

IBM**Systems Reference Library****IBM System/360 Component Description****IBM 2702 Transmission Control**

This publication supersedes SRL Form No. A22-6846-0 and TNL No. N22-0157.

This publication provides information concerning the operation of the IBM 2702 Transmission Control.

The first section contains a general description of the 2702, including the data communication terminals operable with the 2702, the terminal controls used by the 2702 to operate with the various terminals, and the data sets and communication facilities used.

The Operational Functions section discusses communication line addressing, 2702-multiplexor channel operation, and I/O instructions concerning the 2702. This section also contains the various commands and orders used by the 2702 and the transmit and receive operation sequences and, in addition, describes the functions of the status and sense bytes and the polling and addressing of the terminals.

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The IBM 2702 Transmission Control enables the users of System/360, models 30, 40, 50, 65, and 75, to combine data processing and data communications within the same system configuration. The 2702 Transmission Control directs and controls information flow between the system and a variety of remote communications terminals over private and common carrier transmission facilities (Figure 1). Data communication equipment that can be connected to the 2702 includes:

- IBM 1030 Data Collection System
- IBM 1032 Digital Time Unit
- IBM 1050 Data Communication System
- IBM 1060 Data Communication System
- IBM 1070 Process Communication System
- IBM 2711 Line Adapter Unit
- IBM 2712 Remote Multiplexor, models 1 and 2
- IBM 2740 and 2741 Communications Terminal
- AT&T 83B2 or 83B3 Selective Calling Terminals
- Western Union Plan 115A Terminals
- Common Carrier TWX Stations (eight-level code)
- European Teleprinters (World Trade Attachment).

Eight 2702 units can be attached to the multiplexor channel, and operation of each is in the multiplex mode.

The 2702 is flexible in line capacity, transmission code, and speed. The basic 2702 can have 15 half-duplex lines and operate at speeds to 180 baud for any or all attached communication lines. An increase of either the line speed or the number of lines can be made by adding optional features.

The 2702 operates in a start-stop mode at transmission rates up to 600 baud. On input, the 2702 accepts data, serially by bit, from a number of communications lines, converts the data into characters, and transfers the characters (bytes) to the System/360. On output, the 2702 transfers characters, serially by bit, from the System/360 to the remote terminal. One eight-bit buffer per line is provided for multiplex operation on the multiplexor channel. On both input and output, any message buffering is done by the processing unit; the 2702 itself does not impose restrictions on message length. All necessary bit-byte conversions, data control,

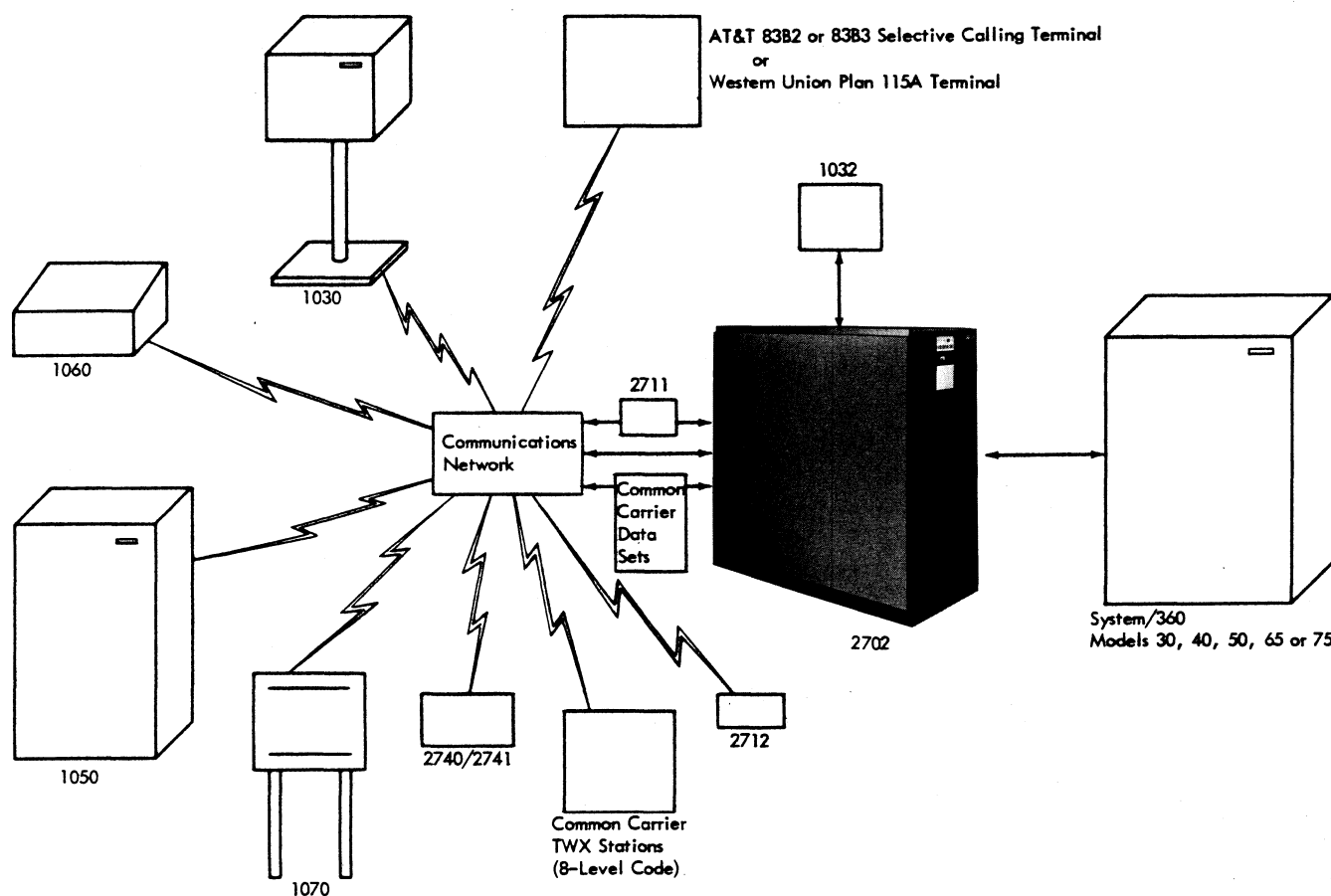


Figure 1. 2702 in a System Environment

and matching to common carrier equipment are accomplished by the 2702.

The 2702 can accommodate transmission codes not exceeding an eight-level, 11-unit structure. On transmit, the start and stop bits are manufactured by the 2702 for transmission onto the communications line. On receive, the start and stop bits are removed from the code structure before each byte is transferred to the multiplexor channel. Transmission codes of less than eight bits are placed in processor storage in the low-order bit positions with the proper number of high-order zeros inserted.

In operation, the 2702 scans each attached communications line to determine if any line has data to send to the CPU or if it needs data from the CPU for transmission. The 2702 takes sample signals from the line, first to derive bits and then to assemble these bits into data bytes. To store these signals during the assembly process, the 2702 uses a delay line storage. This storage keeps the signal circulating until sampling is complete. As soon as a character is assembled, a parity bit is added and the byte is sent to the multiplexor channel.

For output data, when the 2702 is sending data from the CPU to the communications line, this procedure is reversed.

FUNCTIONAL SECTIONS

The 2702 Transmission Control provides for the on-line attachment of input/output devices to an IBM System/360, models 30, 40, 50, 65, and 75, via private and common carrier transmission facilities. All necessary character serializing-deserializing, data control, and matching to common carrier equipment are accomplished by the functional sections of the 2702.

I/O Interface Controls

The I/O interface controls section connects the 2702 to the I/O interface of the System/360, connects models 30, 40, or 50 via the multiplexor channel, or connects models 65 and 75 via the IBM 2870 Multiplexor Channel. The electronic circuitry in this section controls all signal sequences with the multiplexor channel. Because of the asynchronous operation of the multiplexor channel and the 2702, delay line storage and data registers are required. A 2702 buffer register holds a command byte issued by the CPU to a particular communications line until that line is scanned. A separate path is provided within the interface controls for buffering a single data byte or unit status byte. Data transfer between the 2702 and the multiplexor channel of the System/360 is in byte-multiplex mode. Each byte consists of eight data bits plus one odd parity bit.

Storage and Common Controls

This section accepts commands and data bytes from the multiplexor channel via the interface controls section and performs all functions common to each communications line. Two delay lines operating synchronously provide 64 bits of storage called a line control word (LCW) for each communications line. Fields in the LCW define:

- Sample count within a bit
- Bit count
- Assembly-disassembly area
- Longitudinal redundancy check (LRC) accumulator
- Character buffer
- Unit status
- Sequence and mode control
- Sense information
- Other bits for internal control

The storage and common controls section initiates the transfer of data bytes to or from LCW storage and the termination of channel commands by transferring the unit status byte to the channel.

Terminal Controls

This section performs functions associated with a given communications terminal. The terminal control regulates the operation with the attached terminal, performing such functions as character or character sequence recognition and checking of the transmission code. One terminal control services all terminals of the same type. At least one, and no more than three terminal controls can be chosen for any 2702 Transmission Control. The following terminal controls can be selected for the 2702:

IBM Terminal Control Type I enables the 2702 to operate with the 1050 Data Communication System, the 1060 Data Communication System, the 1070 Process Communication System, and the 2740/2741 communication terminals. Three speeds are available (only one speed may be selected without an additional Selective Speed feature):

<u>SPEED</u>	<u>CONNECTION</u>
75 baud	IBM 1050 Terminals over telegraph lines
134.49 baud	IBM 1050, 1060, and 1070 2740/2741 Terminals
600 baud	IBM 1070 Terminals

NOTE: The 2741 Break feature enables the 2702 to operate with a 2741 Communications Terminal equipped with an Interrupt feature at speeds of 134.49 baud. This feature works in conjunction with an IBM Terminal Control Type I, and thus is

addressed as a separate terminal control. The IBM Terminal Control Type I may also be addressed independently of the 2741 Break feature.

IBM Terminal Control Type II enables the 2702 to operate with the 1030 Data Collection System (1031A Input Station, 1032 Digital Time Unit, at 600 baud.

Telegraph Terminal Control Type I enables the 2702 to operate with AT&T 83B2 and 83B3 Selective Calling Terminals or the Western Union Plan 115A Terminals. Three speeds are available (only one speed may be selected without an additional Selective Speed feature):

SPEED	CONNECTION
45.5 baud	Telephone Company Schedule 1 Channels Western Union Class A Channels
56.89 baud	Telephone Company Schedule 2 or Western Union Class B Channels
74.2 baud	Telephone Company Schedule 3 or Western Union Class C Channels

NOTE: The AT&T 83B3 operates at 74.2 baud only.

Telegraph Terminal Control Type II enables the 2702 to operate common carrier TWX stations using an eight-level code at 110 baud on the common carrier or 150-baud teletypewriter exchange (TWX) networks.

World Trade Telegraph Terminal Control enables the 2702 to operate with various European teleprinters over single-current or double-current telegraph lines. Speeds are 50 and 75 baud (only one speed may be selected without an additional Selective Speed feature).

NOTE: The World Trade Terminal Control and the Telegraph Terminal Control Type I are mutually exclusive; that is, either feature may be chosen but not both.

Line Adapters

The line adapter matches the interface of the communications facilities and provides bit buffering for the transmit data line. One line adapter must be selected for each half-duplex communications line attached to the 2702. Five types of line adapters are available. The choice of line adapter is generally independent of the type of terminals and dependent on the communications facility specified. The adapters used with the 2702 are:

Data Set Line Adapter is used for attachment to the following: IBM 2711 Line Adapter Unit; Western Electric data set 103A1* for operation on common carrier switched telephone or 150-baud TWX networks; Western Electric data set 103F2* for operation on common carrier leased private telephone

*or equivalent.

networks; appropriate channel termination provided by the common carrier, as required by local conditions, for operation on telephone company Schedule 3A channels; Western Union data set 11725A* or Western Union Class D (180-baud) channels; Western Electric data set 202D1* for operation on common carrier 4-wire full-duplex leased private telephone lines; and Western Union data set 1601A* for operation on Western Union Class E channels. This line adapter is also used for attachment to the IBM 3976 and 3977 modems for WT connections.

Telegraph Line Adapter is used for attachment via leased telegraph channels utilizing 62.5-ma neutral signaling or the IBM 3945 line terminator (for WT connections).

IBM Line Adapter Limited Distance Type I is used for attachment via customer-provided facilities to IBM terminals equipped with the IBM in-house modem (subset). A maximum of 16 line connections may be made to any one 2702 Transmission Control. See SRL A24-3435 for specifications and restrictions. The capability of this line adapter may also be supplied via the 2711.

IBM Line Adapter (Limited Distance Type I) is used for attachment of the 2740/2741 Communications Terminals. See SRL Manual A24-3435 for specifications and restrictions.

2712 Line Adapter provides the interface between the 2702's common controls and the 2712 Model 1 or Model 2 Adapter feature. One is required for each line operating with the IBM 2712 Remote Multiplexor.

Special Features

The following special features provide expanded capability for the IBM 2702 in terms of line speed, number of lines, and other functions.

Speed Extension Feature allows the 2702 Transmission Control to operate at speeds up to 600 baud on all 15 lines.

31 Line Expansion Feature expands the line-handling capabilities of the 2702 up to 31 half-duplex lines at 200 baud. The 31 Line Expansion feature and the Speed Extension feature are mutually exclusive.

Additional Selective Speed Feature provides for installation of an additional selective speed on terminal controls where more than one speed is available. Without this feature, a terminal control may operate terminals at one speed only.

Auto Call Feature provides the 2702 with automatic dialing capabilities for eight line attachments.

Auto Call Expansion Feature expands the automatic dialing capability of the 2702 to 16 line attachments; the Auto Call feature is a prerequisite.

Auto Call Adapter Feature matches the interface of the common carrier automatic calling unit; the Auto Call feature is a prerequisite. The Auto Call adapter provides for attachment to the dial network via Western Electric Automatic Calling Unit 801A*. A maximum of 16 automatic call adapters can be chosen for one 2702. One adapter is required for each Auto Call line.

Two Processor Switch Feature provides for physically attaching one 2702 to the multiplexor channels of two System/360 processors. Switching the 2702 between the two multiplexor channels is provided automatically by program control.

1032 Attachment Feature allows the IBM 1032 Digital Time Unit to be attached, via a 20-foot cable, to line one of the 2702, provided an IBM Terminal Control Type II, a Speed Extension feature, and a Data Set Line Adapter or IBM Line Adapter are available. Upon being polled, the 1032 provides time data at 600 baud (60 cps) to the CPU. Other 1031 and 1033 terminals may also operate on line one.

IBM 2712 Adapter (models 1 and 2) decreases the total cost of the communications networks. This adapter is used in conjunction with an IBM 2712 Remote Multiplexor. The remote multiplexor is a free-standing unit located at the remote communications point. It allows up to 10 lines operating at 134.49 baud or 14 lines operating at 74.2 baud to be bit-multiplexed onto one high-speed full-duplex communication line. Demultiplexing of the 10- and 14-line signals is accomplished by models 1 and 2, respectively, of the 2712 Adapter.

IBM 2741 Break Feature provides for attachment of the IBM 2741 Communications Terminal with Interrupt feature in time sharing and other applications.

Figure 2 shows the basic and special features of the 2702 Transmission Control.

Figures 3 and 4 list the data communications terminals that can be attached to the 2702, the communication facility and data set used for attachment of each terminal, the operating speed, and the 2702 features required.

*or equivalent.

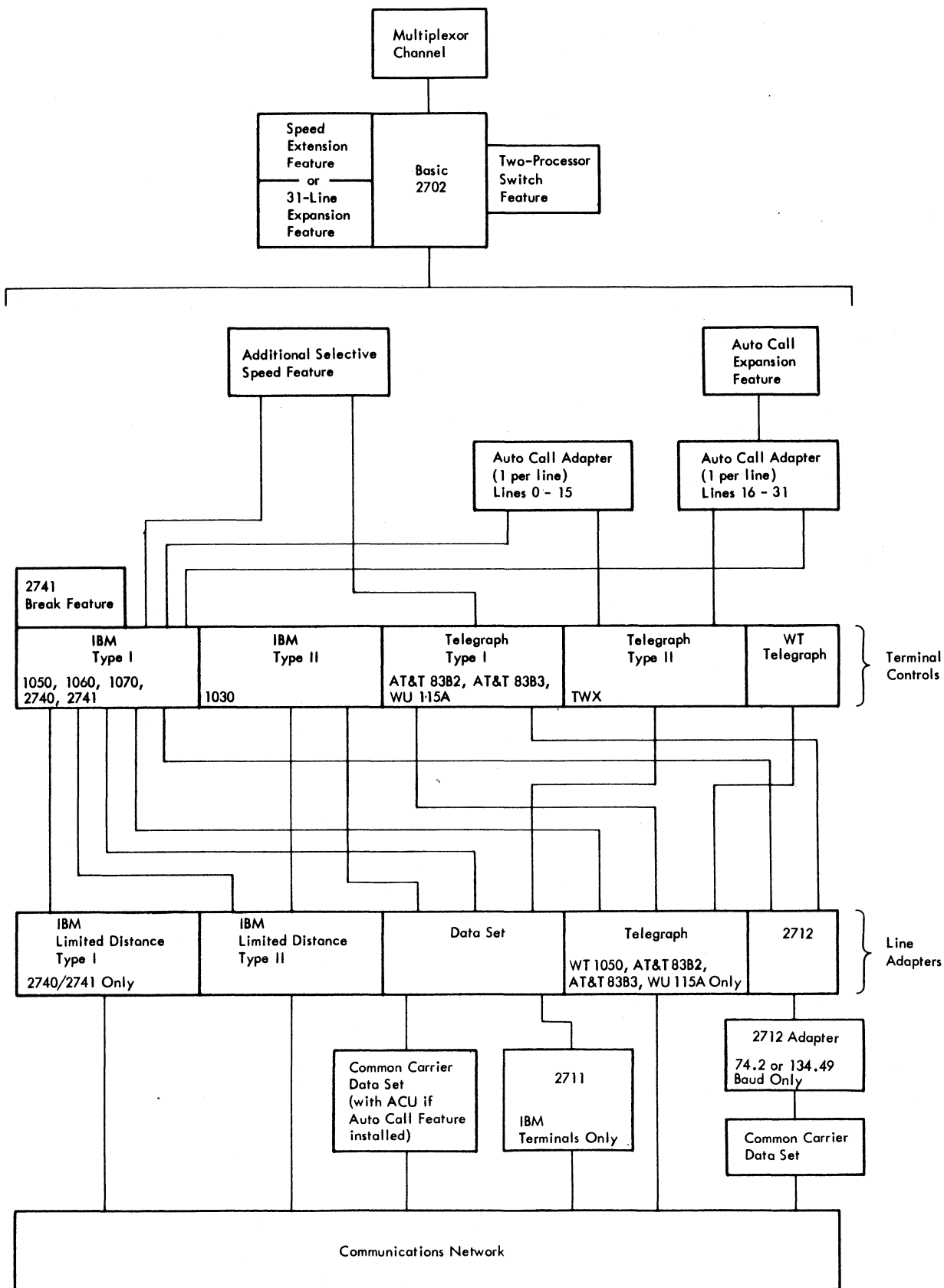


Figure 2. 2702 Configuration

Terminal	Communication Facility	Terminal Data Set*	2702 Data Set*	Speed	2702 Prerequisites
1050 Data Communication System					
1051 Control Unit Model 1 or 2	Common Carrier Switched Telephone Network	Western Electric 103A2	Western Electric 103A2	134.49 Baud	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
	Common Carrier Switched (150 Baud) Teletypewriter Exchange (TWX) Network	Western Electric 103A1	Western Electric 103A1	14.8 Char/Sec	
	Common Carrier Leased Private Line Telephone Service	Western Electric 103F2	Western Electric 103F2		
	Western Union Class D (180 Baud) Channel	Western Union Data Set 11725A	Western Union Data Set 11725A		
	Telephone Company Schedule 3A Data Channels (150 Baud)	An Appropriate Channel Termination Provided by Telephone Company			
1051 Control Unit Model 1 or 2 with Telegraph Attachment #7873	Telephone Company Schedule 3 or Western Union Class C Channels (62.5 ma Neutral Signal)	Not Required	Not Required	75.0 Baud 8.33 Char/Sec	IBM Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)
1051 Control Unit Model 1 or 2 with Line Adapter #4790	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed IBM Line Adapter (#4612) (One per Line)
1060 Data Communication System					
1061 Control Unit Model 1 or 2	Common Carrier Leased Private Telephone Service	Western Electric 103F2	Western Electric 103F2	134.49 Baud	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
	Western Union Class D (180 Baud) Channel	Western Union Data Set 11725A	Western Union Data Set 11725A	14.8 Char/Sec	
	Telephone Company Schedule 3A Data Channels (150 Baud)	An Appropriate Channel Termination Provided by Telephone Company			
1061 Control Unit Model 1 or 2 with Line Adapter #4790	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed IBM Line Adapter (#4612) (One per Line)
1030 Data Collection System					
1031A Input Station	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required	600 Baud 60 Char/Sec	IBM Terminal Control Type II IBM Line Adapter (#4612) (One per Line) Speed Extension Feature
1031A Input Station with Common Carrier Adapter #2068	Common Carrier Leased Four-Wire Full Duplex Private Telephone Service	Western Electric 202D1	Western Electric 202D1		IBM Terminal Control Type II Data Set Line Adapter (One per Line) Speed Extension Feature
	Western Union Class E Channel	Western Union 1601A	Western Union 1601A		
1070 Process Communications System					
1071 Control Unit Model 1	Common Carrier Leased Private Line Telephone Service	Western Electric 103F	Western Electric 103F	134.49 Baud	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
	Western Union Class D (180 Baud) Channel	Western Union Data Set 11725A	Western Union Data Set 11725A	14.8 Char/Sec	
1071 Control Unit Model 1 with Line Adapter #4792	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter (One per Line)
1071 Control Unit Model 2	Common Carrier Leased Four-Wire Full Duplex Private Telephone Service	Western Electric 202D1	Western Electric 202D1	600 Baud	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line) Speed Extension Feature
	Western Union Class E Channel	Western Union 1601A	Western Union 1601A	66.6 Char/Sec	
1071 Control Unit Model 2 with Line Adapter #4793	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter (#4613) (One per Line) Speed Extension Feature
TWX (Teletypewriter Exchange)					
Models 33 and 35 TWX Terminals	Common Carrier Switched 150 bps TWX Networks	Western Electric 103A1	Western Electric 103A1	8-Level code at 110 Baud only	Telegraph Terminal Control Type II Data Set Line Adapter (One per Line)

*Data Sets are those indicated or their equivalent.

Figure 3. Attachable Terminals and Communications Facilities for Domestic Use (Sheet 1 of 2)

Terminal	Communication Facility	Terminal Data Set*	2701 Data Set*	Speed	2701 Adapters
2740/2741 Communications Terminals					
2740/2741 Communications Terminal	Common Carrier Switched Telephone Network	103A2	103A2	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
	Common Carrier Switched TWX Network (150 Baud)	103A1	103A1		
	Western Union Class D Channels (180 Baud)	11725A	11725A		
	Telephone Company Schedule 3A Channels (150 Baud)	An Appropriate Channel Termination Provided by the Telephone Company			
	Common Carrier Leased Private Line Telephone Channels	103F2	103F2		
	Western Union Class E Channels	Western Union 1601A	Western Union 1601A		
2740/2741 with IBM Line Adapter #4790	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed IBM Line Adapter #4612
2740/2741 with IBM Line Adapter #4634	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter I.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter #4634 or #4638
Other Terminals					
AT & T 8382/8383 Selective Calling Terminal	Telephone Company Schedule 1 Channels (45 Baud)	Not Required 62.5 ma. neutral d.c. loop, tip negative, ring positive	Not Required 62.5 ma. neutral d.c. loop, tip negative, ring positive	45.5 Baud	Telegraph Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)
	Telephone Company Schedule 2 Channels (57 Baud)			56.9 Baud	Telegraph Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)
	Telephone Company Schedule 3 Channels (75 Baud)			74.2 Baud	Telegraph Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)
Western Union Plan 115A Terminal	Western Union Class A Channels	Not Required 62.5 ma. neutral d.c. loop, tip negative, ring positive	Not Required 62.5 ma. neutral d.c. loop, tip negative, ring positive	45.5 Baud	Telegraph Adapter Type I #7860
	Western Union Class B Channels (57 Baud)			56.9 Baud	Telegraph Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)
	Western Union Class C Channels (75 Baud)			74.2 Baud	Telegraph Terminal Control Type I Selective Speed Telegraph Line Adapter (One per Line)

*Data Sets are those indicated or their equivalent.

Figure 3. Attachable Terminals and Communications Facilities for Domestic Use (Sheet 2 of 2)

Terminal	Communication Facility	Terminal Data Set	2702 Data Set	Speed	2702 Prerequisites
1050 and 1060 Data Communication Systems and 2740/2741 Terminals					
1051 Control Unit Model 1 or 2 1061 Control Unit Model 1 or 2 or 2740/2741 Terminal	Common Carrier Leased Private Line Telephone Service	IBM 3976	IBM 3976	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
1051 Control Unit Model 1 or 2 2740/2741 Terminal or 1061 Control Unit Model 1 or 2 with Line Adapter #4790	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter (One per Line)
2740/2741 Communications Terminals					
2740/2741 with IBM Line Adapter #4634	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter I.	Not Required	Not Required	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed IBM Line Adapter #4790
2740/2741 with IBM Line Adapter #4790	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter #4634 or #4638
1070 Process Communication System					
1071 Control Unit Model 1	Common Carrier Leased Private Line Telephone Service	IBM 3976	IBM 3976	134.49 Baud 14.8 Char/Sec	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line)
1071 Control Unit Model 1 with Line Adapter #4792	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter (One per Line)
1071 Control Unit Model 2	Common Carrier Leased Four-Wire Private Line Telephone Service	IBM 3977 Model 1	IBM 3977 Model 1	600.0 Baud 66.6 Char/Sec	IBM Terminal Control Type I Selective Speed Data Set Line Adapter (One per Line) Speed Extension Feature
1071 Control Unit Model 2 with Line Adapter #4793	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required		IBM Terminal Control Type I Selective Speed IBM Line Adapter (One per Line) Speed Extension Feature
1030 Data Collection System					
1031A Input Station	Common Carrier Leased Private Line Telephone or Privately Owned Two Wire Communication Facilities Conforming to SRL Manual A24-3435 for Limited Distance Line Adapter II.	Not Required	Not Required	600 Baud 60 Char/Sec	IBM Terminal Control Type II IBM Line Adapter (One per Line) Speed Extension Feature
1031A Input Station with Common Carrier Adapter #2068	Common Carrier Leased Four-Wire Private Line Telephone Service	IBM 3977 Model 1	IBM 3977 Model 1		IBM Terminal Control Type II Data Set Line Adapter (One per Line) Speed Extension Feature
World Trade Teleprinters					
W T Teleprinter	Common Carrier Private Line Telegraph Circuits (Double-Current Telegraph Lines)	Not Required	IBM 3945 Model 11	50 Baud	W T Telegraph Terminal Control Selective Speed Telegraph Line Adapter (One per Line)
				75 Baud	W T Telegraph Terminal Control Selective Speed Telegraph Line Adapter
W T Teleprinter	Common Carrier Private Line Telegraph Circuits (Single-Current Telegraph Lines)	Not Required	IBM 3945 Model 12	50 Baud	W T Telegraph Terminal Control Selective Speed Telegraph Line Adapter (One per Line)
				75 Baud	W T Telegraph Terminal Control Selective Speed Telegraph Line Adapter (One per Line)

Figure 4. Attachable Terminals and Communications Facilities for World Trade Use

COMMUNICATIONS LINE ADDRESSING

The 2702 appears as a control unit to the IBM System/360. Up to eight 2702's can be attached to the multiplexor channel, with each 2702 taking the place of one control unit attachable to the I/O interface.

Each communications line attached to the 2702 is identified by a unique I/O address. This address is specified by an 11-bit binary number that appears in the address field of the I/O instruction. For 2702 operation, this I/O address consists of three parts: a channel address, a group address, and a communications line address. The three high-order bit positions of this field specify the channel address; the next four bits specify the 2702 group address; the last four bits specify the communications line within the group attached to the 2702 (Figure 5).

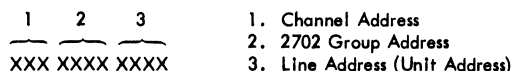


Figure 5. System/360 I/O Address Format

Figure 6 shows the complete address needed by the System/360 to address each one of 10 half-duplex communications lines connected to a 2702 which, in turn, is connected to a specific multiplexor channel.

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XXX XXXX 0000
XXX XXXX 0001
XXX XXXX 0010
XXX XXXX 0011
XXX XXXX 0100

XXX XXXX 0101
XXX XXXX 0110
XXX XXXX 0111
XXX XXXX 1000
XXX XXXX 1001
    
```

Figure 6. I/O Addresses for a 10-Line 2702

For 2702's having more than 15 communication lines attached, two 2702 group addresses are used. All 16 line addresses within the first 2702 address are assigned before the line addresses associated with the second 2702 address are assigned (Figure 7), with one exception. Line address zero is assigned only after line 30 when the 31 Line Expansion feature is present. Without this feature, line address zero is assigned after line 14.

When fewer than 16 lines in a group are being serviced by a given 2702, the remaining unit addresses may be assigned to a second machine on the

channel interface. However, if all 16 lines are later utilized on the 2702, the addresses for the second machine must be changed.

For more information concerning I/O unit addressing, see IBM System/360 Principles of Operation, Form A22-6821, and IBM 1050 Data Communication System, Form A24-3020.

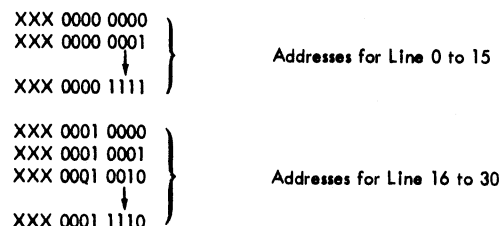


Figure 7. I/O Addresses for a 31-Line 2702

MULTIPLEXOR CHANNEL OPERATION

The 2702 connects to and operates with the multiplexor channel via the I/O interface. This interface consists of byte busses (in and out) and tag lines that indicate the type of information on the byte busses, e.g., command, address, data and status, channel interlock controls, and interface scanning signals. The scanning signals and interlocks establish priority among different 2702's or other control units attached to the multiplexor channel. When the 2702 requires data transfer on any of its communications lines, line 14, for example, the scanning signal is intercepted by the 2702 and an interlock interface lead is raised, indicating the interception of the scan signal to the multiplexor channel. The 2702 places the address of the line requesting service on the input bus. When the 2702 receives acknowledgment from the channel that the appropriate unit control word has been retrieved from storage, data transfer between the 2702 and the channel begins. When transfer of a data byte is complete, the interlock is dropped and the channel resumes scanning the interface.

Selection of the next device (2702, card reader, etc.) is on a priority basis. If no other higher priority machine on the channel interface is selected, the 2702 is again selected if any of its lines requires service.

The multiplexor channel initiates an operation to a 2702 during the CPU execution of a Start I/O instruction. The operation defined in the channel command word is specified for the 2702. Data transfer in either direction across the I/O interface is initiated by the I/O device after it is commanded to start by the program.

I/O INSTRUCTIONS

The System/360 operates with the 2702 through the following I/O instructions: Start I/O, Test I/O, and Halt I/O.

Start I/O

A Start I/O instruction executed by the CPU causes initial command selection and the transfer of a command byte to the 2702. Command chaining within the multiplexor channel also causes selection and transfer of a command to the 2702; however, the 2702 will not signal control unit busy status in response to a command cycle resulting from command chaining. This interlock is effected by presenting unit status to the multiplexor channel only if the 2702 is free to accept a possible chained command.

During initial selection, the 2702 loads the line address and the command byte into registers. The 2702 can make the following status responses to Start I/O:

1. If the command is acceptable to the 2702, an all-zero status byte is sent to the channel.
2. If the command is not acceptable to the 2702, unit check is returned to the channel and the reason for responding with unit check (command reject or bus-out check) is set in the sense field of the LCW.
3. If the 2702 is busy, it signals control unit busy to the multiplexor channel. Control unit busy is defined for the 2702 as the busy, status modifier, and control unit end bits being on in the unit status byte.

Halt I/O

Once the 2702 has responded to initial command selection, the channel can signal Halt I/O. When the 2702 detects a Halt I/O, it loads the line address into a register, the same as for Start I/O. The addressed LCW is commanded to halt. When the current command at the addressed LCW is terminated, the proper status information is returned to the channel. If the current command is write, the character being transmitted and the character buffered, if present, are sent before channel end and device end status are presented to the channel. A maximum three-character delay (up to 500 ms) can occur between the time the Halt I/O is accepted and the presentation of channel end and device end status to the channel.

Test I/O

The 2702 responds unconditionally to an all-zero command byte during initial command selection

with the status modifier bit of the unit status byte. Any existing interrupt conditions in the 2702 are not cleared; the multiplexor channel remains unchanged.

TWO PROCESSOR SWITCH

This feature allows the 2702 to be attached to the multiplexor channels of two System/360 processors. Operations may occur with only one processor at a time. The Two Processor Switch (TPS) may be in one of three states: neutral, channel one attached, and channel two attached. When in the neutral state, the 2702 monitors both channel interfaces. The TPS is available to the first channel which selects it. In this state, a system reset is not executed. When a valid 2702 address is decoded, the entire 2702 attaches to the channel which made the selection. Any signals coming from the unattached channel are bypassed by the 2702 TPS. The address group(s) valid for attachment to channel one may be different from the address group(s) valid for attachment to channel two.

Only the attached channel can cause the TPS to automatically return to the neutral state. When the switch to the neutral state is effected, the entire 2702 (all lines) returns to it. There are two automatic methods whereby this may be accomplished:

1. If a system reset is signaled by the attached channel, the TPS unconditionally returns to the neutral state.
2. If a Release command is issued by the attached channel to any of the valid 2702 addresses for that channel and the command is honored, the TPS returns to the neutral state. In order to determine if the 2702 will honor the Release command, it must be command free (no line is executing a command). If it is not command free, it will not go to the neutral state.

There are two methods whereby the operator may switch to the neutral state through manual intervention:

1. A power-on-reset, initiated by depressing the Power On pushbutton, will cause the TPS to unconditionally return to the neutral state.
2. If the Meter switch on the operator's panel is switched to the OFF position, the TPS causes the 2702 to go off line only when the attached CPU is in a halt or wait state. After going off line, the TPS returns to the neutral state. While the Meter switch is in the OFF position, the TPS cannot be set to an attached state with either channel. When the Meter Switch is ON, the 2702 will go on line when either CPU 1 or CPU 2 is in a halt or wait state.

IBM 1032 ATTACHMENT FEATURE

The 1032 Attachment feature allows the 1032 Digital Time Unit to be connected directly to the 2702. A Digital Time Readout Control feature must be provided in the 1032.

One 1032 can supply time data for two 2702's, upon program request, to provide time identification for designated transaction records received from the input stations. When the 1032 is polled by the 2702, the latter is supplied with four digits of time (tens, units, tenths, and hundredths of hours).

The 1032 model 1 has a synchronous motor-driven clock that advances once each minute. During clock advance, an interlock prevents clock readout. Each transmission of time to the 2702 is followed by an EOB character, signifying that the time data is completed. Time is supplied only upon programmed request (polling).

2741 BREAK FEATURE

The 2741 Break feature, in conjunction with IBM Terminal Control Type I, provides the necessary control to operate the 2741 Communications Terminal having an Interrupt feature. The 2741 Break feature modifies the terminal control operation in two ways: (1) normally, the IBM Type I Terminal Control sets channel end, device end, and unit exception status upon receiving a C character during a Read, Inhibit, or Prepare command. With the 2741 Break feature, only channel end and device end will be set in this situation, thus allowing command chaining to occur; (2) the IBM Type I Terminal Control does not look at the receive data lead from the 103A or 103F data set while transmitting. When the 2741 Break feature is present, the receive data lead is monitored for space during a transmit operation. If a space signal is detected for a character time, the write-type command is ended with channel end, device end, and unit check in the status byte and intervention required in the sense byte.

The Break feature in the 2741 is implemented by a switch or pushbutton which initiates a space of greater than 140 ms on the terminal-to-multiplexor channel of the 103 type data set. Only the 103A or 103F data set, or equivalent, may be used when the Interrupt feature is present. Carrier must be up in both directions whenever all power is on.

After getting the intervention required during a Write command, the program may give a prepare order, followed by a Halt I/O instruction. The 2702 will present channel end and device end status as soon as the line goes back to Mark. This distinguishes the line break from the nonoperational subset which will end the Prepare command immediately with channel end, device end, and unit check

in the status byte and intervention required in the sense byte.

When this feature is present, the maximum number of other terminal controls is two. The maximum number of other terminal controls and Additional Speed features is three. Also, the IBM Terminal Control Type II may not be used in the presence of this feature. The IBM Terminal Control Type I is a prerequisite. This feature does not prohibit using the IBM Terminal Control Type I for operation with 1050, 1060, 1070, 2740, and 2741 (without Break feature) terminals. However, if one of these terminals is used in the 2702, it is considered another terminal control when considering the maximum configuration.

PROGRAMMING CONSIDERATIONS

From a programming standpoint, the 2702 appears as a number of individual communications control devices. When an operation or sequence of operations is to be performed, the programmer prepares a list of one or more channel command words in main storage. The channel command word specifies:

1. The command code (operation) to be performed (write, dial, read, etc.).
2. The number of bytes contained in the record.
3. The address in main storage where data is to be placed when receiving or the address of the first byte to be transmitted when sending.
4. Command flags to control possible modification in command execution. The flags are chain data, chain command, suppress length, skip, and program-controlled interruption.

When the channel command words have been formed, the programmer specifies the channel and path (line) address of the communications line. The execution of a Start I/O instruction causes the command, count, data address, and control information to be stored in a specified subchannel in the multiplexor channel. The channel then selects the 2702 and relays the command and line address to it; the 2702 accepts the command if valid. The channel then indicates successful or unsuccessful execution of the Start I/O instruction to the program.

Once a command has been accepted by the multiplexor channel and the 2702, the CPU program is unaware of the continuance of the operation until the message has been received or transmitted, the multiplexor channel needs program intervention to perform functions such as dynamic storage allocation, or an unusual condition is detected during execution. Because the multiplexor channel contains all the necessary information pertaining to the current operation, data transfer between main storage and the 2702 can be overlapped with CPU processing.

The extent of the overlap varies, depending on the processor group (30, 40, 50, 65, or 75) of the System/360.

When the 2702 is reset, either by a general system reset, a power-on reset, or individually at the CE panel, initialization procedures are required. This includes issuing the Set Address commands (SADxxx) and enabling the communication line by issuing the Enable command where necessary.

Commands

The command code in the channel command word (CCW) specifies, to the multiplexor channel and the 2702, the operation to be performed.

The low-order bits of the command code identify operations — such as read, write, and sense — common to the channel and all I/O devices. All eight bits of the command code are transferred to the I/O devices. The high-order bit positions contain modifier bits, which specify additional control information to the 2702.

In 2702 operation, all commands having modifier bits are classified as orders. Figure 8 lists the command and order codes as defined below:

Commands	P	0	1	2	3	4	5	6	7
Write	0	0	0	0	0	0	0	0	1
Read	0	0	0	0	0	0	0	1	0
Sense	0	0	0	0	0	0	1	0	0

Orders									
Autowrap	1	0	0	0	0	0	1	0	1
Dial	0	0	0	1	0	1	0	0	1
Break	0	0	0	0	0	1	1	0	1
Prepare	1	0	0	0	0	0	1	1	0
Inhibit	1	0	0	0	0	1	0	1	0
Search	0	0	0	0	0	1	1	1	0
Sadzer	0	0	0	0	1	0	0	1	1
Sadone	1	0	0	0	1	0	1	1	1
Sadtwo	1	0	0	0	1	1	0	1	1
Sadthree	0	0	0	0	1	1	1	1	1
Enable	1	0	0	1	0	0	1	1	1
Disable	0	0	0	1	0	1	1	1	1
Release	1	1	1	0	1	0	1	0	0
Reserve	0	1	1	1	1	0	1	0	0
I/O No - Op	1	0	0	0	0	0	0	1	1
Test I/O	1	0	0	0	0	0	0	0	0

Figure 8. Commands and Orders

Read

Bytes are transferred from the addressed communications lines to the channel at a data rate equal to that of the communications line.

Write

Bytes are transferred from the channel to the addressed communications line at a data rate equal to that of the communications line.

Sense

On acceptance of this command, the 2702 returns a single byte to the channel from the sense field in the LCW of the addressed communications line. This byte defines the condition of the addressed communications line.

Autowrap

On accepting this order, the 2702 wraps the output of the addressed line (other than line 0) to the input of line 0. The command within the channel operates as a Write command. Data may be transmitted from the addressed unit to line 0 and inspected by the program if line 0 is available for use and is issued a Read command.

Dial

On accepting this order, the 2702 transfers dial digits through the Auto Call feature to the dial equipment provided by the common carrier at a data rate dictated by the dial equipment.

Break

On accepting this order, the addressed line transmits a continuous space signal. To provide control over the length of space signal, a byte count must be specified by the program.

Prepare

This order may be used in a contention type communications system to indicate to the processor when data is arriving. When a valid start bit is detected by a line instructed to prepare, a character is strobed off. If at stop time the line is at mark, the Prepare command is terminated with channel end and device end status. The character assembled is not transferred to the multiplexor channel. If the line is at space, a 28-second timeout is started. If the line returns to mark before the timeout is complete, the Prepare command is terminated with channel end and device end. The Prepare command is terminated when the timeout occurs, indicating an open line condition with channel end, device end, and unit check status, and indicating timeout in the sense byte.

Inhibit

On accepting this order, the 2702 performs normal read operations except that line timeout is inhibited.

Search

On accepting this order, the 2702 places the addressed LCW in a state so that data received is not transferred to the channel but is monitored for EOT (end of transmission). Line timeout is active during the execution of this command. The search order is rejected by the 2702 for terminals other than those controlled by the Telegraph Terminal Control Type I or the World Trade Telegraph Terminal control.

Sadzer

On acceptance, the 2702 will set the TC field within the addressed LCW to zero so that the terminal control and line oscillator with the internal address equal to zero is associated with the addressed communication line. No data transfer occurs.

Sadone

On accepting this control order, the 2702 sets the terminal control (TC) field within the addressed LCW to one so that the terminal control with the internal address equal to one is associated with the addressed communications line. No data transfer occurs.

Sadtwo

On accepting this control order, the 2702 sets the TC field within the addressed LCW to two so that the terminal control with the internal address equal to two is associated with the addressed communications line. No data transfer occurs.

Sadthree

On accepting this control order, the 2702 sets the TC field within the addressed LCW to three so that the terminal control with the internal address equal to three is associated with the addressed communications line. No data transfer occurs.

Enable

On accepting this control order, the 2702 sets the enable latch within the line adapter of the addressed communications line. No data transfer occurs.

Disable

On accepting this control order, the 2702 resets the enable latch within the line adapter of the addressed communications line. No data transfer occurs.

Release

Upon honoring this order, the 2702 may release itself from the issuing multiplexor and return to the neutral state. This order is used only when the 2702 is attached to two processors by means of the Two Processor Switch feature. (See Two Processor Switch feature.)

I/O No Op

This command is treated as a control immediate by the 2702. No operation is performed by the 2702. Channel end and device end are stored in the status byte. No access is made to the 2702 storage unless the multiplexor channel stacks the status response. The order does not reset the sense field.

Reserve

This command causes the Two Processor Switch to attach itself to the channel of the issuing processor, provided the Two Processor Switch is in the neutral state.

Receive Operation

The receive operation is initiated when the 2702 accepts a Read command from the multiplexor channel. On detection of a start bit, the 2702 prepares to receive a character. Before each bit is placed in the low-order bit position of the serial data field, the field is shifted forward one bit position in the high-order direction. Each bit of the character is received by the 2702 this way until the terminal control signals stop time to the common controls. Stop time occurs when the bit count equals N, a number preset in the terminal control. For example, N for the IBM Terminal Control Type I is 8. At stop time, the 2702 transfers the character in the serial data field to the data buffer field. The 2702 then sets character service and prepares to receive the next character.

The storage and common controls provide a 28-second timeout between data characters during a receive operation, provided a Read command or search order has been accepted by the 2702.

The timeout process is interrupted by a received start bit and is restarted at the following stop time. If the timeout elapses before a start bit is received, the Read or Search command is terminated.

Timeouts shorter than 28 seconds are provided by certain terminal controls. The duration of these timeouts is given in the Terminal Controls section. The same timeout mechanism is used for the short timeout; however, the terminal control specifies the duration of the timeout.

Transmit Operation

The transmit operation is initiated upon acceptance of a Write command by the 2702. During the transmit operation, the high-order bit position occupied by a character of a given terminal type is sent from the serial data field in the LCW to the transmit data buffer in the line adapter. The serial data field is shifted one bit position toward the high-order bit before sending the data bit to the line adapter. The terminal control associated with each LCW selects the bit position of the serial data field in the LCW from which bits are sent to the line adapter. The bit position from which the bit is sent depends on the character length, determined by the terminal control.

The 2702 sends the character, serially by bit, to the line adapter until the associated terminal control signals stop time to the storage and common controls. Stop time is detected by the terminal control when the bit count equals X, a number predetermined by the terminal control. At stop time, the 2702 sends a stop bit (MARK) to the selected line adapter. The 2702 then transfers the data buffer to the serial data field, and sets character service requesting the next character from the channel.

Echo Check

An echo check is made during all transmit operations to determine if a data or equipment error has occurred in the transfer of the data bit to the communications line. On the detection of an error, the appropriate equipment check or data check bit is set in the sense byte. An equipment check error causes immediate termination of the current operation.

Line Break

The 2702 performs a line break by issuing a Break command to the desired communications line. The byte count of the channel command word (CCW) specifies the length of space signals in character times. Continuous space signals are sent to the line adapter until all bytes specified in the channel command word are transferred to the 2702.

Write Marks

The Write command has a built-in feature to allow transmission of continuous mark signal for a number of character times. The storage and common controls send marks in place of the normal data structures when the DF byte (hexadecimal representation) is decoded in the data buffer field. The byte count in the CCW specifies the length of mark signal in character times.

Status Byte

The 2702 responds to initial command selection by sending to the multiplexor channel a unit status byte except when:

1. Power has been brought down on the 2702.
2. An IBM customer engineer has thrown the 2702 off-line test switch and the 2702 has gone off line.
3. The 2702 is equipped with the Two Processor Switch feature and selection is attempted by the inactive processor when the switch is not in the neutral state.
4. The 2702 machine clock or line control word (LCW) storage has failed.
5. The 2702 is not metering because the 2702's Meter switch on the operator's panel is in the OFF position.
6. The address coming from the multiplexor channel has incorrect parity.

The unit status byte provides the status of the 2702 to the CPU program as a result of initial selection or as definition of the condition under which a 2702 operation has been terminated.

The following status conditions can be presented to the multiplexor channel during initial command selection.

All Zeros Status indicates, in response to operations initiated by a Start I/O instruction or command chaining, that the 2702 has accepted a command.

Busy, Status Modifier, and Control Unit End Status indicates the temporary 2702 control unit busy. The 2702 will also be busy for 1.5 ms when performing a general reset.

Unit Check Status indicates, in response to operations initiated by a Start I/O instruction, that the command issued to the 2702 will not be executed because it is invalid or has improper interface parity.

Status Modifier Status serves as an unconditional response to a Test I/O instruction.

The following status conditions can be presented to the channel at the end of a 2702 command execution.

Channel End and Device End Status indicates that the current command has been brought to a normal end and the unit is free to accept another command.

Channel End, Device End, and Unit Exception Status indicates that the current command has been brought to a successful conclusion and EOT has been received. Note that EOT can either be an EOT character or a NO response to a poll.

Channel End, Device End, Unit Exception, and Unit Check Status indicates that the current command has been ended by unusual conditions and EOT

has been received. A Sense command must be issued to the addressed unit to further define these conditions.

Channel End, Device End, and Unit Check Status indicates that the current command has been ended by unusual conditions. A Sense command must be issued to the addressed unit to further define these conditions.

Sense Byte

The sense byte is transferred to the multiplexor channel during the sense operation; the bit position in which these bits are sent to System/360 storage is given below:

- | | |
|---|-----------------------|
| 0 | Command reject |
| 1 | Intervention required |
| 2 | Bus out check |
| 3 | Equipment check |
| 4 | Data check |
| 5 | Overrun |
| 6 | Lost data |
| 7 | Timeout |

Command Reject is set by the interface controls if the command transferred to the 2702 cannot be executed because it is not defined for the 2702.

Intervention Required is set by the common controls when it discovers:

1. Attached data set has power off or is in test mode.
2. An attached automatic calling unit has power off.
3. Continuous space signal has been received on a given communications line for more than one character time.

Bus Out Check is set when a parity error has been detected on the bus out lines of the I/O interface. Parity is always checked on the bus out lines when the I/O interface is connected to the 2702. The 2702 will not recognize one of its addresses unless the address on the bus out lines has correct parity.

Equipment Check is set when a machine check within the 2702 is detected, such as:

1. Discovering an active command in the LCW addressed by the initial command selection sequence.
2. Detecting an echo check within a 2702 line adapter.
3. Detecting Halt I/O during a service cycle.
4. Detecting a failure within an Auto Call adapter.

Data Check is set during receive operations if:

1. At stop time, the receive data sample is a space signal.

2. If a parity error or cyclic check errors are detected. During transmit operations, this bit is set if an echo check is detected at the relay interface of a telegraph line adapter.

Overrun is set during receive operations if a byte is lost because data service could not be obtained within the byte interval of the addressed unit.

Lost Data is set whenever the addressed unit is engaged in receiving data. The Auto Call feature sets this bit when a Dial command is issued to a line that is currently "off-hook."

Timeout is set when the communications line has been idle for 28 seconds or a shorter time specified by the terminal control and the active command is Read or Search. The Auto Call feature sets this bit to indicate that the dial operation has not been successfully completed.

TERMINAL CONTROL OPERATIONS

The 2702 operates with the following terminal controls:

- IBM Terminal Control Type I
- IBM Terminal Control Type II
- Telegraph Terminal Type I
- Telegraph Terminal Type II
- World Trade Telegraph Terminal Control

The World Trade Terminal Control and Telegraph Terminal Control Type I cannot be attached to the same 2702. A maximum of three terminal controls can be chosen for any 2702. The proper control is associated with the LCW via a terminal control field assignment specified at installation time. The sadzer, sadone, sadtwo, and sadthree orders are used to set up these terminal control field assignments after every system reset or 2702 machine reset.

IBM Terminal Control Type I

The IBM Terminal Control Type I provides controls for the attachment of the 2740/2741, 1050, 1060, and 1070 Terminals at 14.8 characters per second (cps) (134.49 baud), 1070 Terminals at 66.6 cps (600 baud), and 1050 Terminals over telegraph facilities at 75.0 baud. The transmission code is six-bit BCD with the following relation to the I/O interface and the 2702 serial data field (Figures 9, 10, and 11).

0	1	2	3	4	5	6	7	
Shift	B	A	8	4	2	1	Check	System/360 Byte
S							C	Six-Bit BCD

In the six-bit BCD transmission code, S represents the shift bit. A logical one identifies the upper case, a logical zero represents the lower case. The B bit is the first bit transmitted following the start bit. An odd parity (check) bit is transmitted following

the one bit. Each received character is checked for odd vertical parity.

Shifted character set conversion, a standard feature, automatically deletes the up-shift and down-shift characters from the received data stream, notes the last shift character received, and inserts an eighth bit S to indicate the appropriate shift character to the System/360. On outgoing data, the S (shift) bit is removed and noted. A change in this S bit automatically causes the insertion of the appropriate shift character (up shift or down shift) in-

to the outgoing data stream before sending the data character.

Start	B	A	8	4	2	1	Check C	Stop	Outgoing Data Character
-------	---	---	---	---	---	---	------------	------	----------------------------

The C (check) bit in the character indicates the correct odd parity count: a logical one if the bit count of the character is even, a logical zero if the bit count of the character is odd.

Vertical redundancy check (VRC) and longitudinal redundancy check (LRC) are provided; any error

Bit Position → (01)																
(4 5 6 7)	00				01				10				11			
	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
0 0 0 0		8	@		Ⓝ	-		h		*	o		Ⓝ	-		H
0 0 0 1	Space			y		q	&		Space			Y		Q	+	
0 0 1 0	1			z		r	a		=			Z		R	A	
0 0 1 1		9	/		i			i		(?		J			I
0 1 0 0	2			#		MZ	b		ç			₣		\	B	
0 1 0 1		ø	s		k			pz)	S		K			x
0 1 1 0		ⓓ EOA #	t		l			Ⓨ		ⓓ EOA ±	T		L			Ⓨ .
0 1 1 1	3			,		\$	c		;			,		!	C	
1 0 0 0	4			By-pass		Re-store	d		:			By-pass		Re-store	D	
1 0 0 1		Punch On	u		m			Punch Off		Punch On	U		M			Punch Off
1 0 1 0		ROR Stop	v		n			Tab		ROR Stop	V		N			Tab
1 0 1 1	5			LF		CR LF	e		%			LF		CR LF	E	
1 1 0 0		Up Shift	w		o			Down Shift		Up Shift	W		O			Down Shift
1 1 0 1	6			ⓑ EOB		Bk-space	f		'			ⓑ EOB		Bk-space	F	
1 1 1 0	7			Pre-fix		Idle	g		"			Pre-fix		Idle	G	
1 1 1 1		ⓒ EOT	x		p			De-lete		ⓒ EOT	X		P			De-lete
	0	1	2	3	4	5	6	7	System/360 Byte							
	Shift S	B	A	8	4	2	1	Check C	Six-Bit BCD							

Figure 9. Code Structure for 1050 Data Communication System

Bit Position → (01)																
(23) 00				01				10				11				
(4 5 6 7)	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
0000		8	Add		Ⓝ -			H								
0001	Space			Y		Q	+									
0010	1			Z		R	A									
0011		9	/		J			I								
0100	2					Mess	B									
0101		∅	S		K			*								
0110		ⓓ EOA #	T		L			Ⓨ								
0111	3					\$	C									
1000	4					Re- store	D									
1001			U		M			Subt								
1010			V		N			Tab								
1011	5			LF		CR	E									
1100			W		O											
1101	6			Ⓟ EOB			F									
1110	7					Idle	G									
1111		Ⓢ EOT	X		P											
	0	1	2	3	4	5	6	7	System/360 Byte							
	-	B	A	8	4	2	1	Check C	Six-Bit BCD							

Figure 10. Code Structure for 1060 Data Communication System

detected sets the data check bit within the sense byte. A data check will not cause termination of the current command.

Polling and Addressing

Polling and addressing of terminals is performed by a Write and a Read command initiated by a Start I/O instruction. When polling, command chaining is utilized so that the Read command and the allocated storage are ready to receive the incoming data.

On sending out polling characters (provided by the program), chaining occurs to a Read command

and a timeout begins. At this point, the IBM Terminal Control Type I pre-empts the 28-second timeout provided by the storage and common controls with its 2-second short timeout. The 2702 interrupts the CPU program if a Ⓝ character is received or if a timeout occurs. Unit exception is set in the unit status byte if Ⓝ is received. Unit check is set in the unit status byte if a timeout occurs; the timeout bit is set in the sense field.

During addressing, command chaining to a Read command is used to provide for receiving the Ⓝ or Ⓨ character. Ⓝ sets unit exception in the status byte, as in polling, to interrupt the CPU program. Ⓨ causes a normal end, which can be command-chained to the output message.

Bit Position → (01)																
(23) 00				01				10				11				
(4 5 6 7)	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
0000		8	@		(N) -			H								
0001	Space			Y		Q	&									
0010	1			Z		R	A									
0011		Addr 9	/		J			I								
0100	2						B									
0101		Poll Ø	S		K											
0110		(D) EOA #	T		L			(Y)								
0111	3			(S) ,		\$	C									
1000	4					(T)	D									
1001			U		M											
1010			V		N											
1011	5						E									
1100			W		O			(A)								
1101	6			(B) EOB			F									
1110	7						G									
1111		(C) EOT	X		P											
	0	1	2	3	4	5	6	7	System/360 Byte							
	-	B	A	8	4	2	1	Check C	Six-Bit BCD							

Figure 11. Code Structure for 1070 Process Communication System

Character Recognition

The following characters are recognized by the 2702 during write operations:

(B) End of block (EOB) indicates the end of a block of text and that the next character is the LRC.

(C) End of transmission (EOT) indicates the end of transmission and places the 2702 in the control mode. It is normally followed by polling or addressing.

(D) End of address (EOA) indicates the end of address and is normally followed by text.

Shift (S) bit, within the data character, determines the case of the data character. When the

line is transmitting in a down-shift mode, any character with the S bit on causes an up-shift character to be sent and the mode changed to up-shift before the data character is transmitted. When transmitting in an up-shift mode, any data character with the S bit off causes the down-shift character to be transmitted and the mode changed to down-shift before the data character is sent.

The following characters are recognized during read operations:

(B) End of block (EOB) indicates the end of a block of text and that the next character to be checked is the LRC.

(C) End of transmission (EOT) indicates the end of transmission.

(D) End of Address (EOA) indicates that the following characters are text.

(N) Negative response indicates that the addressed system is not ready to receive data or that the text received is incorrect.

(Y) Positive response indicates that the text received is correct or the addressed system is ready to receive data.

When receiving text, an up-shift character sets the up-shift mode if the line is in the down-shift mode. If the line is already in up-shift, the character has no effect. The up-shift character is never transferred to the multiplexor channel. It is included in the LRC accumulation.

Receiving a down-shift character sets the down-shift mode if the line is in up-shift. If the line is already in text in down-shift, a text out, or control mode, the character has no effect. The down-shift character is never transferred to the multiplexor channel. It is included in the LRC accumulation.

Delete characters (BA8421C) and idle characters (B8421) are removed from the data stream. Neither type is sent to the multiplexor channel, but they are included in the LRC accumulation.

The IBM Terminal Control Type I recognizes the delete and idle characters and includes them in the accumulated LRC but inhibits the transfer of these characters to the CPU.

Operation with 1050 System Line Correction Feature - Message Restrictions

Exercise care in programming the 1050 Terminal when the Line Correction special feature has been installed in it. Timeouts may occur at the 2702 while re-reading or re-punching is being performed, as controlled by this special feature.

When transmission of text is being made to the IBM 1055, the block length should not be more than 156 characters. Otherwise, an LRC check will cause the tape to backspace to the beginning of the block and then punch delete characters for the entire block in error. The (N) answerback from the 1050, in this case, is given to the 2702 when this delete operation has occurred. For a block of more than 156 characters in length, the 1050 may take more than 28 seconds to respond to the Read command given by the processor to accept the answerback from the IBM 1055. Thus, the 2702 will end the Read command prematurely with channel end, device end, and unit check status with timeout in the sense byte.

In IBM 1054 Paper Tape Reader operation, the same problem exists in waiting for the 1054 to return to the beginning of a block for a re-read operation. In this case, the maximum block length is

312 characters. Over this length, a timeout is possible before the re-read begins.

1070 Printer Operation at 600 Baud - Message Restrictions

After a 1053 Printer that is operating on a 600-baud 1071 Model 2 Terminal Control Unit has been properly selected, an output message may be transmitted to it. The printer operates at 15 characters per second while the line has a 66.6 character per second rate at 600 baud. Hence, a four-character delay must be inserted between each of the processor's output printing characters. This is effected under the Write command by utilizing four special pad characters, inserted between every printing character. It is the program's responsibility to insert these special characters.

IBM Terminal Control Type II

The IBM Terminal Control Type II provides controls for the attachment of the 1030 Data Collection System to the IBM System/360 at a transmission rate of 600 baud. The transmission code is six bits plus parity with the following relation to the I/O interface and the 2702 serial data field (Figure 12).

0	1	2	3	4	5	6	7	System/360 Byte
-	B	A	8	4	2	1	Check C	

Six-Bit BCD

B is the first bit transmitted onto the communications line following the start bit. The C (check) bit in the character indicates the correct odd parity count; a logical one if the bit count of the character is even, a logical zero if the bit count of the character is odd. A minimum of two stop bits are transmitted on every character.

Start	B	A	8	4	2	1	Check C	Stop	Outgoing Data Character

Each received character is checked for odd vertical parity; the check bit is transferred to storage. Vertical parity errors cause data check to be set in the sense field of the LCW but do not cause termination of the command.

Polling and Addressing

Polling of the 1031 Input Stations is performed by Write and Read commands initiated by the Start I/O instruction. During polling, command chaining is utilized so that the Read command and allocated storage are ready for incoming data. On sending out the polling character (provided by the program), chaining occurs to a Read command and a timeout

Bit Position → (01)																			
(4 5 6 7)	(23) 00				01				10				11						
	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11			
0 0 0 0		8			(N) -			H											
0 0 0 1	Space			Y		Q	&												
0 0 1 0	1			Z		R	A												
0 0 1 1		9	/		J			I											
0 1 0 0	2						B												
0 1 0 1		Ø	S		K			?											
0 1 1 0		(D) EOA #	T		L			(Y)											
0 1 1 1	3					\$	C												
1 0 0 0	4						D												
1 0 0 1			U		M														
1 0 1 0			V		N			Tab											
1 0 1 1	5			LF		CR	E												
1 1 0 0			W		O														
1 1 0 1	6			(B) EOB			F												
1 1 1 0	7					Idle	G												
1 1 1 1		(C) EOT	X		P														
	0	1	2	3	4	5	6	7	System/360 Byte										
		B	A	8	4	2	1	Check C	Six-Bit BCD										

Figure 12. Code Structure for 1030 Data Collection System

will begin. At this point, the IBM Terminal Control Type II pre-empts the 28-second timeout provided by the storage and common controls with its 3-second short timeout. Interruption of the CPU program is made if (N) is received or if timeout occurs. Unit exception is set in the status byte if (N) is received. Unit check is set in the status byte if a timeout occurs and the timeout bit is set in the sense field.

When addressing, a (S) character (provided by the program) is transmitted before the addressing characters. Command chaining to a Read command is used to provide for receiving the (N) or (Y) character. (N) sets unit exception in the status byte, as

in polling, to interrupt the CPU program. (Y) causes a normal end that can be command-chained to the output message.

Character Recognition

The following characters are recognized during write operations:

(C) End of transmission (EOT) indicates the end of transmission and places the 2702 in a control mode. It is normally followed by polling or addressing.

(D) End of address (EOA) indicates the end of an address (start of message) and is normally followed by text.

The following characters are recognized during read operations:

(B) End of block (EOB) indicates the end of a block of text.

(D) End of address (EOA) indicates that the following characters are text.

(N) Negative Response indicates that the addressed system is not ready to receive data or that the text received is incorrect.

(Y) Positive Response indicates that the addressed system is available or that the text received is correct.

Delete (BA8421C) and idle (B8421) characters are not sent to the multiplexor channel. Both types are removed from the data stream by IBM Terminal Control Type II.

1033 Operation - Message Restrictions

After the 1033 printer has been selected, an output message may be transmitted to it. The 1033 printer operates at 15 characters per second (cps); the transmission line operates at 600 baud (or a comparable rate of 60 cps). A three-character delay time is required between output printing characters. This is effected by using the Write command with three special characters (DF in hexadecimal representation) inserted between every printing character. The CPU program must take into consideration the difference in operating speed between the transmission line and the printer and provide the necessary delays for printing the output, via the insertion of these write mark characters. Delays can also be effected in this manner to carriage returns, tabs, line feeds, etc.

Telegraph Terminal Control Type I

This terminal control provides controls for operating telegraph terminals under AT&T 83B2/83B3 or Western Union Plan 115A Terminals line control. The speed of transmission is 45, 57, or 75 baud; only one of these speeds may be chosen without using a special Additional Speed feature. Transmission code is Baudot with the following relation to the I/O interface and the 2702 serial data field (Figures 13 and 14).

0	1	2	3	4	5	6	7
-	-	Case S	1	2	3	4	5

System/360 Byte
Shifted Baudot Code

S represents the case: a logical one identifies upper case; logical zero, lower case. The one bit is the first bit transmitted following the start bit.

Shifted character set conversion, a standard feature, automatically deletes LTRS and FIGS characters from the received data stream and remembers the case. A sixth bit is added to the code set by the terminal control to indicate case to the processor. Data bytes transferred from the channel are in six-bit form. The terminal control will remove the sixth bit and note the case. A change in case automatically causes the insertion of the proper shift characters (LTRS or FIGS) into the outgoing data stream. The terminal control sends two stop bits and checks for the presence of one stop bit on receive.

Polling and Addressing

Polling and addressing of AT&T 83B2/83B3 or Western Union Plan 115A Terminals are performed by Write and Read commands initiated by a Start I/O instruction. When polling, command chaining is utilized so that the Read command and allocated storage are ready for incoming data. On sending out the polling characters (provided by the program), chaining occurs to a Read command and a timeout begins. At this point, the Telegraph Terminal Control Type I pre-empts the 28-second timeout provided by the common controls with its 2-second short timeout. The CPU program is interrupted if a V or M is received or a timeout occurs. Unit check is set in the status byte if a timeout occurs; the timeout bit is set in the sense field.

When addressing, command chaining to a Read command is used to provide for receiving the V or M response. A timeout sets unit check in the status byte and timeout within the sense field, as in polling, to interrupt the CPU program. V or M causes a normal channel end and device end status that can be command-chained to the output message.

When operation on the multidrop line allows interterminal traffic, different line control is required. In response to a polling message, the positive response is a CDC (call directing code) or SSC (station selection code). If the CPU or a terminal on the other line is addressed, the CDC or SSC of the CPU must be the first address sent by the terminal. The character AZ is assigned to the CPU in all systems. If AZ is detected, the V answerback must be sent by the program and a chained Read command must be provided for receiving the text. If the terminal has no message to send, it will respond with a V. The V causes termination of the Search command via channel end and device end status. If a sequence other than AZ or V is received, a stop signal is given by the channel when the EOT sequence is detected. No part of this message other than the EOT is transferred to the CPU. Text messages must begin with end

Bit Position → (01)															
(23) ← (4 5 6 7)				00				01				10			
				00	01	10	11	00	01	10	11	00	01	10	11
0000	Blank	E	Blank	3											
0001	T	Z	5	"											
0010	CR	D	CR	\$											
0011	0	B	9	?											
0100	Space x	S	Space x	Bell											
0101	H	Y	#	6											
0110	N	F	,	!											
0111	M	X	'	/											
1000	LF	A	LF	-											
1001	L	W)	2											
1010	R	J	4	'											
1011	G	Figs ↑	∞	Figs ↑											
1100	I	U	8	7											
1101	P	Q	Ø	!											
1110	C	K	:	(
1111	V	Ltrs ↓	;	Ltrs ↓											
				0	1	2	3	4	5	6	7	System/360 Byte			
						Shift S	1	2	3	4	5	Shifted Baudot Code			

Figure 13. Code Structure for AT&T 83B2/83B3 Western Union Plan 115A and World Trade Teleprinter Terminals (C Keyboard)

of address (EOA). For the AT&T 83B2 and 83B3 Terminals, EOA is CR, LF, LTRS; for the Western Union Plan 115A Terminals, EOA is the space character.

Character Recognition

The following characters are recognized during read operations:

1. V (or M) received as the first non-shift character sets channel end and device end status.
2. FIGS-H, LTRS are received as EOT and set channel end, device end, and unit exception status.

3. The two character processor address AZ, when received as the first two non-shift characters of a message under the Search command, sets channel end and device end.
4. LTRS (Letters Shift) character sets LTRS mode if the line is in FIGS mode. Transfer to the multiplexor channel is inhibited.
5. FIGS (Figures Shift) character sets FIGS mode if the line is in LTRS mode. Transfer to the multiplexor is inhibited.
6. Space character sets LTRS mode when received, and "un-shift on space" is wired. The space character is then transferred to the multiplexor channel with its shift (S) bit set to zero.

Bit Position (4 5 6 7)				(23) 00				01				10				11			
0000	Blank	E	Blank	3															
0001	T	Z	5	"															
0010	CR <	D	CR <	\$															
0011	O	B	9	5/8															
0100	Space x	S	Space x	Bell															
0101	H	Y		6															
0110	N	F	7/8	1/4															
0111	M	X	o	/															
1000	LF	A	LF	-															
1001	L	W	3/4	2															
1010	R	J	4	'															
1011	G	Figs ↑	∞	Figs ↑															
1100	I	U	8	7															
1101	P	Q	∅	1															
1110	C	K	1/8	1/2															
1111	V	Ltrs ↓	3/8	Ltrs ↓															
	0	1	2	3	4	5	6	7	System/360 Byte										
			Shift S	1	2	3	4	5	Shifted Baudot Code										

Figure 14. Code Structure for AT&T 83B2/83B3 Western Union Plan 115A, and World Trade Teleprinter Terminals (A Keyboard)

The following characters are recognized during write operations:

1. When in LTRS mode, any data character with the S bit on causes the line to send the FIGS character and set the FIGS mode before sending the data character.
2. When in LTRS mode, any data character with the S bit off causes the line to send a LTRS character and set the LTRS mode before the data character is transmitted.
3. When "un-shift on space" is wired, the space character sets the LTRS mode. The S bit of the space character is ignored. "Un-shift

on space" is provided as a standard wiring optional feature of this terminal control. "Un-shift on space" means that the space character, when transmitted or received, causes the line to be set to LTRS case. The terminal control must be wired for "un-shift on space" only when the attached AT&T 83B2/83B3 and Western Union Plan 115A Terminals have this feature installed. When wired for "un-shift on space", the S bit of the space character is ignored under write-type commands. No shift characters are sent ahead of the space character when its S bit indicates a shift change.

Message Restrictions

Terminal to Processor:

1. All messages transmitted by a Western Union Plan 115A Terminal from its paper tape reader must be preceded with the sequence A, V, space.
2. A space character received by the 2702 will not downshift (FIGS to LTRS) unless the "un-shift on space" option is installed.
3. Text immediately following the sequence FIGS-H, LTRS, (EOT) is lost. EOT must not be sent between blocks of data.

Processor to Terminal:

1. When transmitted, the characters (CR, LF, space, and blank) must be in the same case as the preceding character.
2. The terminal control automatically inserts the proper shift character in outgoing data when a change of case is encountered.

Terminal to Terminal:

1. AZ is the address assigned to the CPU and recognized by the 2702.
2. End of address (EOA) must precede the transmission of text.
EOA for AT&T 83B2 or 83B3 - CR, LF, LTRS
EOA for WU Plan 115A - Space

World Trade Telegraph Terminal Control

This terminal control provides controls for operating WTC teletypewriter attachments at transmission speeds of 50 or 75 baud (only one speed can be selected). The transmission code is Baudot, with the following relation to the I/O interface and the 2702 serial data field (Figures 13 and 14).

0	1	2	3	4	5	6	7	System/360 Byte
-	-	Shift 5	1	2	3	4	5	Shifted Baudot Code

S represents the case. A logical one identifies upper case; logical zero, lower case. The one bit is the first bit transmitted following the start bit.

Shifted character set conversion, a standard feature, automatically deletes LTRS and FIGS characters from the received data stream, notes the last shift character received, and inserts a sixth bit in the code set to indicate the case to the processor. On outgoing data, the S (case) bit is removed and noted. A change in the S (case) bit automatically causes insertion of the appropriate shift character in the outgoing data stream before sending the data character.

Attachment to the World Trade Telegraph Terminal Control is point to point; thus, the line control method used is contention rather than polling.

For transmitting, the programmer inserts from 4 to 20 LTRS characters before the start of message character (line feed) to insure that the terminal is able to receive properly. If the terminal bids for the line simultaneously with the processor, an echo check occurs, terminating the write operation at the CPU.

For receiving, the Prepare command is issued to the terminal line to wait for the completion of the first character from the terminal. Command chaining to a Read command can be used to accept the message. This terminal does not have a short timeout to pre-empt the normal 28-second timeout.

Character Recognition

End of Transmission (EOT) format is FIGS, CHARACTER, LTRS, with the character assigned on a per system basis. EOT sets channel end, device end, and unit exception status.

End of block (EOB) format is FIGS, CHARACTER, with the character assigned on a per system basis. EOB sets channel end and device end status.

V (or M) received as the first character does not set channel end and device end for WT contention (point to point) systems in the manner of a V (or M) response to polling in domestic multidrop systems.

Message Restriction

Terminal to Processor:

1. The characters used in EOB and EOT must not be the same.
2. A space character received by the 2702 will not downshift (FIGS to LTRS) unless the "Un-Shift on Space" option is installed.
3. Text immediately following FIGS, CHARACTER, LTRS is lost. EOT must not be sent between blocks of data.

Processor to Terminal:

1. When transmitted, the characters (CR, LF, space, and blank) must be in the same case as the preceding character.
2. The terminal control automatically inserts the proper shift character in outgoing data when a change of case is encountered.

Telegraph Terminal Control Type II

The Telegraph Terminal Control Type II provides controls for the attachment of telephone company teletypewriter exchange (TWX) stations to the 2702. Control is point to point and is on common carrier switches 150 baud TWX service. Transmission speed is 110 baud. The transmission code used is the eight-bit data interchange code, with the following

relation to the I/O interface and the 2702 serial data field (Figure 15).

0	1	2	3	4	5	6	7	System/360 Byte
1	2	3	4	5	6	7	8	Eight-Level Data Interchange Code

One start bit and two stop bits are transmitted and received by this terminal control.

Line Control

Identification type of answerback is handled by the 2702 and the System/360. Output messages can be

of any length or format. Input messages can be of any length, but certain format restrictions are imposed because of the line control used by these terminals. On input, or during read operations, the following characters are recognized by the 2702 and cause termination of the I/O operation with subsequent interruption of the program.

Message Restrictions

Terminal to Processor:

1. Delete characters are recognized and the 2702 inhibits their transfer to the System/360.

Bit Position (4 5 6 7)		(23) 00				01				10				11			
		00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11
0000																	
0001		Null		EOT	Form	EOA	Line Feed		SO	SOM	HOR TAB	WRU	Return	EOM	Vert Tab	Bell	SI
0010																	
0011		@	H	D	L	B	J	F	N	A	I	E	M	C	K	G	O
0100																	
0101		SP	(\$,	"	*	&	.)	%	-	#	+	'	/
0110																	
0111																	
1000																	
1001		DCo		Tape Aux Off		Tape Aux On				X-on				X-off		LEM	
1010																	
1011		P	X	T	\	R	Z	V	↑	Q	Y	U]	S	[W	←
1100																	
1101		O	8	4	<	2	:	6	>	1	9	5	=	3	;	7	?
1110																	
1111																	

0	1	2	3	4	5	6	7	System/360 Byte
1	2	3	4	5	6	7	8	Eight-Bit Data Interchange Code

Figure 15. Eight-Bit Data Interchange Code

2. WRU, XOn, XOff, and EOT terminate receive operations.

Processor to Terminal: The hexadecimal byte DF (System/360) cannot be part of the eight-level data interchange code set. This byte is used for the write marks operation.

Automatic Wraparound

The Automatic Wraparound feature of the 2702 can be utilized by the programmer to help determine the source of error for a given 2702 line. The wrap-around function is initiated by issuing the autowrap order to the 2702 line address on which trouble is suspected.

The 2702 wraps the output of the line to which the autowrap order is issued to the input of line 0. Wraparound is accomplished within the line adapter to avoid line termination mismatches since line 0 is not necessarily the same type of line as the line being tested. The execution of the autowrap order is one way; that is, transmit operation on the line in question and receive operation on line 0. A Read command must be issued to line 0 before autowrap is started in order to receive data transmitted by the autowrap order.

The program must insure that normal operations on line 0 have been completed before issuing an autowrap order to any communications line on the 2702. The program must not issue an autowrap order to more than one communications line at a time. The program can make a character-by-character comparison of received data with transmitted data and/or monitor the operation of recognizable control characters.

Line 0 is not reserved as a test line, but is used during the autowrap process. Since line 0 is used with all wraparound operations, the autowrap operation selects the proper terminal control so that line 0 operates as if it were the same kind of communications line as the line being tested. In this way, a complete check of the storage and common controls as well as the terminal control of the line in question can be made. Note that receive operations are checked because a common terminal control performs the work.

Output data from the unit that issued the autowrap order can be blocked from going onto the communications line by issuing the disable order to the 2702 line before the autowrap order.

Auto Call Feature

The Auto Call feature provides the 2702 with automatic dial-out capability under the programmer's control. The Auto Call feature services dial connection lines one at a time on a time-shared basis.

Dial requests are queued in the 2702 until the Auto Call hardware is free. Each dial connection line requires an Auto Call adapter.

The programmer initiates the automatic dialing function when he issues a dial order to an appropriate 2702 unit line address. On acceptance of the dial order by the 2702, the bytes (dial digits) are received from the multiplexor channel the same as any other bytes of output data and are transferred to the common carrier provided dial equipment. Dial digits (bytes) are transferred to the dial equipment until the channel signals stop in response to a dial digit request from the 2702. This terminates the automatic dialing function and frees the Auto Call feature to initiate dialing on another line.

Command chaining to a read or write can be utilized, depending on the terminal type and line control used. At the completion of the transmission, the call to the remote device is terminated when a Disable command is issued.

Before issuing a dial order to a dial access line, a Disable command should be issued to the communications line to prevent the automatic answering function from being initiated by a terminal. If automatic answering on the line is desired after completion of the transmission initiated by the Auto Call operation, an Enable command must be issued after terminating the call.

Automatic Answering

Automatic call answering is standard on any 2702 provided with a data set line adapter and a common carrier data set. This feature permits programmed control over the automatic answering capability of the 2702. To allow for automatic answering of calls, an enable order can be issued to the appropriate 2702 unit address.

Command chaining can be utilized when a call is answered. The command chained to may be either a Read or Write command, depending on the terminal type and line control used (to accept data or to poll the calling terminal). To terminate the call when transmission is completed, a Disable command is issued. To allow further calls to be automatically answered from this line, the Enable command must be issued again.

Additional Selective Speed Feature

This feature allows a second (or third) line speed to be associated with one of the terminal control features which have selective speed options; three line speeds with a single terminal control are implemented by having two Additional Speed features operating with that control. An Additional Speed feature can be associated with only one terminal control in a 2702.

The SADxxx commands are used to set the TC field to one of the four combinations for each line. As the TC field is decoded for each line, the proper terminal control and line oscillator are selected. If an Additional Selective Speed feature is chosen by the customer, its TC field assignment selects the additional line oscillator for any lines associated with this feature.

Since the TC assignments are made by plugboard, the customer may determine his own assignments in preparing his programs.

2712 Model I or Model II Adapter

The 2712 Adapter, when used in conjunction with an IBM 2712 Remote Multiplexor, permits replacement of a number of low-speed lines with one high-speed synchronous line. Figure 16 shows a typical configuration. Half-duplex low-speed lines are brought into the 2712 Remote Multiplexor which bit-multiplexes data from the terminals onto a high-speed full-duplex line. The data is separated by the 2712 Adapter in the 2702 and fed into the individual 2712 Line Adapters in the 2702.

Data going to the terminals is multiplexed by the 2702's 2712 Adapter and sent over the other half of the full-duplex high-speed line. The remote 2712 separates the data and sends it to the terminals over the lower speed lines.

The presence of the 2712 is not detected by the CPU. To the CPU, it will appear to be working with a number of low-speed lines. Thus, no programming changes are required.

Two models of this feature are available. The first, model 1, operates with up to 10 lines at speeds of 134.49 baud. Terminals which can be attached are the 1050, 1060, 2740 and 2741. The

second model, model 2, operates at 74.2 baud with 83B2 or 83B3 line control (model 28 teletypewriter) and can have up to 14 lines. Table 1 shows the possible configurations of the 2712, model 1, and the 2712, model 2, on the 2702.

There is a maximum of two 2712 features (any combination) on one 2702; the second of these features prohibits the Auto Call Expansion feature on lines 8 to 15. In addition to the basic feature, a 2712 Line Adapter is required for each line which is attached to the 2712 Remote Multiplexor.

Model 1 requires a Schedule 4B (or equivalent) full-duplex data channel; model 2 requires a Schedule 4A (or equivalent) full-duplex data channel. A Data Set 202D2 or equivalent must be used between the communication line and the 2712. Any 2702 lines not using the 2712 feature and not exceeding the maximum of 31 for the machine may be used in the normal manner.

Table 1. 2712 Configurations

Configuration	2712 Adapter Features		Number of Low-Speed Lines Served
	Mod 1	Mod 2	
1	1	0	1-10
2	2	0	1-20 (No Auto Call Expansion feature)
3	1	1	1-24 (No Auto Call Expansion feature)
4	0	1	1-14
5	0	2	1-28 (No Auto Call Expansion feature)

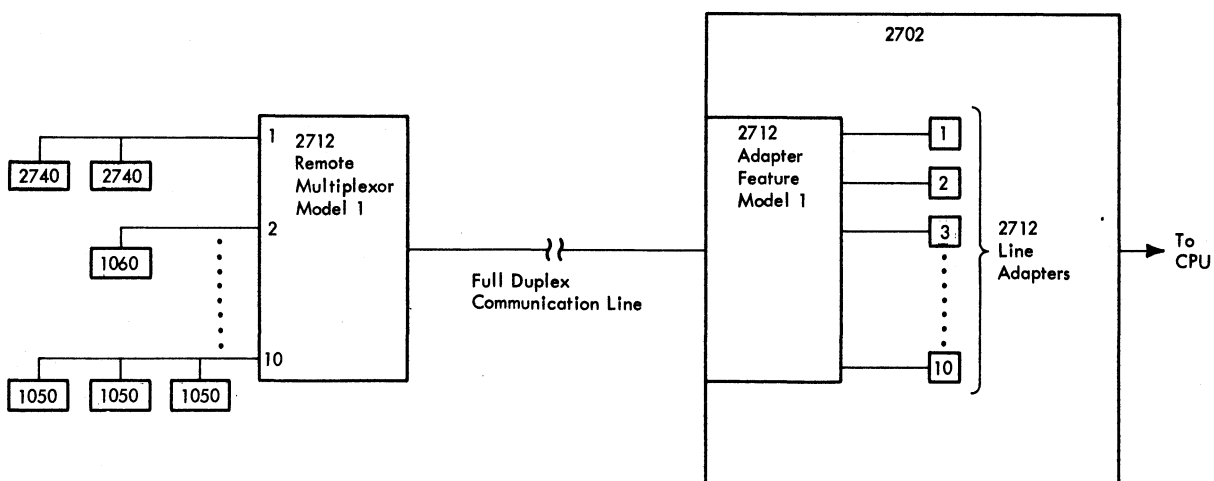


Figure 16. A Typical 2712 Configuration

Operator's Control Panel

The operator's control panel contains the following indicators and switches:

Indicators

Thermal	On when any thermal unit has tripped (turns dc off)
CB	On when a power supply circuit breaker is tripped
CE Test Meter	On when CE test switch is on Indicates elapsed running time of the unit
Power On	On when dc power is on

Switches

Power On	Turns on dc power
Power Off if in Local	Turns off dc power if Power Control switch on CE panel is in Local
Meter Enable	In off position, the 2702 goes off-line

Metering

The 2702 usage meter will run when the 2702 is on line and the CPU is not in a halt or wait state or the CPU is in a halt or wait state but the 2702 is performing active work or any control unit on the same channel is performing active work.

On line means that 2702 power is on, the 2702 Usage Meter switch is set to the ON position, the 2702 storage and clock are operational, and the CE Off Line Test switch is set to NORMAL.

The 2702 is performing active work when any of its lines are under control of any command other than the Enable or Prepare commands.

If the 2702 Meter switch is changed to the OFF position or the CE Off Line Test switch is changed to the OFF LINE TEST position while the CPU is not in a halt or wait state, the 2702 meter continues to run until the CPU is in a halt or wait state.

If the CPU is in a halt or wait state and the 2702 meter is running as a result of another control unit on the same channel performing active work, changing either the 2702 Meter switch to the OFF position or the CE Off Line Test switch to the OFF

LINE TEST position causes the 2702 meter to stop immediately.

Special Programming Considerations

The following 2702 functions require special programming considerations:

1. The 2702 signals Control Unit Busy in response to initial selection when the CMDR and AR2 are in use with a previous command cycle or when the 2702 is executing a machine reset resulting from a system reset or power-on reset. The 2702 responds to the interface signals, Address Out, and Select Out, and to a valid unit address on Bus Out with the interface tag, Status In, and the Busy, Status Modifier, and Control Unit End bits on Bus In.

The Control Unit Busy condition is temporary and lasts a maximum of 480 μ s on the basic 2702 and a maximum of 992 μ s on the 2702 with the 31-Line Expansion feature, unless a machine reset is being executed. The reset lasts a minimum of 1.12 ms and a maximum of 2.55 ms.

Note that the Control Unit Busy response may occur as a result of any initial selection which is executed just after command chaining within the channel. The CMDR and AR2 are in use at this time even though the previous initial selection may not have occurred for at least the maximum time limits given above.

2. In order to allow enough time for a private line data set to turn itself on after the Enable latch is set, the program should provide for a timeout after the Enable command ends. This is necessary to delay issuing a read or write-type command (other than AUTOWRAP) to the line. A 500-ms timeout is a sufficient period for all announced data sets. If this timeout is not performed, the command may be ended with Unit Check status on.
3. On an end of transmission sequence, when a © is sent under a write-type command to a private line using a Data Set Line Adapter with an IBM Terminal Control Type I or II, at least two additional consecutive ©'s must be sent by the program. This prevents receiving a false start bit, generated by the remote data set, when the terminal turns off its Request To Send lead.



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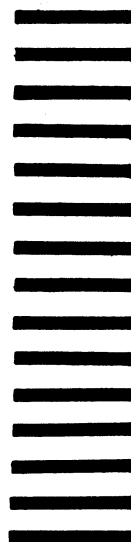
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