example* of Dial Operation with an External Automatic Calling Unit (Part 2 of 2)

Time is variable from 1.6 μs
to Bit Period of Osc 0 + 0.153 ms.
If Osc 0 freq= 134.49 Hz max
time would be 7.5 ms + .153 ms
or 7.653 ms.

PWI active

CRQ

DLO

PND   ← ACU Dependent
                                                   (may stay on)

DPR
NB1

NB2

NB4

NB8

COS   COS is active when connection is established.

ACR   ACR is active on time out
                                                of ACU with incomplete call.
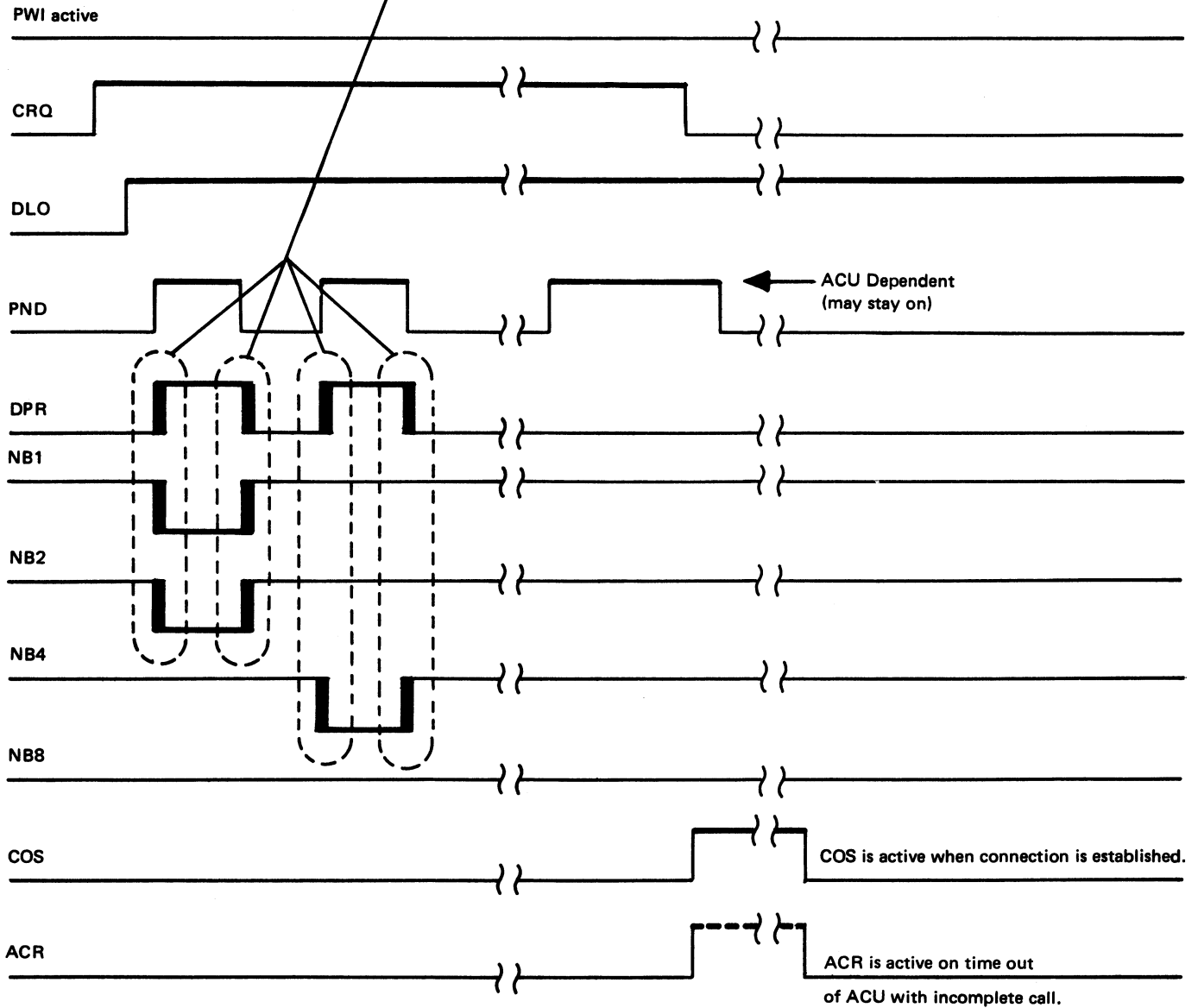
Figure 12. Automatic Call Operation

Cable Descriptions

Figure 13 shows the cables required for installing the IBM 3704 and 3705 Communications Controllers. Since the selection of line sets incorporated in a particular IBM 3704 and 3705 depends on customer requirements, the figure does not indicate the specific cables nor the quantity of each for a given system. The selection of machine features also affects the choice and quantity of cables.

Figures 14 and 15 show the cable plugs, inserted in IBM equipment, and the serpent contacts. The cable plugs (inserted in IBM equipment) are identified as follows.

Style	Color
Style A	Light Gray
Style B	Dark Gray
Style B	Dark Gray (without threaded insert)

Figures 16-32 contain drawings of cables with wire/contact information.
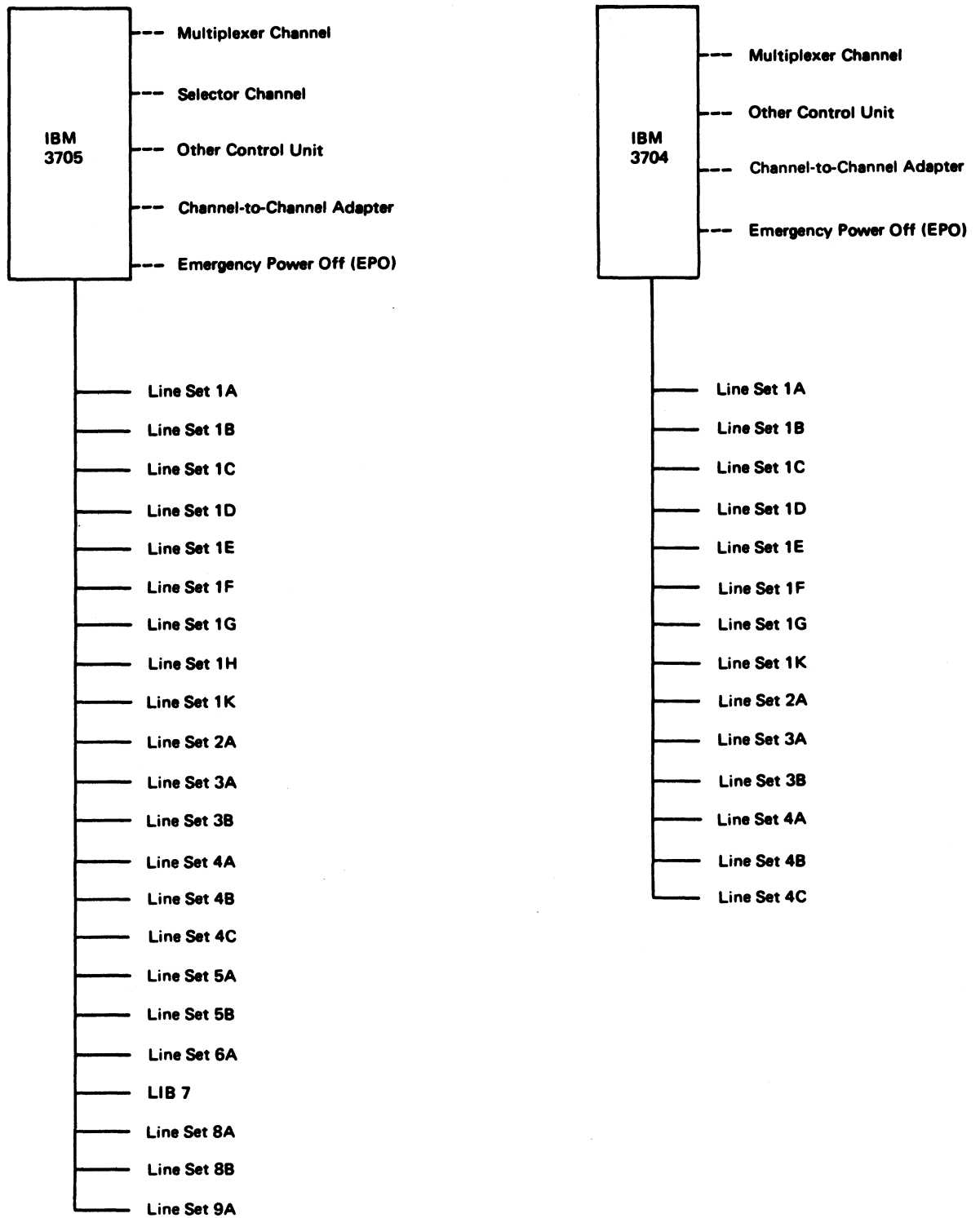
Figure 13. IBM 3704 and 3705 Cables
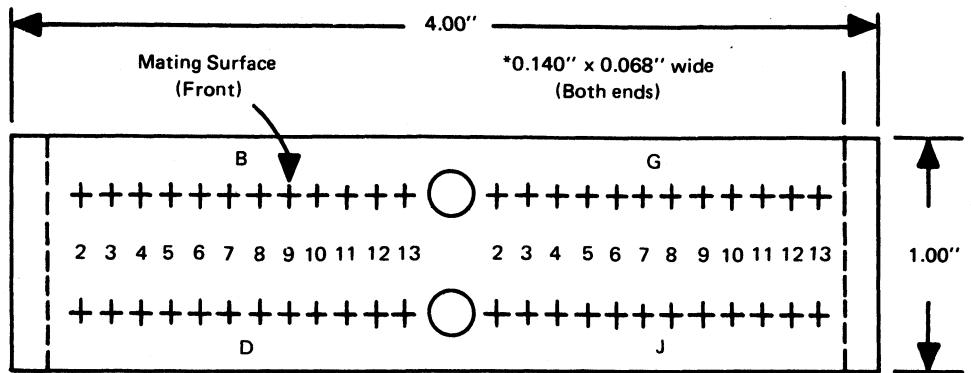
"A" Style Block -- Light Gray
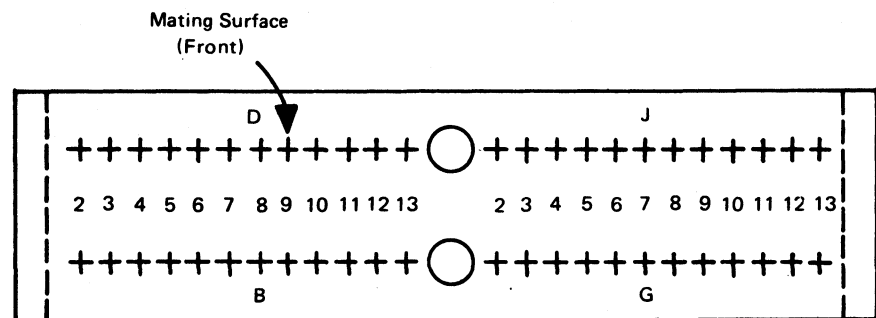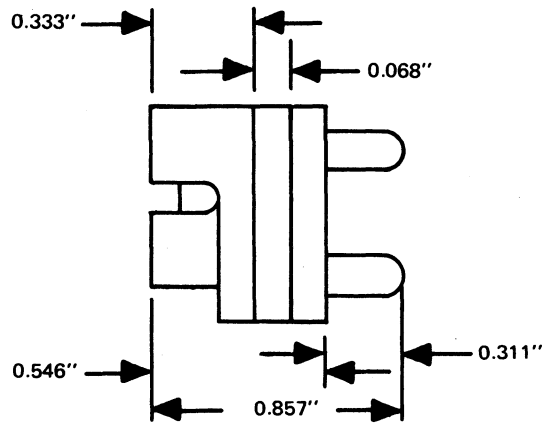
"B" Style Block -- Dark Gray with Threaded Insert
"B" Style Block -- Dark Gray, No Threaded Insert

*Mounting Slots

Figure 14. Connector Blocks and Contact Location

A. Part Identification

Ski

Retaining
Tab

Insulation
Support

Latch Tab

Crimp
Barrel

B. Dimensions

0.684"

0.028 0.004"

0.025+0.015"
-0.000"

C. Mating Configuration

Two Point Contact

Two Point Contact
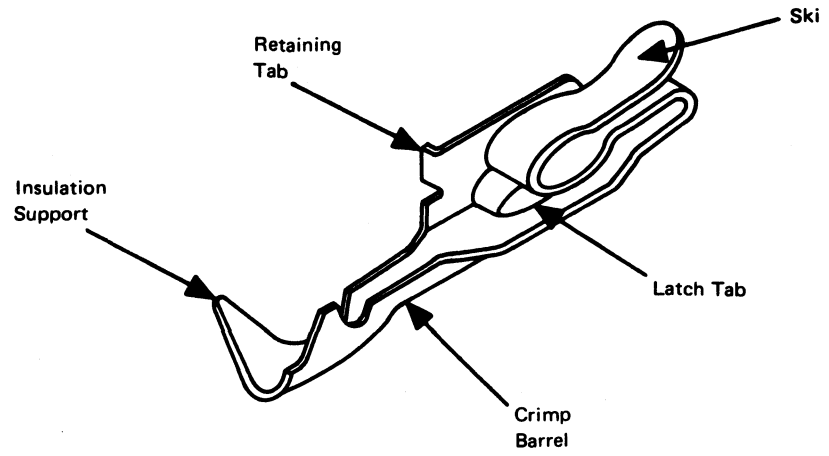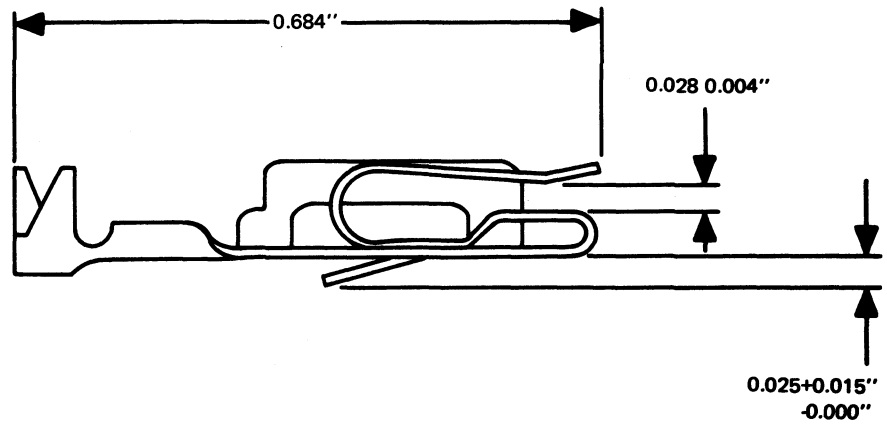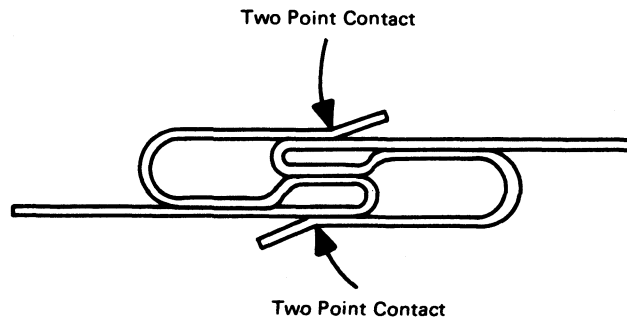
Figure 15. Serpent Contact
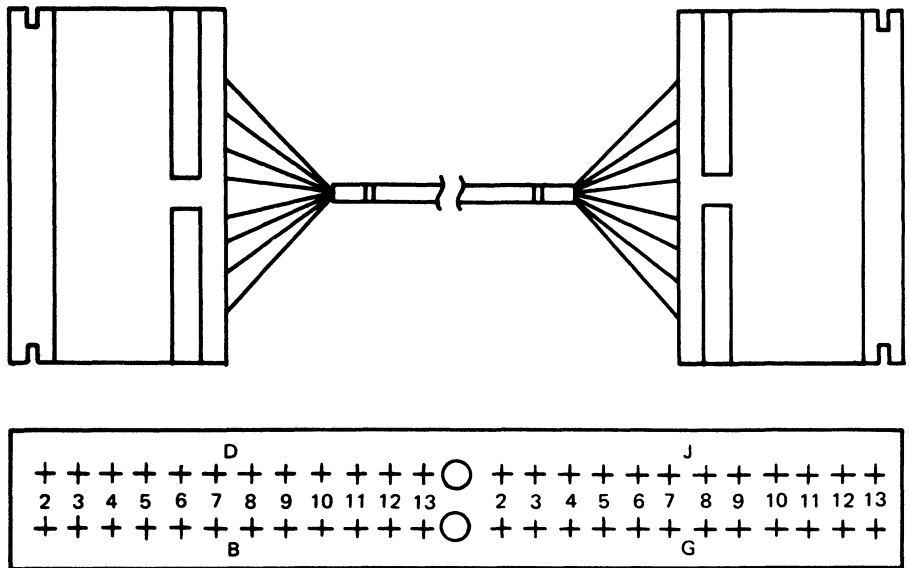
Figure 16. IBM 3704 and 3705 to System/360 or System/370 Cables

Make Certain These Grounding Straps are Connected.
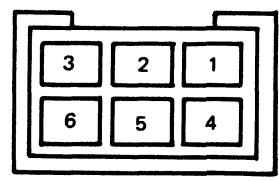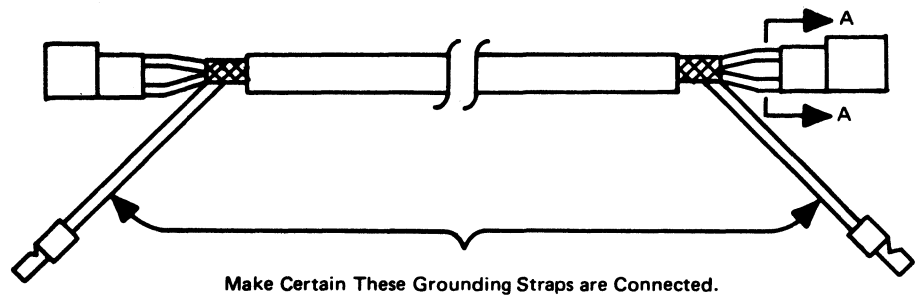
View A—A

Figure 17. Emergency Power Off (EPO) Cable

Serpent Conn

Cable No. 2

CONN. B

Cable No. 1

CONN. A

SEE DETAIL A

DETAIL A
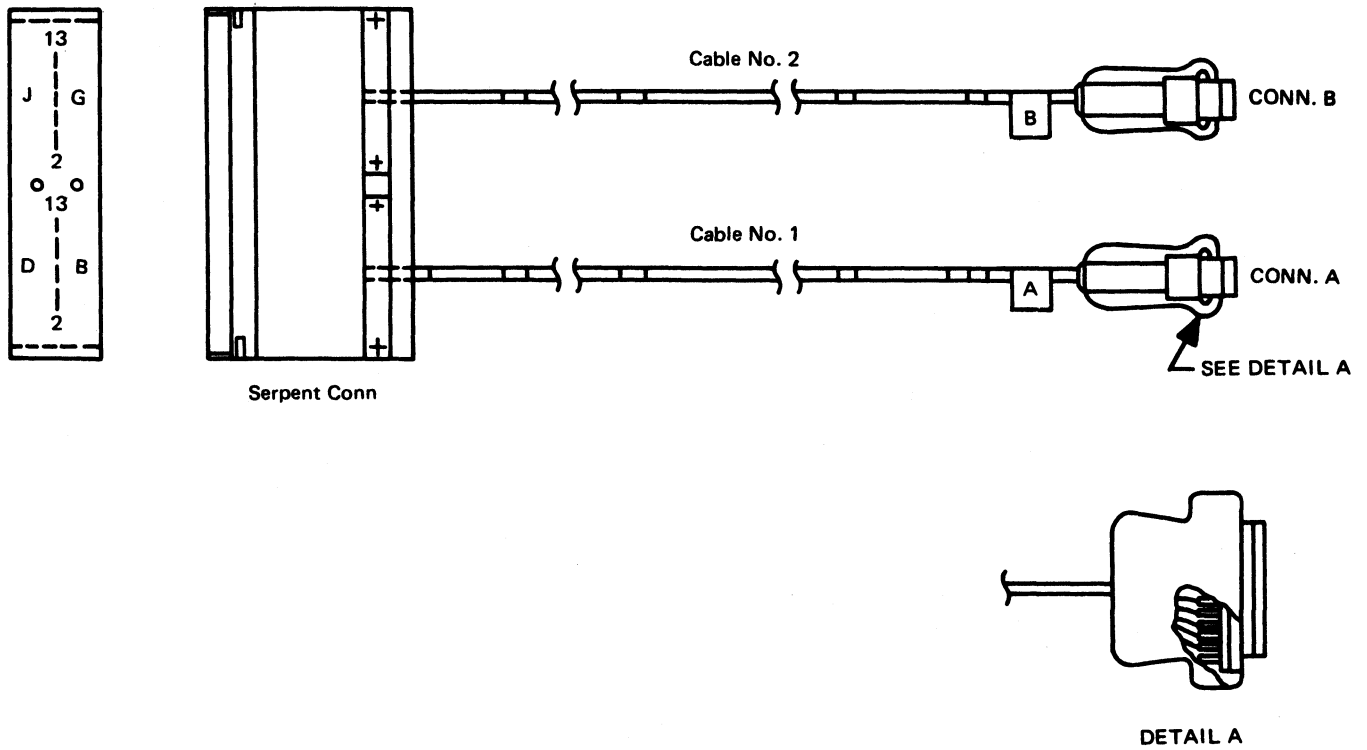
LEAD NO.	CABLE NO. 1		LEAD NO.	CABLE NO. 2	
	SERPENT CONN	"A" CONN		SERPENT CONN	"B" CONN
1	B02	2	1	G02	2
2	B04	3	2	G04	3
3	B06	4	3	G06	4
4	B05	5	4	G05	5
5	B08	6	5	G08	6
6	D08	7	6	J08	7
7	D02	8	7	J02	8
8	D07	13	8	J07	13
9	D10	14	9	J10	14
10	B10	15	10	G10	15
11	D09	16	11	J09	16
12	B13	17	12	G13	17
13	D11	18	13	J11	18
14	D03	20	14	J03	20
15	D05	22	15	J05	22
16	D06	23	16	J06	23

Figure 18. Line Set 1A and 1D Interface Cable
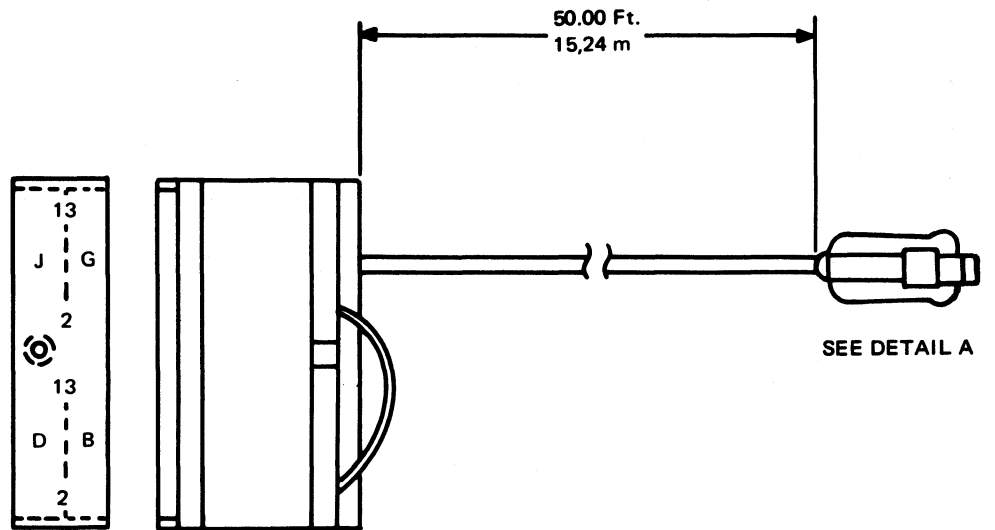
50.00 Ft.
15,24 m

SEE DETAIL A

DETAIL A

BODY COLOR	TRACER	LEAD NO.	SERPENT CONN	DATA SET CONN
RED	BLUE	1	B02	2
RED		2	G04	3
NATURAL	BLACK	3	B06	4
NATURAL	BROWN	4	B05	5
NATURAL	YELLOW	5	G08	6
NATURAL	BLUE	6	D08	7
TAN		7	J02	8
ORANGE		8	J03	20
BLACK		9	J05	22
BLACK		10	D03	
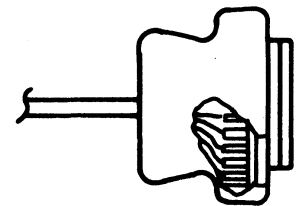
Figure 19. Line Set 1B Interface Cable
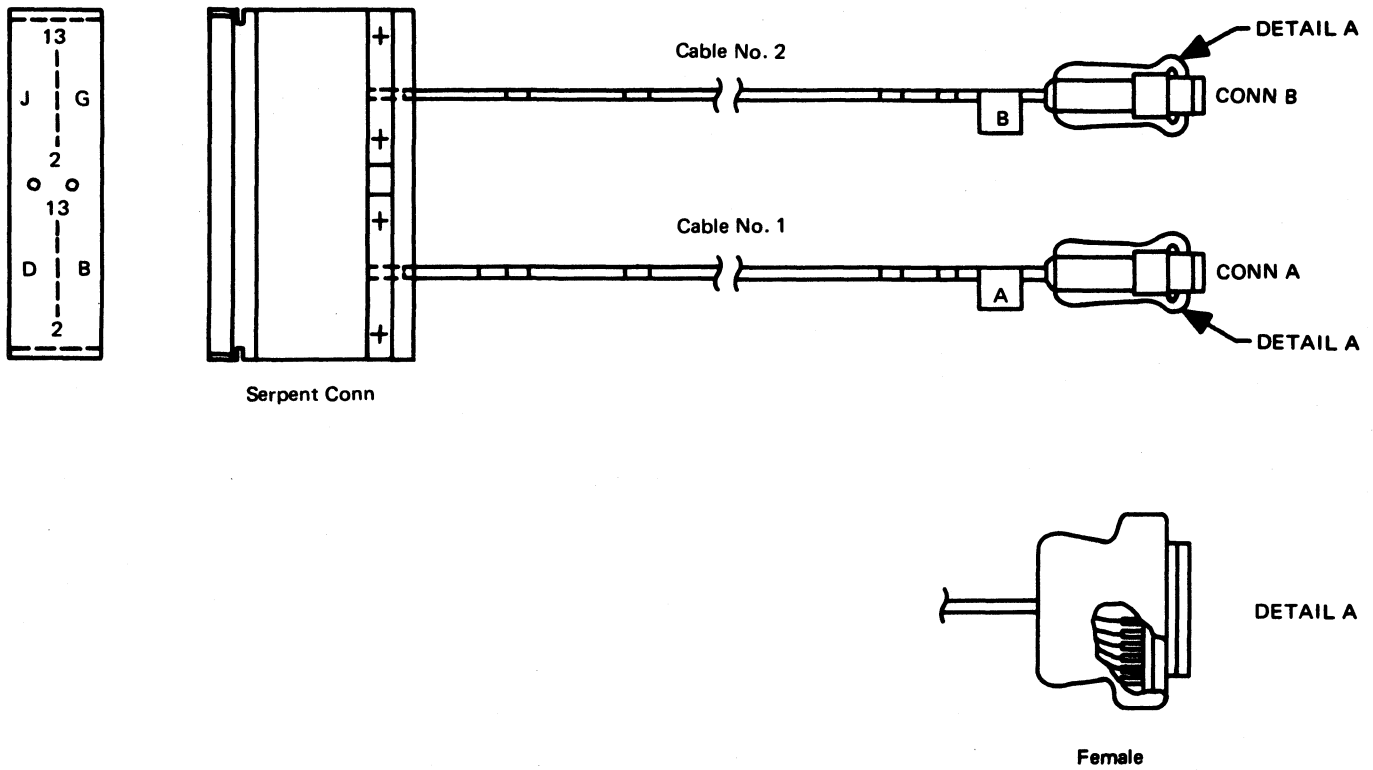
Figure 20. Line Set 1C Interface Cable

BODY COLOR	LEAD NO.	CABLE NO. 1		LEAD NO.	CABLE NO. 2	
		SERPENT CONN	"A" CONN		SERPENT CONN	"B" CONN
YELLOW	1			6		
BLACK	1T			6T		
YELLOW	2	B04	2	7	G04	2
BLACK	2T	D08	7	7T	J08	7
YELLOW	3	B02	3	8	G02	3
BLACK	3T	D08	7	8T	J08	7
YELLOW	4	D06	8	9	J06	8
BLACK	4T	D10	6	9T	J10	6
BLACK	5	B05 TO B06	4 TO 5	10	G05 TO G06	4 TO 5
BLACK	11	D03 TO B08		12	J03 TO G08	

Serpent Connector

CONN B

CONN A

SEE DETAIL A

Cable No. 2

Cable No. 1

DETAIL A

Figure 21. Line Set 1E Interface Cable
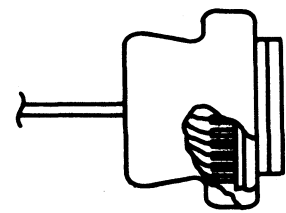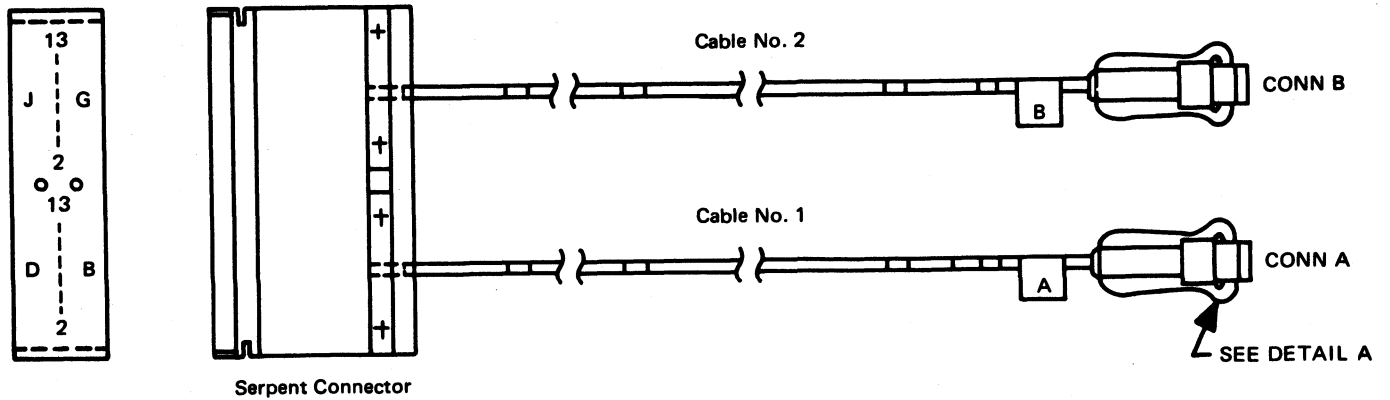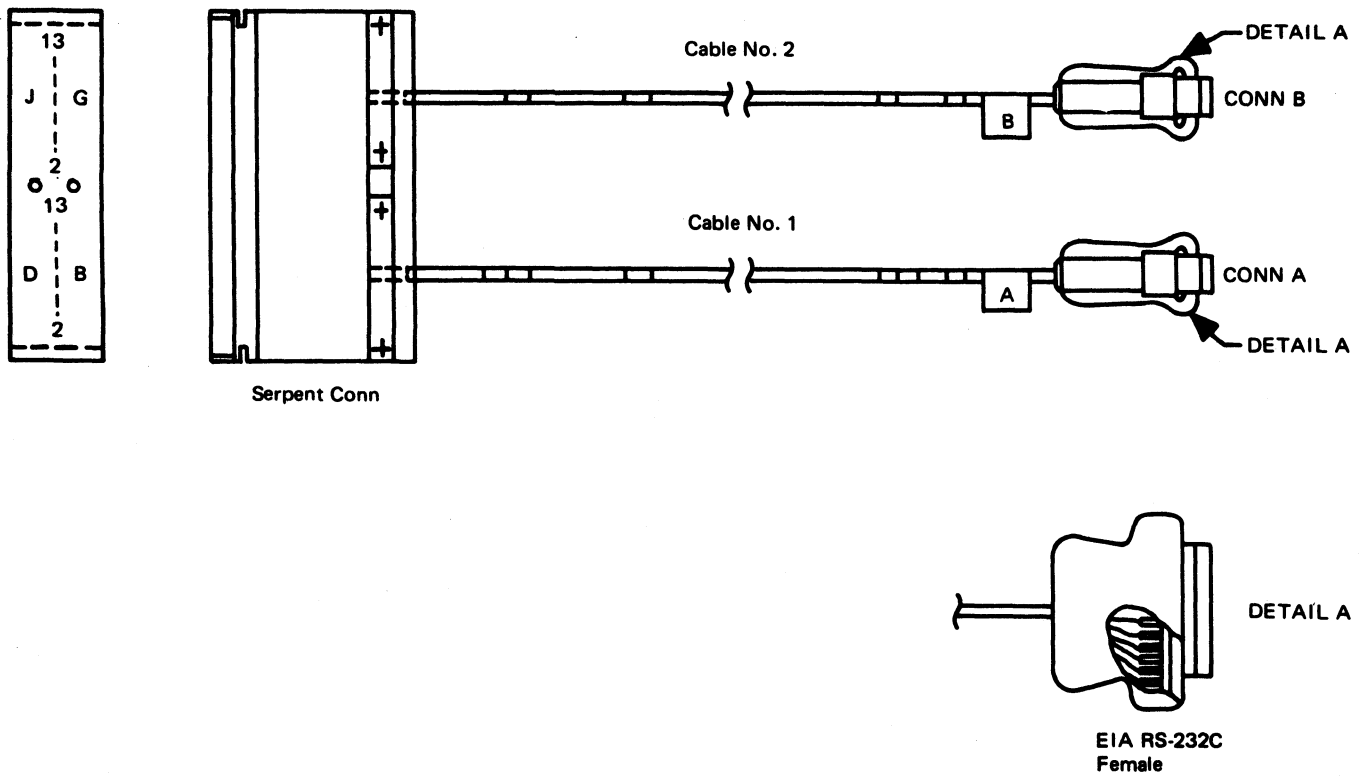
LEAD NO.	CABLE NO. 1		LEAD NO.	CABLE NO. 2	
	SERPENT CONN	"A" CONN		SERPENT CONN	"B" CONN
1	B02	2	1	G02	2
2	B05	3	2	G05	3
3	B06	4	3	G06	4
4	B04	5	4	G04	5
5	B08	6	5	G08	6
6	D08	7	6	J08	7
7	B10	13	7	G10	13
8	D10	14	8	J10	14
9	D11	15	9	J11	15
10	D06	16	10	J06	16
11	D03	17	11	J03	17
12	D05	22	12	J05	22

Serpent Conn

Cable No. 2

CONN B

DETAIL A

Cable No. 1

CONN A

DETAIL A

DETAIL A

EIA RS-232C
Female

BODY COLOR	LEAD NO.	CABLE NO. 1		LEAD NO.	CABLE NO. 2	
		SERPENT CONN	"A" CONN		SERPENT CONN	"B" CONN
YELLOW	1	UNUSED	UNUSED	6	UNUSED	UNUSED
BLACK	1T	D06	8	6T	J06	8
YELLOW	2	B04	2	7	G04	2
BLACK	2T	D08	7	7T	J08	7
YELLOW	3	B02	3	8	G02	3
BLACK	3T	D08	7	8T	J08	7
YELLOW	4	D03	6	9	J03	6
BLACK	4T	B08	20	9T	G08	20
BLACK	5	B05 TO B06	4 TO 5	10	G05 TO G06	4 TO 5

Figure 22. Line Set 1F Interface Cable

CONNECTING SCREW

Burndy Conn

END VIEW
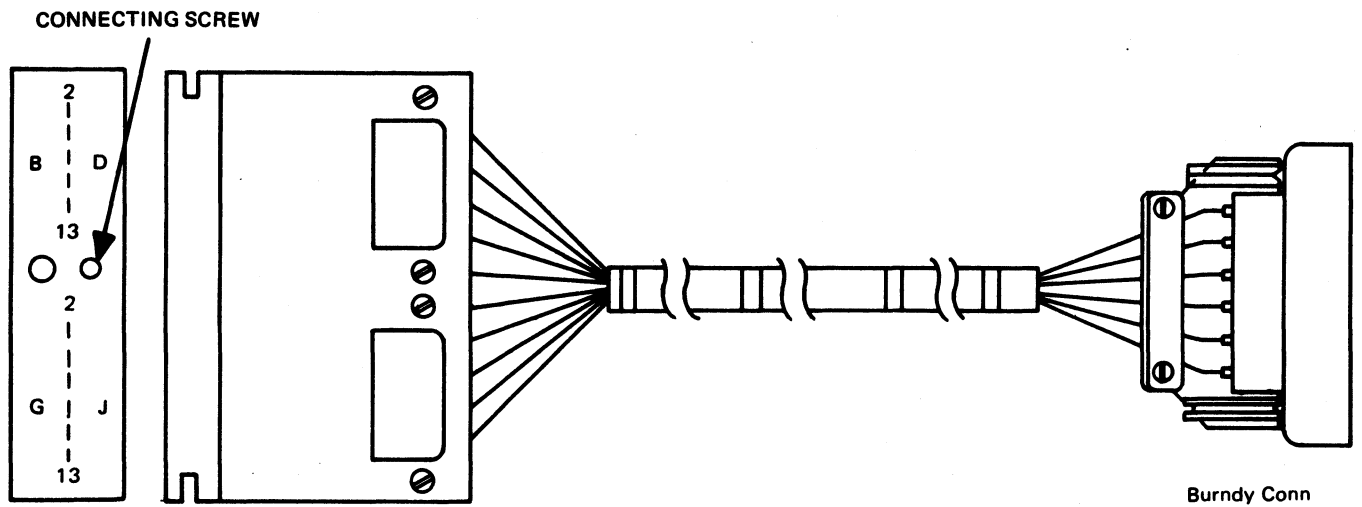
FROM BURNDY CONN POSITION NO.	TO STYLE B CONN.	
	SIGNAL	SHIELD GND.
A	B3	B2
B	J9	G9
C	G5	J5
D	J3	G4
E	G2	J2
F	B5	D2
G	D13	B13
H	G8	J8
J	J6	G7
K	G12	G13
L	J11	J12
M	B4	B8
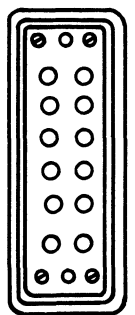
Figure 23. Line Set 1G Interface Cable
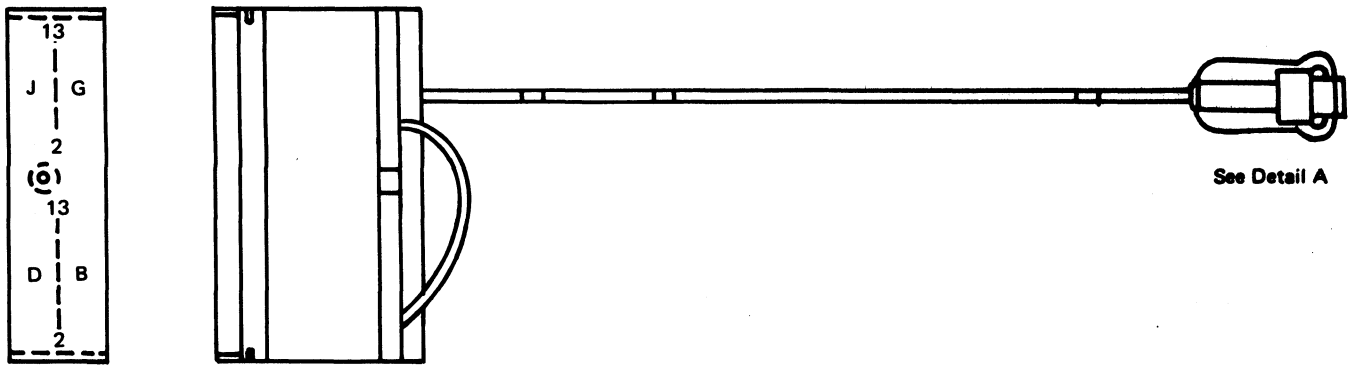
See Detail A

Detail A

BODY COLOR	TRACER	LEAD NO.	SERPENT CONN	DATA SET CONN
RED	BLUE	1	B02	2
RED		2	G04	3
NATURAL	BLACK	3	B06	4
NATURAL	BROWN	4	B05	5
NATURAL	YELLOW	5	G08	6
NATURAL	BLUE	6	D08	7
TAN		7	J02	8
NATURAL	RED	8	D07	13
NATURAL	ORANGE	9	D10	14
YELLOW	RED	10	B10	15
RED	YELLOW	11	D09	16
GRAY		12	G13	17
BLUE		13	D11	18
ORANGE		14	D03	20
BLACK		15	D05	22
BROWN		16	D06	23
BLACK		17	J03	
		17	B08	
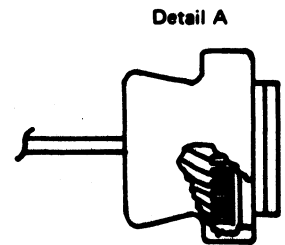
Figure 24. Line Set 1H Interface Cable
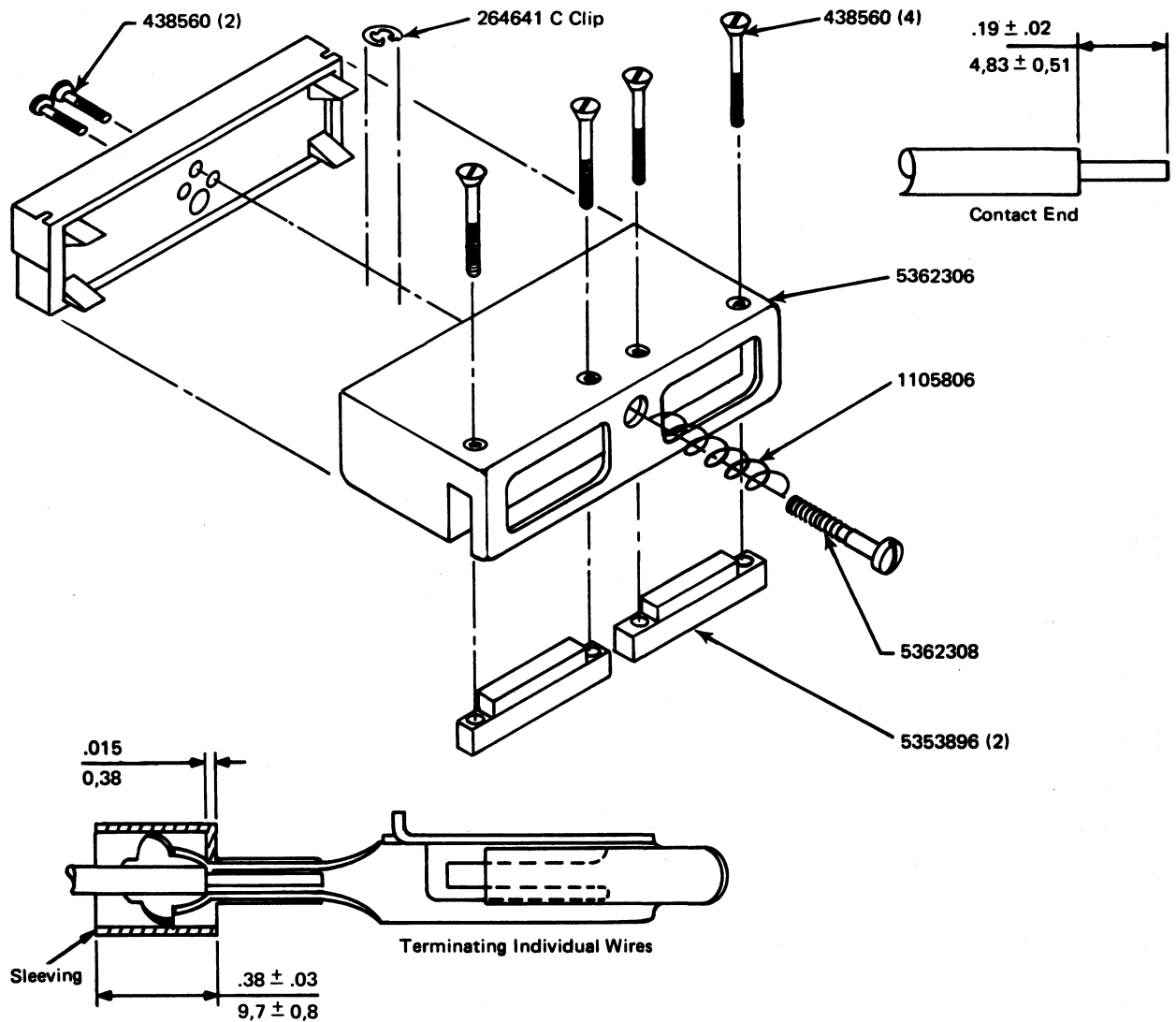
Connector Terminations	
Line Description	Connector Pin
Transmit Clock	D02
Signal Return Transmit Clock	B13
Receive Clock	B05
Signal Return Receive Clock	B02
Mark Receive Data	D06
Signal Return Receive Data	D07
Mark Send Data	D10
Ground Send Data	B11

Terminating Individual Wires	Contact
No. 22 Solid and Stranded	5362301
No. 24 Solid and Stranded	5362301
No. 26 Solid and Stranded	5362301
No. 18 Solid and Stranded	5404480
No. 20 Solid and Stranded	5404480

Terminating Multiple Wires	Contact
Two No. 24 Solid	5404480
Two No. 24 Stranded	5404480
Two No. 26 Solid	5362301
Two No. 29 Solid	5362301
Two No. 30 Solid	5362301
Five No. 29 Solid	5362301
Ten No. 29 Solid	5404480
Two No. 22 Solid	5404480
Two No. 22 Stranded	5404480
No. 20 and No. 24 Solid	5404480
No. 20 and No. 24 Stranded	5404480

Figure 25. Line Set 1J Cable Connector Block

WIRE NO.	CONN PIN	BODY COLOR	TRACER COLOR	MODEM CONN
T1	D08	YELLOW	NONE	B
T1	B13		BLACK	C
T2	D11		NONE	D
T2	D12		BROWN	L
T3	D09		NONE	F
T3	B07		RED	N
T4	D13		NONE	E
T4	B11		ORANGE	M
T5	B04		NONE	R
T5	D05		BLUE	T
T6	B08		NONE	V
T6	B10		VIOLET	X
T7	B06		NONE	P
T7	D07		GRAY	S
T8	D02		NONE	Y
T8	B02	YELLOW	WHITE	a
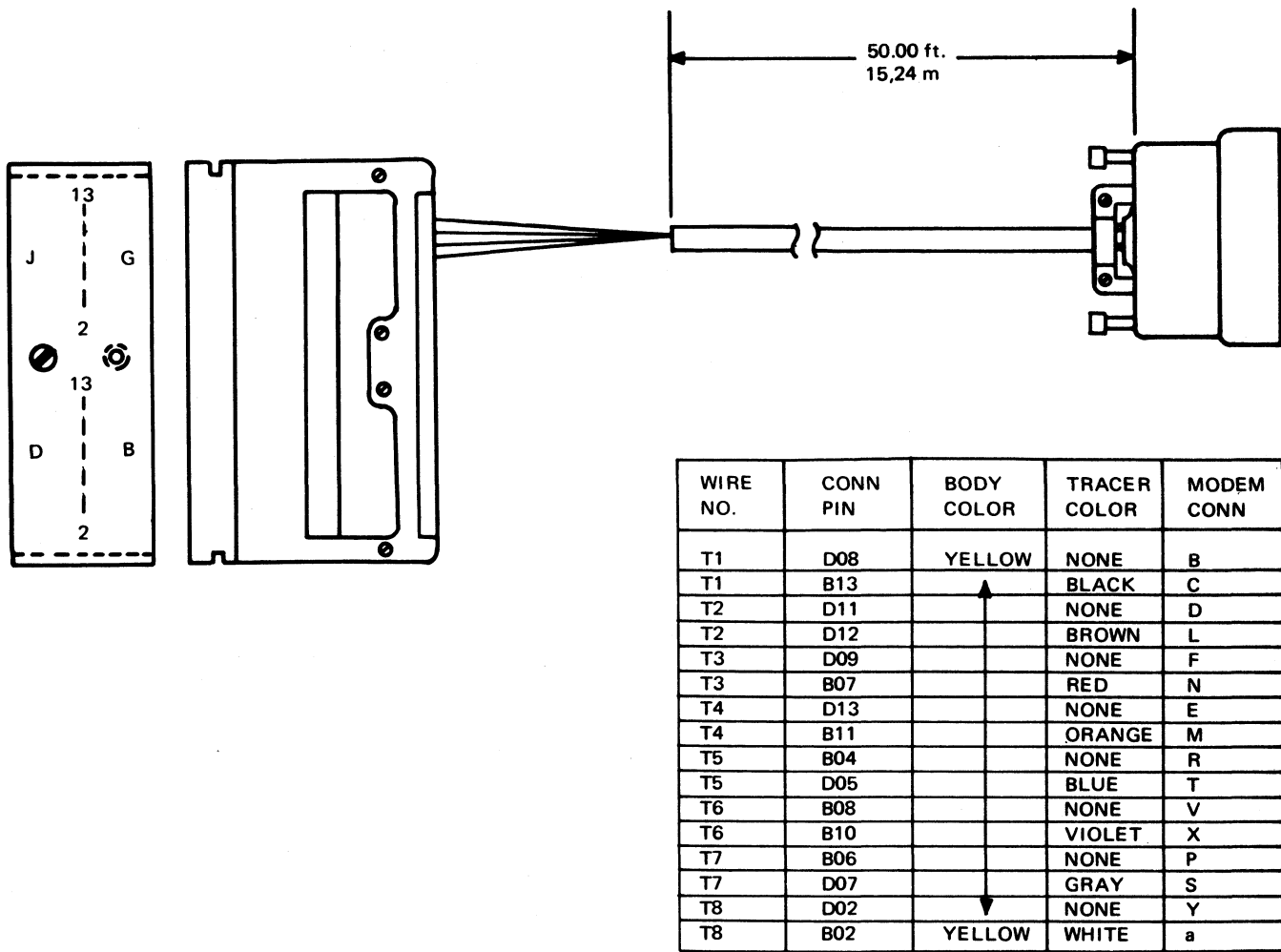
Figure 26. Line Set 1K Interface Cable
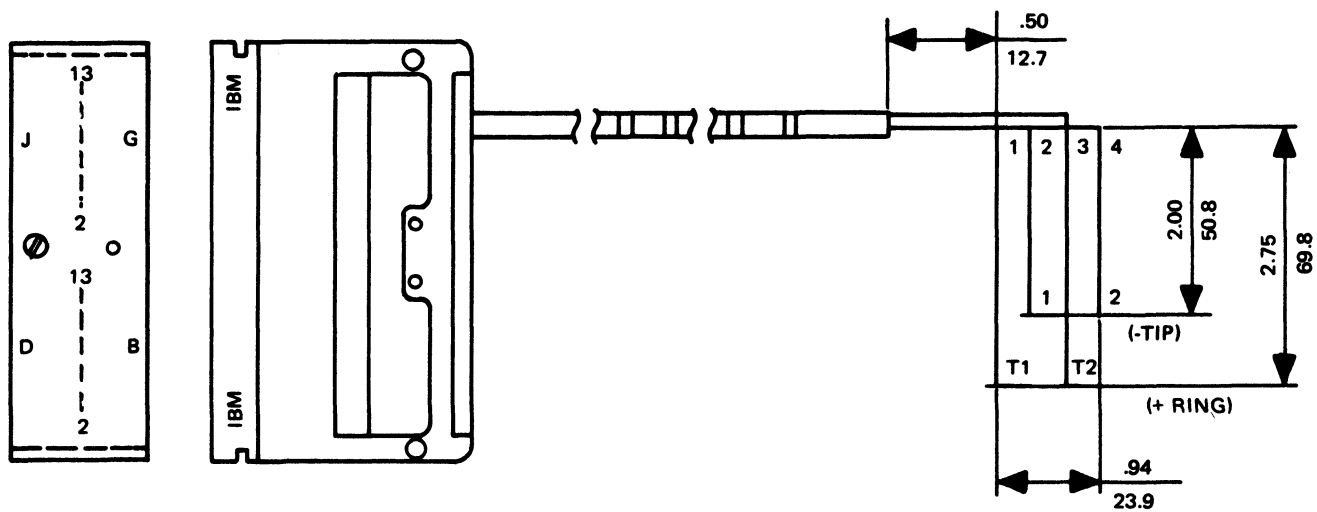
WIRE NO.	CONN PIN	COLOR
T1	G02	BLACK
1	G05	YEL
T2	G09	BLACK
2	G13	YEL

Figure 27. Line Set 2A Interface Cable
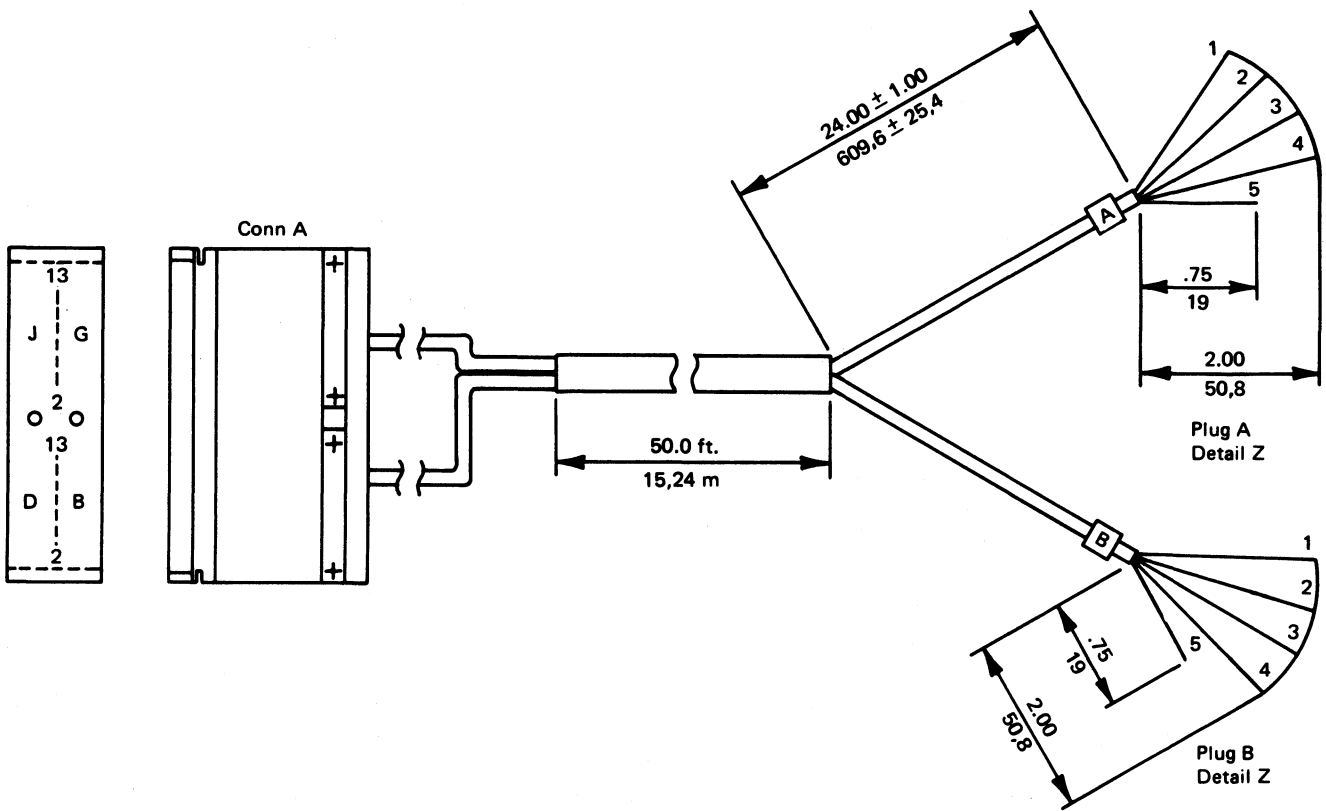
LEAD NO.	CABLE A		CABLE B	
	CONN "A"	CONN "B"	CONN "A"	CONN "B"
1 (RED)	D09	R	J09	R
2 (WHITE)	D02	GN	J02	GN
3 (BLACK)	D07	BK	J07	BK
4 (YELLOW)	D05	Y	J05	Y
5 (SHIELD)	D03		J03	

WIRING SIDE OF CONNECTION

Detail Z
Male Telephone
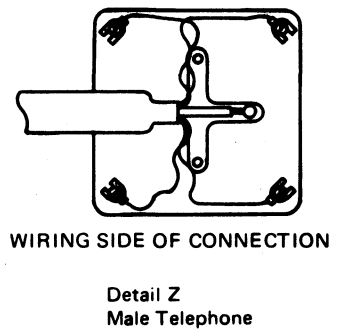
Figure 28. Line Set 3A, 3B, 4A, 4B, and 4C Interface Cable
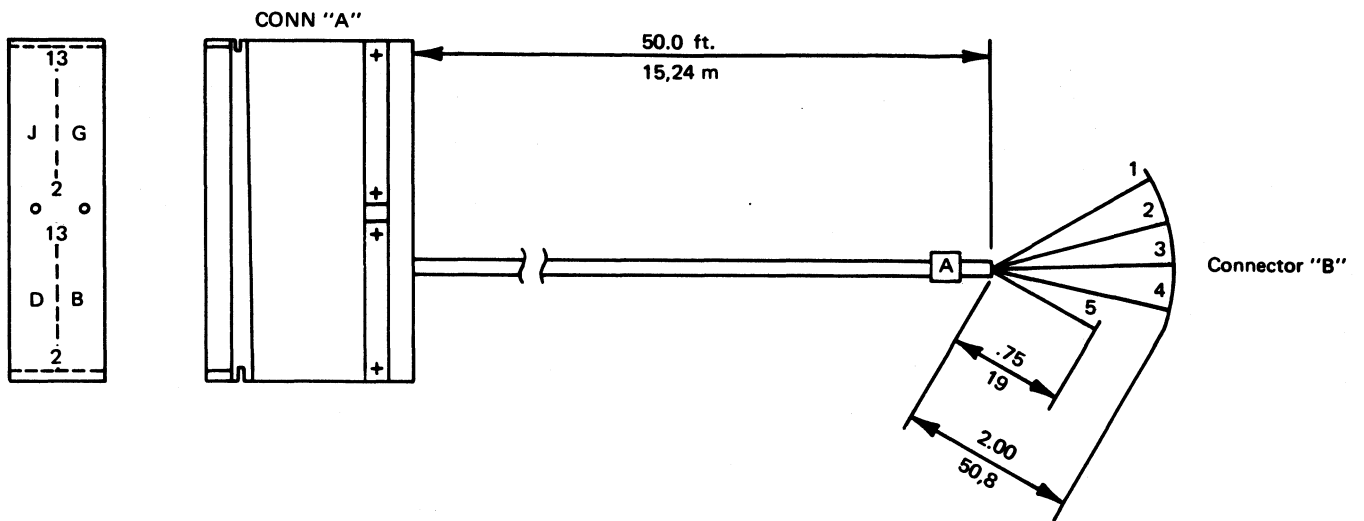
LEAD NO.	CABLE A	
	CONN "A"	CONN "B"
1 (RED)	D09	R
2 (WHITE)	D02	GN
3 (BLACK)	D07	BK
4 (YELLOW)	D05	Y
5 (SHIELD)	D03	
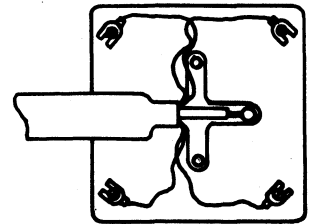
Wiring Side of Connector "B"
Male Telephone (U.S. and Canada only)

Figure 29. Line Set 5A and 5B Interface Cable
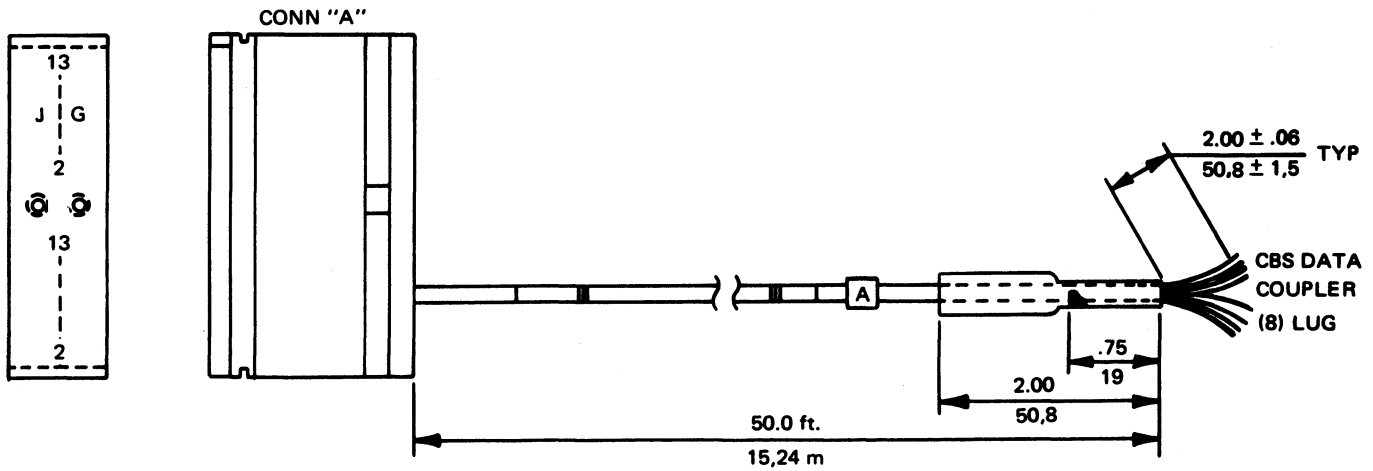
Note: This cable is applicable to the U.S. and Canada only.

LEAD NO.	CABLE A
	SERPENT CONN
1 (BROWN)	B02
2 (RED)	B09
3 (VIOLET)	B04
4 (YELLOW)	B05
5 (GREY)	B08
6 (BLUE)	B08
7 (WHITE)	B12
8 (BLACK)	B13
9 (PINK)	
10 (PINK/BLUE)	
11 (ORANGE)	
SHIELD	D03

Figure 30. Line Set 6A, 9A, and LIB 7 Interface Cable
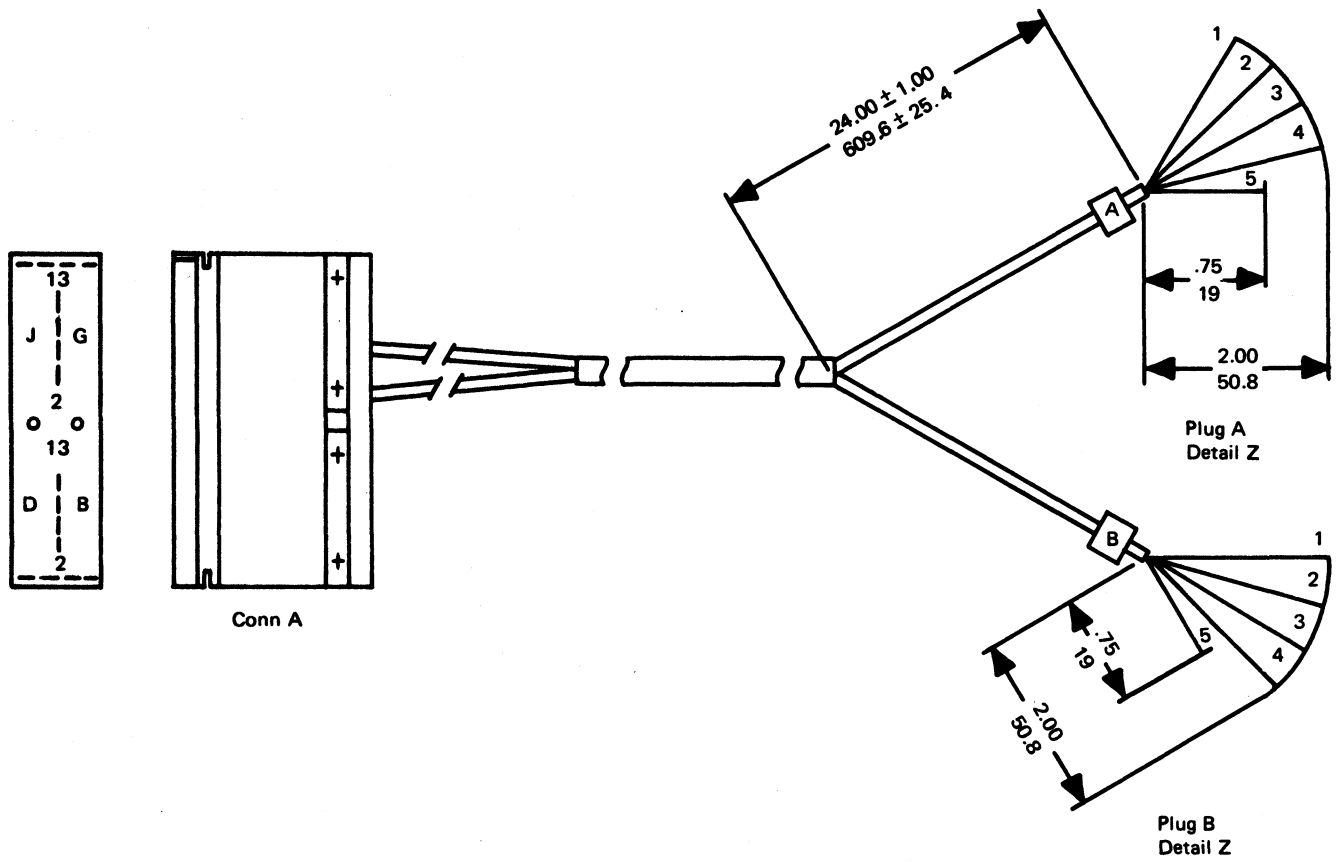
LEAD NO.	CABLE A		CABLE B	
	CONN "A"	CONN "B"	CONN "A"	CONN "B"
1 (RED)	B02	R	B05	R
2 (WHITE)	D02	GN	D06	GN
3 (BLACK)	B04	BK	B06	BK
4 (YELLOW)	D05	Y	D07	Y
5 (SHIELD)	B03		D04	
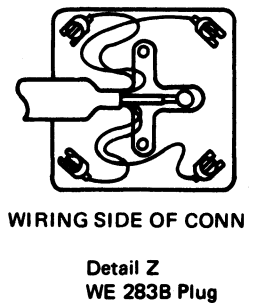
Figure 31. Line Set 8A Interface Cable
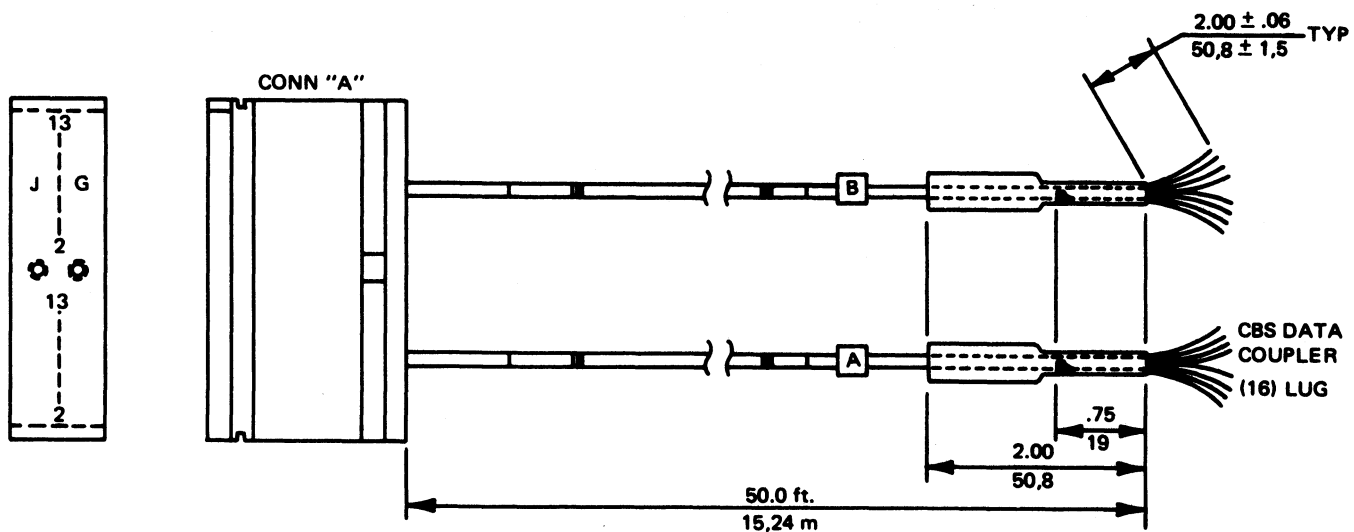
Note: This cable is applicable to the U.S. and Canada only.

LEAD NO.	CABLE A	CABLE B
	SERPENT CONN	SERPENT CONN
1 (BROWN)	B02	G02
2 (RED)	B09	G09
3 (VIOLET)	B04	G04
4 (YELLOW)	B05	G05
5 (GREY)	D08	J08
6 (BLUE)	B08	G08
7 (WHITE)	B12	G12
8 (BLACK)	B13	G13
9 (PINK)		
10 (PINK/BLUE)		
11 (ORANGE)		
SHIELD	D03	J03

Figure 32. Line Set 8B Interface Cable

Appendix: Examples of Character Framing

I. Start-Stop, 9/7 Bit Control, Transmit

BCD Code	C	1	2	4	8	A	B

PDF | 0 | | | | | | | 7 |

Start bit from Scanner

SDF | 0 | | | | | | | | | 9 |

ICW 24   33

Transmit Buffer in line interface

Stop Bit

II. BSC, EBCDIC, Transmit

EBCDIC Char | 0 | | | | | | | 7 |

PDF | 0 | | | | | | | 7 |

SDF | 0 | | | | | | | | | 9 |

ICW 24   33

Transmit Buffer in line interface
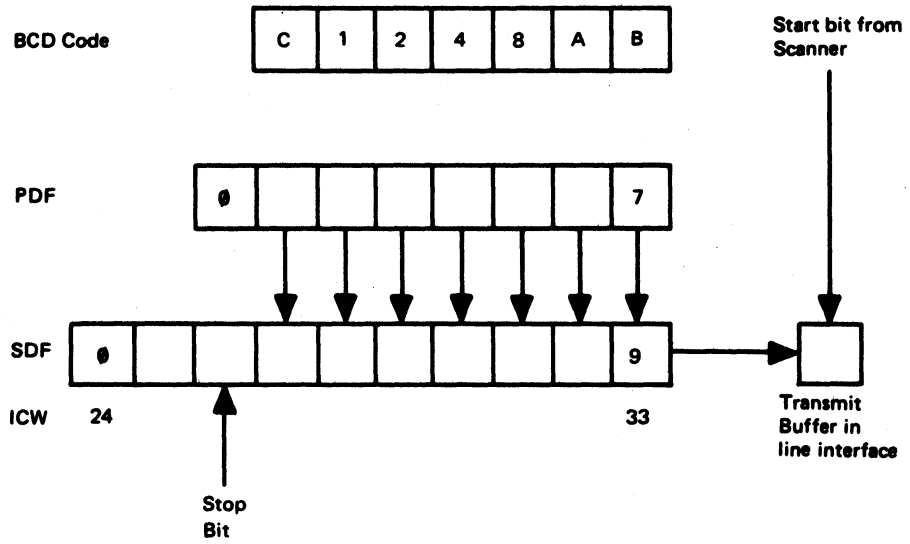
Tag bit
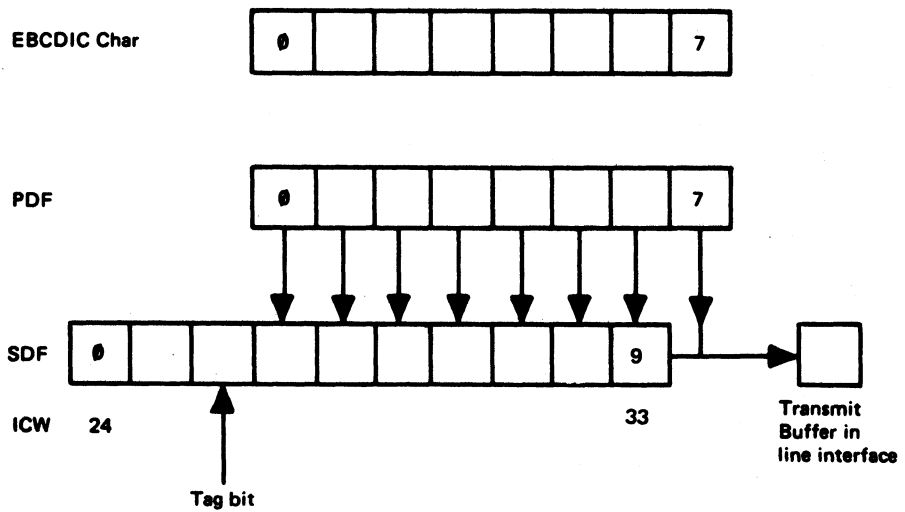
Bit Service. The process of character assembly or disassembly.

Buffer. A temporary storage area for data.

Channel Adapter. An IBM 3704 and 3705 hardware unit that provides attachment of the IBM 3704 and 3705 to a System/360 or System/370 channel.

Character Service. The process by which a character is moved to a buffer from the storage area where it was assembled.

Data Set. A device which performs the modulation/demodulation and control functions necessary to provide compatibility between business machines and communications facilities.

Duplex. Simultaneous two-way independent (equal data rate) transmission in both directions.

Full Duplex. Same as Duplex.

Half Duplex. Alternate, one way at a time, independent transmission. Contrast with duplex.

Interrupt. A halt in processing that allows processing to be resumed at the place it left off.

Line Interface Base. An IBM 3704 and 3705 hardware unit that provides for the attachment of up to 16 communication lines to the IBM 3704 and 3705.

Line Set. An IBM 3704 and 3705 hardware unit through which one or two lines are attached to a line interface base.

Modem. (1) (MOdulator-DEModulator) A device that modulates and demodulates signals transmitted over communication facilities. (2) See also data set.

Telecommunication Lines. Telephone and other communication lines that are used to transmit messages from one location to another.

Telecommunications. (1) Pertaining to the transmission of signals over long distances, such as by telegraph, radio, or television. (2) Data transmission between a computing system and remotely located devices via a unit that performs the necessary format conversion and controls the rate of transmission.

Teleprocessing. The processing of data that is received from or sent to remote locations by way of telecommunication lines.

Terminal. A teleprocessing device capable of transmitting or receiving data (or both) over a communication line.

Transmission Code. A code for sending information over communication lines.

Transmission Control Unit. A unit that provides the interface between communication lines and a computer. The transmission control unit interleaves the transfer of data from many lines across a single channel to the computer.

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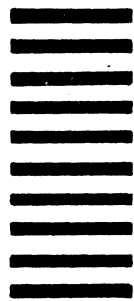
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