

UNIVAC®

9000
SERIES

DATA
COMMUNICATIONS
SUBSYSTEM

PROGRAMMER/OPERATOR
REFERENCE MANUAL

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1. INTRODUCTION

1.1. GENERAL

The Data Communications Subsystem (DCS) of the Univac Division of Sperry Rand Corporation serves as the interface between the UNIVAC 9000 Series Central Processors and any device which meets the accepted standard for data transmission. Because it serves as an interface, the DCS is treated in terms of the hardware environment created by both the central processor and the communications equipment.

This manual outlines the data transfer characteristics which stipulate the onsite interaction between the DCS and the central processor, briefly describes the communications facilities and devices which dictate external response, and details how the DCS meets these conflicting demands.

1.2. MANUAL ORGANIZATION

This manual is divided into numbered sections. The manual contains information that is valid regardless of the particular UNIVAC 9000 Series Central Processor used. A supplement is provided which supplies information that is peculiar to the DCS when it is operating with a particular UNIVAC 9000 Series Central Processor. Thus, the manual and the supplement supplied with it give only the information needed to understand and to operate your particular system.



2. THE COMMUNICATION ENVIRONMENT

2.1. GENERAL

In stipulating the design requirements of a communication subsystem, the complexities may be reduced to manageable proportions, because hardware implementation is always concerned with the transmission characteristics of the communication environment but seldom involved with the operational features of the individual terminals. These transmission characteristics, while they are in large measure dictated by the communication devices, are to a degree regulated by commonly accepted standards and may be categorized in terms of transmission mode, transmission method, and transmission rate. The operational features, such as language, selection capability, media characteristics are normally relegated to device-oriented software.

2.2. TRANSMISSION MODE

Communication devices all operate by signaling externally on a direct current (DC) basis. Figure 2-1 shows a direct current circuit on which a receiving device is linked to a typical transmitting mechanism. This mechanism consists of a plate which mounts one electrically isolated segment for each element of a character, and a wiper arm which makes one complete revolution for each character transmitted.

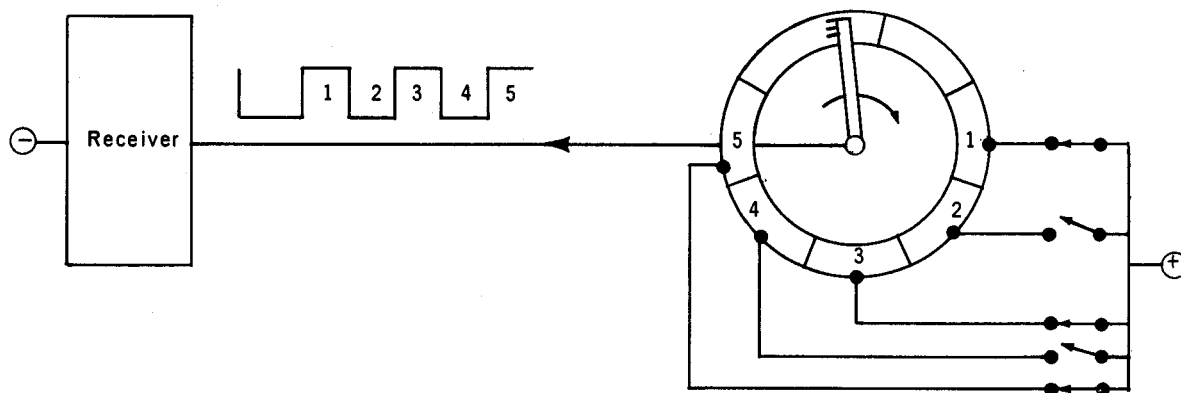


Figure 2-1. Bit-Serial Transmission

Each segment is wired to a sensing contact which, in turn, would be operated by a mechanical component of the transmitter such as a paper tape sensing pin. Current flows in the circuit connecting this transmitter to the receiver when the wiper arm traverses a segment whose associated sensing contact is closed. Because the wiper arm tests each segment in order, the circuit responds accordingly and the generated code elements are presented serially to the receiver.

By substituting a compatible receiver and eliminating the distributing mechanism (shown in Figure 2-1), it is possible to illustrate parallel transmission (shown in Figure 2-2).

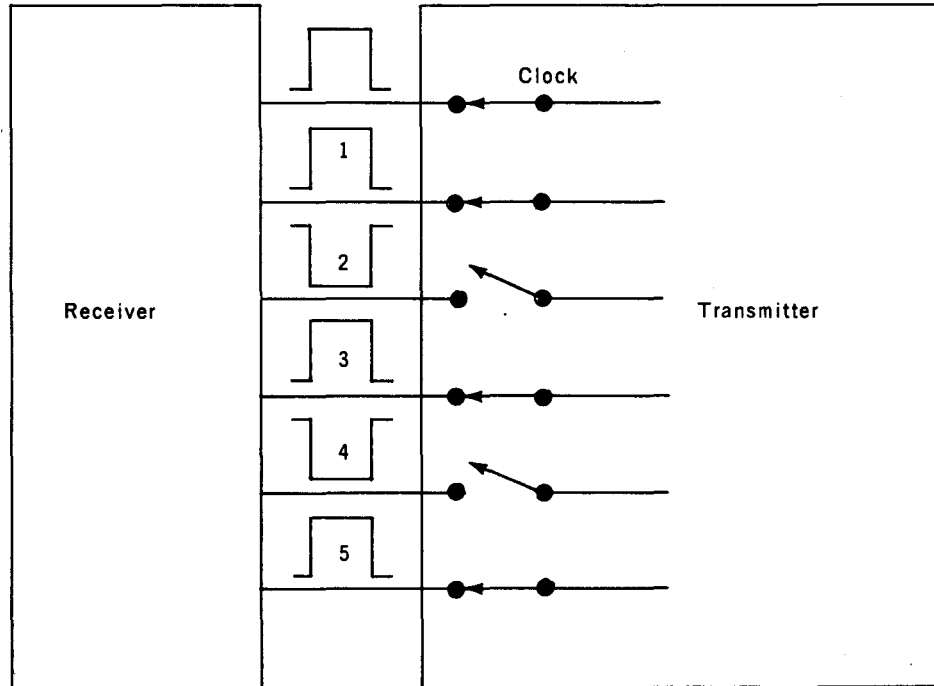


Figure 2-2. Bit-Parallel Transmission

In summary, a communication device presents information to the transmission circuit in one of two modes: bit-serial or bit-parallel.

2.3. TRANSMISSION METHOD

A communication receiver is designed to accept and act upon the intelligence contained in the signal received from a remote transmitter. To do this, receivers must know how many bits constitute one character and then be made to operate in a time frame dictated by the transmitter. The bit-serial receiver must know when the first bit of a character is available and must know the fixed time interval which separates each subsequent bit. The bit-parallel receiver must be capable of distinguishing between the quiescent condition of the data leads and the occurrence of information. The transmitter and the receiver must be synchronized and, because there is no mechanical linkage between the two, the requisite timing information must be conveyed on the circuit connecting them. This synchronism is established by one of two transmission methods: asynchronous or synchronous.

2.3.1. The Asynchronous Method

Asynchronous transmission, by definition, is the method in which the requisite timing is derived from each character transmitted. Asynchronous circuits presume a normal (current ON) line condition. To initiate operation, the transmitter precedes the data bits of each character with a START (current OFF) bit. This reversal of the normal line condition advises the receiver to process the subsequently known number of bits as data. The transmitter follows the last data bit with a return to the normal line condition by the

addition of a STOP (current ON) interval, the length of which is determined by the occurrence of the earliest subsequent character. The term, asynchronous, is synonymous with START-STOP and implies that the receiver comes to rest between each character. The START element provides synchronism with each incoming character and causes the receiving device to make one complete cycle.

In many processor-to-teletypewriter circuits, the processor interface is operating slightly slower than the teletypewriter. Figure 2-3 elaborates on Figure 2-1 by showing the START element being inserted ahead of the first intelligence bit and how, when the wiper arm comes to rest in the STOP segment, the signal circuit remains closed until the distributor is triggered by the advent of the next character. The STOP segment has a fixed length but the transmitted STOP element may only be described when continuous transmission is assumed.

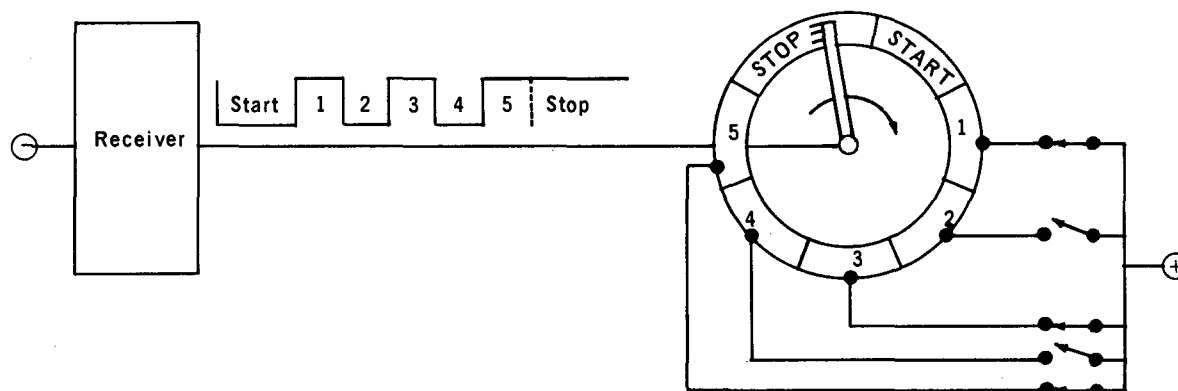


Figure 2-3. Asynchronous (Bit-Serial) Transmission

To operate asynchronously, the bit-parallel receiver relies upon the occurrence of a timing or 'clock' pulse to signal the simultaneous arrival of data. The timing contact (shown in Figure 2-2), would be operated when any one of the sensing contacts closed.

2.3.2. The Synchronous Method

This more sophisticated transmission method assumes that both the transmitter and the receiver are being driven at identical rates and that the corresponding functions of each (bit generation by the transmitter and detection of that same bit by the receiver) occur at the same point in time. The internal cycling rates of the transmitter and receiver are matched by the transmission of timing patterns. The bit configuration of these timing patterns ('sync' characters) is system-specified and is wired into the receiver.

In some systems, data traffic is inserted into a continuous stream of sync characters; in others, sync characters are only sent when a data message has been readied for transmission. In all systems, the receiver is designed to do a bit-by-bit positional comparison of the incoming bit stream to the bit configuration of the wired sync character. When a match is detected, the receiver is said to be locked-on and data characters may then be forwarded without additional timing information. The receiver can then distinguish between the individual bits of a data character, because the sync character has been positionally established.

The transmitter may or may not be aware that the receiver has locked-on. If a separate circuit is available, a supervisory 'ready' signal could be returned by the receiver. If not, only a parity examination following the message transmission can determine whether the number of sync characters which were transmitted did establish the requisite

synchronization. The number of sync characters that are needed depends primarily upon the circuit used for any given message. The synchronous transmission method is advantageous for two reasons:

- In asynchronous transmission, timing information is included with each transmitted character. In a 'worst case' situation (five-level code), the timing overhead in each character approaches 50% (7 1/2 bits). Synchronous transmission has the inherent advantage of being able to discharge this timing responsibility by placing a few sync characters at the beginning of a long message. Cost overhead becomes a significant factor because high speed remote terminals demand high cost transmission facilities. Therefore, the user must consider which of these overheads is most detrimental to him when choosing the transmission method.
- Asynchronous transmission requires the receiver to start and stop as each character is processed. As transmission rate increases, the time between successive characters decreases. Electromechanical receivers may not have enough time to reach a stop condition before the next character requires it to restart. Even when it is theoretically possible to stop the receiver between characters, excessive wear is likely to result.

2.4. TRANSMISSION RATE

Communication terminals operate at many different speeds and individual devices are frequently capable of operating at two or more transmission rates. The speed at which a unit is made to operate may reflect the economics of facility procurement rather than maximum efficiency. A card transceiver capable of ten cards-per-minute transmission may be geared to transmit three cards-per-minute in order to utilize a less expensive telegraph grade circuit. A teletypewriter requiring no better than 150 bits-per-second service may be linked to a voice-grade facility to take advantage of Wide Area Telephone Service. The circuit termination capability of a communication subsystem is occasionally expressed in terms of 'line' speeds when the primary consideration is actually the transmission rate of the remote device. In order to select the appropriate terminal, it is necessary to understand how the speed of the associated remote devices is expressed and how it is calculated.

2.4.1. How Transmission Rates Are Expressed

The speed of a communication terminal can be expressed as: operations-per-minute (OPM), characters- or cycles-per-second (CPS), words-per-minute (WPM), and baud, bauds, bits-per-second (B/S). The terms, baud and bauds, are used interchangeably as equivalents of bits-per-second. See Section 9 for further definition. Characters-per-second provides adequate device definition for bit-serial equipment. Characters-per-second also serves to describe the transmission rate of the bit-parallel device, because, by definition, this device requires separate circuits for each bit in a character thus making characters-per-second the equivalent of bits-per-second on any one circuit. But bit-serial terminals have a varying number of bits in each character and transmission facilities are concerned with the maximum number of electrical transitions they may be required to tolerate. Therefore, bit-serial devices and transmission facility

limitations are expressed in terms of bits-per-second.

2.4.2. How Transmission Rates Are Calculated

The number of bits in a transmitted character should not be automatically equated to the number of bits required to define a character in the bit-serial unit's code structure. For example, the USASCII code requires only seven bits for character description, but the synchronous transmitter adds a parity bit while the asynchronous device not only adds parity but includes a START bit and STOP interval.

- For synchronous devices, rates are calculated as follows:

$$\text{Bits/Second} = \text{Characters/Second} \times \text{Bits/Character (Data Bits + Parity Bit)}$$

- For asynchronous devices, however, the calculation is complicated by the fact that the STOP element (assuming automatic transmission) is seldom the same length as the START element or data bits. The asynchronous character must first be described in terms of bit-lengths or, more properly, described as the time-independent Unit Code. The START element is considered as the unit length and serves to define the length of all data bits. The STOP interval is longer than the START interval but not always by an even number of units. In the standard, five-level teletypewriter code, this STOP interval is 1.42 units. In certain card and paper tape transmission systems, the STOP interval is 1.5 units while some teletypewriters currently use a two-unit STOP interval. To describe the character, these units must be totaled:

	TELETYPEWRITER STANDARD	CARD/PAPER TAPE SYSTEMS	NEWER TELETYPEWRITER
START	1 unit	1 unit	1 unit
Data Bits	5 units	7 units	7 units
Parity Bits	(not used)	1 unit	1 unit
STOP	1.42 units	1.50 units	2 units
Unit Code =	7.42	10.50	11.00

For asynchronous transmission, the formula is:

$$\text{Bits/Second} = \text{Characters/Second} \times \text{Unit Code}$$

The number of bits-per-second that a device generates determines the transmission facility grade, whether data sets are required, and the characteristics of the interface to be furnished by a communications subsystem.



3. DATA COMMUNICATIONS SUBSYSTEM

3.1. GENERAL

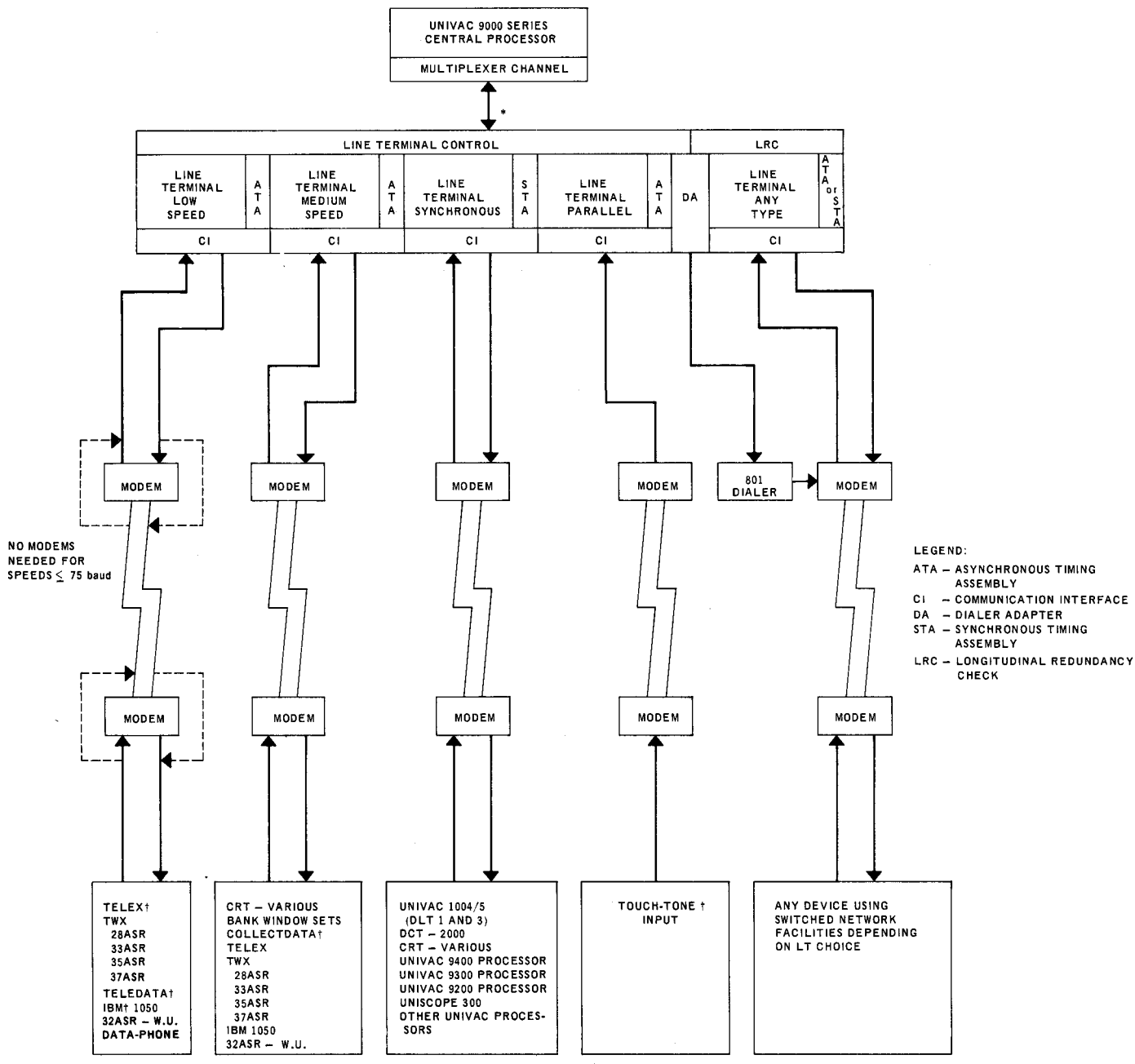
The UNIVAC Data Communications Subsystem (DCS) satisfies the I/O transfer requirements of the UNIVAC 9000 Series Central Processors and permits time-shared access to any of these central processors from a virtually unlimited variety of onsite and remote communications devices.

The DCS is available in three basic configurations:

- DCS-1 1 Line Terminal Control
 - 1 Line Terminal
 - 1 Communication Interface
 - Asynchronous or Synchronous Timing Assembly as required
- DCS-4 1 Line Terminal Control
 - and Up to 4 Line Terminals
- DCS-4A Up to 4 Communication Interfaces
 - 1 Dialing Adapter
 - Asynchronous and Synchronous Timing Assemblies as required
- DCS-16 1 Line Terminal Control
 - Up to 16 Line Terminals
 - Up to 16 Communication Interfaces
 - Up to 4 Dialing Adapters
 - Asynchronous and Synchronous Timing Assemblies as required

The DCS is linked to the UNIVAC 9000 Series Central Processors by the multiplexer channel (channel). The channel provides eight shared subchannels. Although it is physically possible to connect eight DCS's to the channel, practical considerations limit the number of DCS's that can be connected. In the case of the UNIVAC 9200/9300 Central Processor, no more than two DCS's can be connected thereby limiting the number of duplex channels to eight (two DCS-4's). For the UNIVAC 9400 Central Processor, no more than four DCS's can be connected which impose a limit of 64 duplex channels (four DCS-16's).

The DCS can take a variety of configurations, depending upon the particular application. Figure 3-1 illustrates a typical installation.



* A SECOND UNIVAC 9400 CENTRAL PROCESSOR CAN BE CONNECTED TO THE DATA COMMUNICATIONS SUBSYSTEM (DCS-16) THROUGH THE USE OF THE DUAL CHANNEL ADAPTER. THIS CONNECTION IS MANUALLY SWITCHED AND ALLOWS ONLY ONE PROCESSOR AT A TIME TO INTERFACE WITH THE DATA COMMUNICATIONS SUBSYSTEM.

† TELEX - TRADEMARK OF WESTERN UNION TELEGRAPH CO.
TELEDATA AND COLLECTDATA - TRADEMARKS OF FRIDEN, INC.
IBM - REGISTERED TRADEMARK OF INTERNATIONAL BUSINESS MACHINES CORP.
TOUCH-TONE - REGISTERED SERVICE MARK OF A.T. & T. CO.
DATA-PHONE - REGISTERED SERVICE MARK OF A.T. & T. CO.

Figure 3-1. UNIVAC Data Communications Subsystem

3.1.1. Central Processor-Subsystem Interface

The channel (Figure 3-2) is the interface between the central processor and the DCS. The controllers begin sampling when informed by the channel that a device address is available. If the address byte contains a correct device (line terminal) address and its parity is correct, the initial selection sequence begins. The appropriate controller alerts the addressed line terminal that an initial selection sequence is beginning. If the addressed line terminal is busy with a previously initiated command, the appropriate status is stored in the line terminal for return to the central processor when the command byte is issued later in the sequence.

After allowing 400 (± 100) nanoseconds for address comparison, a polling signal (SELECT OUT) probes each controller in descending priority order. Assuming that the addressed line terminal is not busy, the controller, when polled, captures the interface. The controller returns a signal (OPERATIONAL IN) which indicates to the channel that the controller has captured the interface and is ready to proceed.

The line terminal address is then sent to the central processor and, in response, the central processor issues a command byte and informs the controller that the command byte is available. If command byte parity is correct and the command is in the repertoire of the addressed line terminal, the line terminal returns, by way of the controller, a status byte indicating to the central processor that the command was accepted. If the line terminal was busy, the appropriate status byte is returned at this time and the sequence terminates.

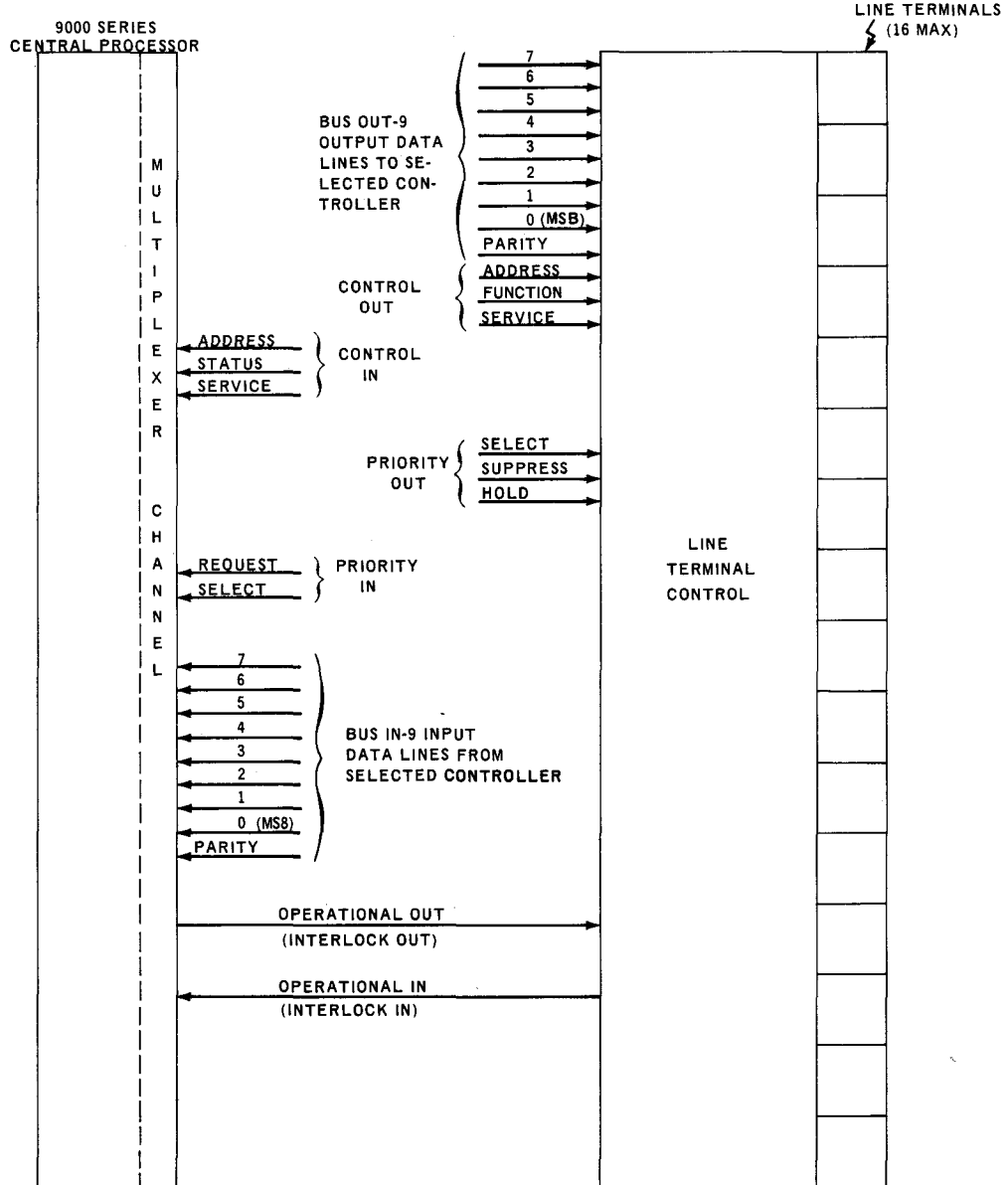
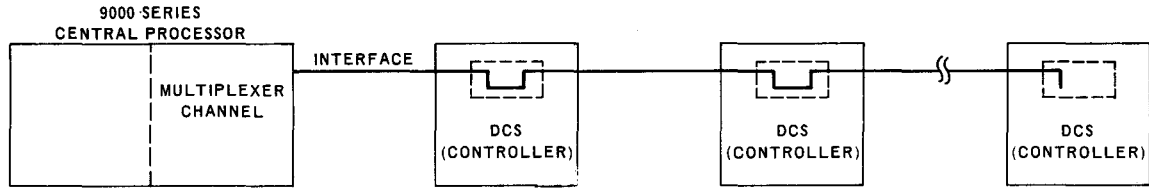


Figure 3-2. Processor-Subsystem Channel Detail

The initial selection sequence terminates upon acceptance of the command. The subsystem now enters the input or output data sequence, as appropriate. Once initiated, the data transfer proceeds, a byte at a time, on a reciprocal request/acknowledge basis until the amount of data specified in the Buffer Control Word has been transferred (channel is not locked up by central processor). When the data transfer is completed, the line terminal returns a status byte to the central processor indicating whether or not the data transfer was error-free. On data transfers, a buffer area is set up in main storage either to receive incoming data or to store output data. Access to this buffer is controlled by the Buffer Control Word and the channel. In this manner, data transfers can proceed without attention by the central processor and the central processor is free for computational work.

3.1.2. DCS Addressing and Priorities

On data transfers to and from the central processor, the device (line terminal) effecting the transfer must identify itself (input) or must be addressed (output). This device address is contained in one nine-bit byte (eight address bits plus parity). Address format and interpretation depend upon the central processor used in the system. Line terminals consist of input and output logic each of which is independently addressable. The *input logic* always takes an *odd* address, while the *output logic* always takes an *even* address. Since the format of the address byte depends upon the central processor model, detailed information on addressing is presented in the appropriate supplement.

Two levels of priority are involved in the DCS: DCS controller priority and line terminal priority. Controller priority is governed by connections made on priority patch boards. Figure 3-3 illustrates the controller priority scheme.

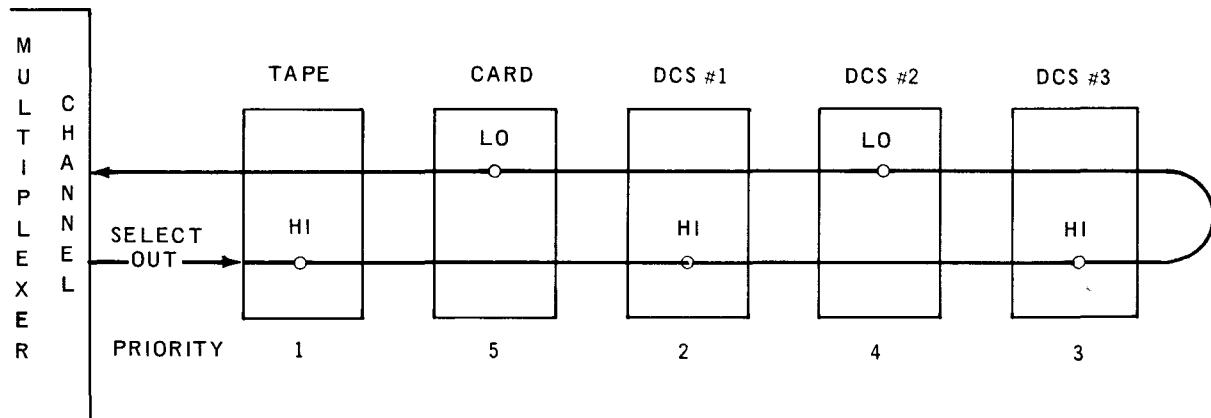
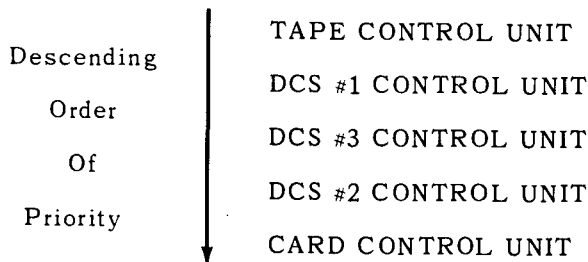


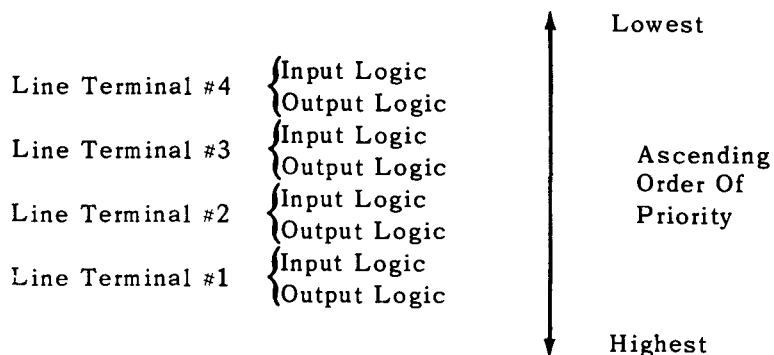
Figure 3-3. Control Unit Priority Scheme

The threading of the SELECT OUT line through the various control units can be represented as a loop. As the SELECT OUT signal is propagated down the line, it is made available to the control unit in the sequence established by the patch board connections. Thus, in the example shown in Figure 3-3, the signal is available to the various controllers in the following sequence:



As a result, the tape controller has the highest priority and the card controller has the lowest priority. The DCS1 and DCS 3 controllers have higher priority than the DCS 2 controller. It is strongly recommended that the high speed DCS configurations be given priority over the low speed DCS configurations.

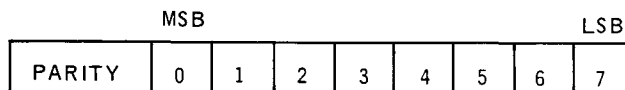
The line terminals attached to a controller also have their own priorities and, similar to addressing, the input logic and the output logic of a line terminal can be independently assigned priorities. These priorities depend on position relative to the other line terminals. Input logic is given higher priority than output logic within a given line terminal. Thus, in a DCS-4, the priority sequence is as follows:



Obviously, since input and output logic priorities depend upon relative position, the line terminal priority can be changed by changing the physical location of the boards that comprise the input and the output logic.

3.1.3. Byte Transfers

All transfers between the channel and a controller are on a nine-bit byte basis as shown below:



Hardware conversion is employed to expand or compress these nine-bit bytes for the remainder of the DCS for example, line terminal may be handling five bits plus parity characters. Thus, all *unused* data bits of a central-processor-generated byte *must be zero*.

3.1.4. Command Bytes

The command bytes accepted by various line terminals from a central processor, by way of the controller, are listed in Table 3-1. This table lists the name, bit configuration, and function of each command. In the command format, P is the parity bit and bit position O is the most significant bit. A controller is never busy and it will 'look at all commands.

COMMAND	BIT CONFIGURATION P 0 1 2 3 4 5 6 7	FUNCTION
WRITE COMMANDS		
SEND DATA	P 0 0 0 0 0 0 0 1	Initiates output data sequence. Sent during initial selection sequence.
DIAL	P 0 0 0 0 0 1 0 1	Same as SEND DATA. Acceptable only by a line terminal equipped with a dialing adapter. Dialing function is performed by the dialing adapter and not by the line terminal.
READ COMMANDS		
TURN-ON	P 0 0 0 0 0 0 1 0	Initiates input data sequence. Sent during initial selection sequence. When data is made available on input data lines, it is transmitted to the central processor.
LOOK FOR SYNC	P 0 0 0 0 0 1 1 0	Suppresses character synchronization in line terminal (input only) and causes line terminal to recognize two contiguous unique sync characters and optional Start-Of-Message (SOM) character in a serial data stream. When recognized, new character synchronization is established. Line stops and does not resume the input operation until recognition of first non-sync character following resynchronization.
NEW SYNC	P 0 0 0 0 1 0 1 0	Sent to communication interface (F1002-03 only) associated with addressed line terminal which enables communication interface to turn off receive clock of a synchronous modem. This permits fast resynchronization with a newly turned on remote transmitter. Generally used only in multiparity applications.

Table 3-1. Command Bytes Accepted by Data Communications Subsystems (Part 1 of 3)

COMMAND	BIT CONFIGURATION P 0 1 2 3 4 5 6 7	FUNCTION
CONTROL COMMANDS		
TURN-OFF	P 0 0 0 0 0 0 1 1	Initiates early termination of input or output data sequence.
DCS TEST (For field engineering use only)	P 0 0 0 0 1 0 1 1	Sent to line terminal input logic. Terminates connection between associated communication interface and remote device. Connects addressed line terminal input logic with its paired line terminal output logic to permit back-to-back testing of DCS by central processor.
END TEST (For field engineering use only)	P 0 0 0 0 1 1 1 1	Sent to line terminal input logic. Returns communication interface and line terminal to normal operation after completion of tests initiated by DCS TEST or LOCAL TEST control commands.
DISCONNECT	P 0 0 0 1 0 0 1 1	Sent to line terminal input logic which causes associated communication interface (F1002-04 only) to "hang-up" call. Upon receipt of command, data terminal ready lead is dropped which directs modem to "hang-up".
LOCAL-TEST (For field engineering use only)	P 0 0 0 0 0 1 1 1	Sent to line terminal input logic. Causes associated communication interface (F1002-05 only) to place modem in back-to-back test mode which permits testing of all onsite hardware, including modem, by central processor. Applicable only when modems have turnaround capability.

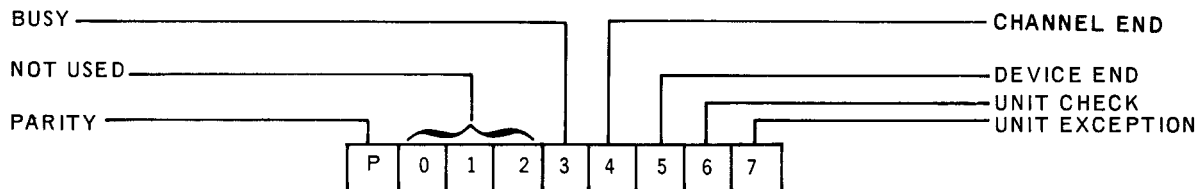
Table 3-1. Command Bytes Accepted by Data Communications Subsystems (Part 2 of 3)

COMMAND	BIT CONFIGURATION P 0 1 2 3 4 5 6 7	FUNCTION
GENERAL COMMANDS		
SENSE	P 0 0 0 0 0 1 0 0	When error condition exists, line terminal sends a UNIT CHECK status byte to central processor. Central processor replies with a SENSE command (implemented by software). Upon receipt of the SENSE command, line terminal returns two SENSE bytes to the central processor.
TEST I/O	P 0 0 0 0 0 0 0 0	Used to obtain present status of a line terminal. Command does not cause generation of new status.
PARALLEL TEST (For field engineering use only)	P 0 0 0 0 0 1 1 0	Special command for parallel line terminal. Upon receipt of command, line terminal requests input data and then automatically generates data. In effect, it simulates the presence of output logic in the line terminal thereby permitting back-to-back testing of the parallel line terminal.
SEND BREAK	P 0 0 0 1 0 0 0 1	Sent to line terminal output logic. Causes associated communication interface to send a break (spacing) signal for 205 milliseconds (minimum) for TWX and 1 second (minimum) for TELEX. Used to turn off a remote transmitter. Implementation is restricted to full duplex circuits.
ANSWER BACK A ANSWER BACK B ANSWER BACK AB	P 0 0 0 1 0 0 1 0 P 0 0 0 1 0 1 1 0 P 0 0 0 0 1 1 1 0	Sent to line terminal input logic. Causes associated communication interface to send one of three different tones on answer back channel of type 403A modem. Preselects and controls tone by issuing appropriate command. Selected tone is sent for three to five seconds.

Table 3-1. Command Bytes Accepted by Data Communications Subsystems (Part 3 of 3)

3.1.5. Status Byte

A status byte contains information about the acceptance of a command, status of a unit, or the performance of a command. A status byte may be returned to the channel, by way of the controller, following acceptance of a command, termination of an operation, or request by the central processor. The bits of a status byte are designated as shown in Figure 3-4.



NOTE: Status is indicated by setting appropriate bit position to a 1 bit.

Figure 3-4. Status Byte Format

Status information is stored in the input or the output logic of the line terminal handling the operation. The bits of the status byte have the following significance (when set):

- **BUSY**

Indicates a previously initiated command is in progress.

- **CHANNEL END**

Indicates an initiated command has been completed.

- **DEVICE END**

Is the same as CHANNEL END.

- **UNIT CHECK**

Indicates an error condition. When the central processor receives this status, it may issue a SENSE command to determine cause of error.

- **UNIT EXCEPTION**

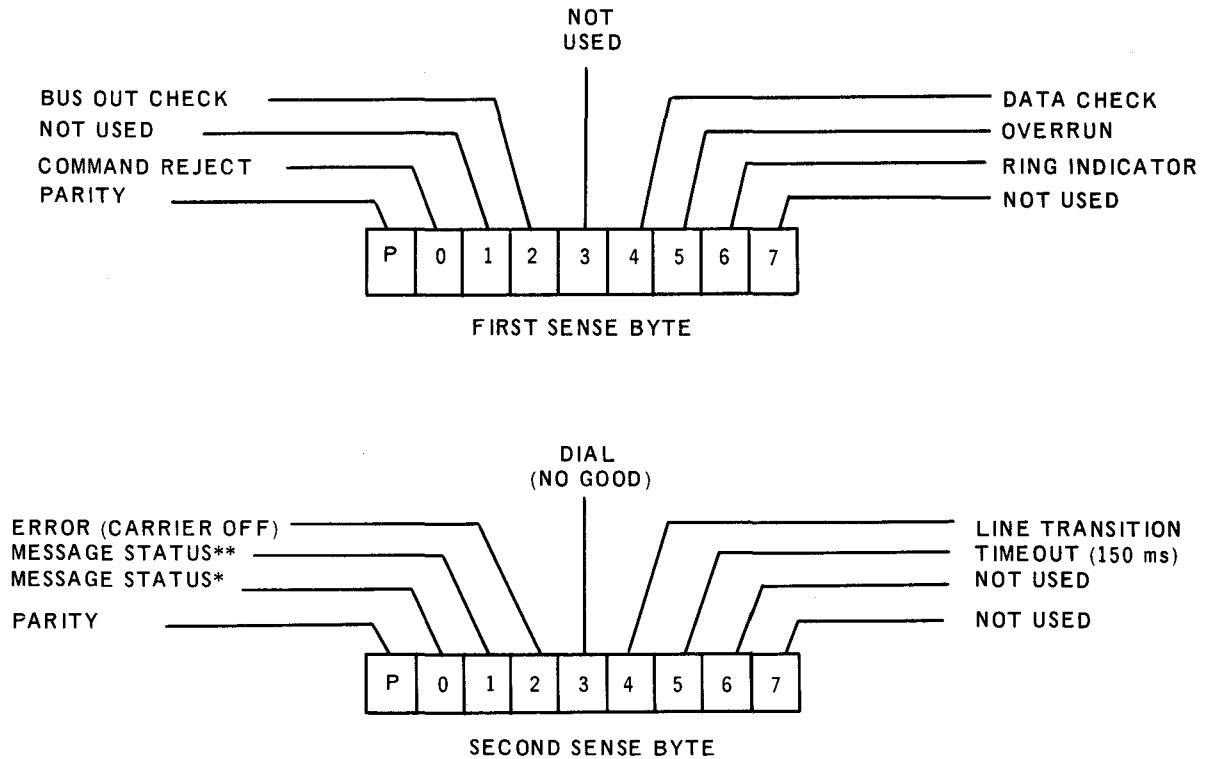
Indicates that addressed line terminal (input or output logic) is nonexistent or is not active.

3.1.6. Sense Bytes

Whenever the central processor receives a UNIT CHECK status bit from line terminal logic (input or output), it indicates one of the following:

- there is an error of some kind in the last message;
- a command was rejected for some reason;
- there is a malfunction in the data set;
- there is a malfunction in the channel;
- A dialing connection by a remote station is being attempted; or
- that line (over which automatic dialing is being done) is receiving a busy signal.

Upon receipt of a status byte containing a UNIT CHECK bit, the central processor issues a SENSE command (software generated) to the line terminal logic. When the SENSE command is received, the line terminal logic returns two sense bytes to the central processor. The sense byte bits are designated as shown in Figure 3-5.



*Longitudinal Redundancy Check Error

**Character Parity Check Error

NOTE: Sense is indicated by setting the appropriate bit position to a 1 bit.

Figure 3-5. Sense Byte Formats

The bits of the first sense byte, when set, have the following significance:

- **COMMAND REJECT**

Indicates that the command was rejected because it was an invalid (not acceptable to line terminal) command.

- **BUS OUT CHECK**

Indicates that the controller has detected a parity error in the command byte received from the channel.

- **DATA CHECK**

Indicates that the controller has detected a parity error in one of the data bytes received from the channel.

- **OVERRUN**

Indicates that the channel did not acknowledge receipt of a data byte or send a data byte, when requested, during a specified time period.

- RING INDICATOR

A dialed connection is being attempted from a remote location. This is applicable only when communication interface (F1002-04 only) must answer calls automatically.

The bits of the second sense byte, when set, have the following significance:

- MESSAGE STATUS (Longitudinal Redundancy Check)

Indicates that a block parity error was detected in the last message received.

- MESSAGE STATUS (Character Parity Error)

Indicates that a character parity error was detected in the last message received.

- ERROR (Carrier Off)

Indicates that the carrier was lost while receiving a message:

- DIAL (NO GOOD)

Indicates an unsuccessful dialing attempt, for example, the called number or the invalid number is busy.

- LINE TRANSITION

Indicates that input line has transitioned from spacing to marking condition sometime after expiration of 500 ±50 millisecond timeout period.

- TIMEOUT (150 Milliseconds)

Indicates that the line terminal has received a break signal. Break signal consists of a 150-millisecond (minimum) spacing signal. Used by receiving station to stop transmission by computer. Implementation is restricted to full duplex circuits.

3.1.7. Special Conditions

Line terminal logic is busy once it has been turned on and remains busy until it has been turned off. However, line terminal logic accepts certain commands after it has been turned on. These commands are any one of the three Answer Back commands, which are SEND BREAK, LOOK FOR SYNC, and NEW SYNC. The dialing adapter is associated with the output logic of a particular line terminal and is busy under the same conditions as the line terminal.

A *selective reset* causes the line terminal operation and any status it may have stored to be reset and is issued after a malfunction or time-out. The DCS must receive a new TURN ON command if the line terminal is to be used after the receipt of a selective reset.

A BUSY status byte is returned to the central processor:

- If addressed line terminal logic is active; or
- If addressed line terminal logic is active and issued command is an invalid command;
or

- SEND DATA command is issued to line terminal output logic after a DIALING command has been issued and before the dialing sequence has terminated.

If the line terminal logic is inactive, the command is accepted and the appropriate status byte is returned to the central processor.

A *systems reset* terminates all devices and no status is returned to the central processor.

The conditions listed below will be indicated by a UNIT CHECK bit and detailed information in the sense bytes. The first sense byte has COMMAND REJECT bit set and the second sense byte is all 0's.

- Read command to line terminal output logic or a write command to line terminal input logic. (Control commands are not considered Read or Write commands.)
- Issuing a SET INHIBIT STATUS, RESET INHIBIT STATUS, or STATE OF INHIBIT STATUS REMAINS UNCHANGED commands to a DCS.

3.2. LINE TERMINAL CONTROL

The line terminal control (controller) functions as the DCS control center to coordinate and control data transfers between the central processor and the remote devices. It also acts as the interface between the channel and one or more line terminals. Backboard wiring connects the controller to a maximum of 16 line terminals. External circuitry (shown in Figure 3-2) links the controller to the processor.

The major functions of the controller are as follows:

- Responds to commands from the central processor and requests from the line terminals.
- Performs byte parity generation and checking on channel/line-terminal transfers and notifies central processor of results.
- Controls all types of line terminals and permits operation of line terminals concurrently.
- Presents status information to the central processor when requested by the line terminal. Status is *not stacked* by the controller.
- Selects line terminals requesting service according to line terminal logic priority.
- Releases each line terminal after it has completed its operation.

3.2.1. Longitudinal Redundancy Check

This optional functional characteristic permits the checking of block parity on data being transferred to and from the central processor. While the logic of this feature is installed as part of the controller it can only be exercised by line terminals that incorporate the longitudinal redundancy check characteristic. Detailed information concerning this feature can be found in 3.5.4.4.

3.2.2. Parity Check and Generate

The controller has the capability of checking and generating parity for the bytes being transferred to and from the central processor over the channel. This operation is separate and distinct from the character parity check and generates functional characteristic of the line terminals. On transfers to the central processor, the controller generates and adds a parity bit (P-bit) to the byte being transferred. On bytes coming from the central processor, the controller checks byte parity. If a parity error is detected in a command byte, the controller sets the BUS OUT CHECK bit in the addressed line terminal. For parity errors detected in data bytes, the DATA CHECK bit is set in the line terminal handling the transfer.

3.3. LINE TERMINALS

The line terminal provides circuit termination for telegraph, telephone, or broadband communication lines. Line terminals consist of input (receive) and output (send) logic which interconnect to permit half duplex or full duplex operation. All line terminals are compatible with all controllers. Line-terminal/communication-interface requirements are largely dependent upon communication service and application requirements. Table 3-2 supplies information about line-terminal/communication-interface compatibility.

COMMUNICATION LINE SERVICE	CI MODEL NUMBER	LINE TERMINAL LOW SPEED								LINE TERMINAL MEDIUM SPEED				LINE TERMINAL SYNCHRONOUS					LINE TERMINAL PARALLEL						
		F1003-								F1004-				F1005-					F1006-99						
		99		98		97		96		99		98		99		98		97							
		out (00)	in (01)	out (02)	in (03)	out (06)	in (07)	out (06)	in (07)	out (00)	in (01)	out (02)	in (03)	out (00)	in (01)	out (02)	in (03)	out (04)		in (05)					
20 ma Neutral Teletype*	F1002-00	X	X	X	X					X	X	X	X												
50-60 ma Neutral Teletype	-00	X	X	X	X					X	X	X	X												
20-40 ma Polar Teletype	-00	X	X	X	X					X	X	X	X												
EIA Private Line (Voice Grade)	-03	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X				
EIA DATA-PHONE (Voice Grade)	-04	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X				
TELPAK†	-05															X	X	X	X	X	X				
Parallel	See 1.																								X
2058 Modem	-08															X	X	X	X	X	X				
TWX 4-row	See 2.							X	X																
TELEX	-10					X	X																		

NOTES:

1. C/I for Parallel line service is an integral part of F1006-99
2. C/I for TWX line service is an integral part of F1003-96

* Teletype-Trademark of Teletype Corp.

† TELPAK - Trademark of A.T.&T. Co.

Table 3-2. Line-Terminal/Communication-Interface Compatibility

Line terminals arrange data in the format required by the central processor or in the format demanded by the circuit with which the line terminal is designed to operate. Incoming data is received from the associated communication interface and is arranged in bit-parallel form for transmission to the central processor by way of the controller. Output data is formatted by the line terminal in accordance with the requirements of the associated communication circuit. (Bit-serial format, except when dialing adapter or parallel line terminal, is used.)

A wide variety of line terminals are available which have features and options that make them suitable to operate with virtually all types of communications facilities. Table 3-3 summarizes the major features of the various line terminals.

SYSTEM CHARACTERISTICS	FEATURE/OPTION BREAKDOWN
Number of Terminals	Duplex mode – one, four, or 16 positions
Type of Operation	Simplex, half duplex, or full duplex
Data Transfer Rate	Low speed – 45.45 to 300 bits per second Medium speed – 300 to 1800 bits per second Synchronous (voice grade) – 2000 to 4800 bits per second Synchronous (broadband) – 40.8K or 50K bits per second
Character Size	Low speed – five or eight bits Medium speed – four to eight bits Synchronous – five, six, seven, eight, or ten bits
Special Applications	<ul style="list-style-type: none"> ● One dialing adapter can be attached to a DCS-4 (or four dialing adapters in the case of a DCS-16) to permit the central processor to control an A.T.&T. 801A or 801C Automatic Calling Unit. ● A parallel line terminal (input only) enables the central processor to interface with a Touch-Tone* telephone. It operates by means of an A.T.&T. 403D5 or 403E3 Data Set (two out or eight codes). ● A dual channel access feature allows two UNIVAC 9400 Multiplexer Channels to access the same DCS-16 through operator intervention.

*Registered Service Mark of A.T.&T. Co.

Table 3-3. Line Terminal Features

3.4. COMMUNICATIONS INTERFACE

The Communications Interface (CI) makes the necessary conversion between the electrical operating levels of the line terminals and those of the particular external circuit with which the CI is designed to operate. Table 3-4 presents the various characteristics of the different CI's. Table 3-5 presents relevant information concerning CI/modem compatibility. CI compatibility with the various line terminals is shown in Table 3-2. A brief description of the features is as follows:

- 20 ma Neutral Telegraph

Certain telegraphic systems employ a DC current of 20 milliamperes for signal transmission. Binary 1's are a marking (closed loop, current flowing) condition and binary 0's are a spacing (open loop, no current) condition.

- 60 ma Neutral Telegraph

Same as for 20 ma Neutral Telegraph except that a heavier current flow is employed.

- 20 to 40 ma Polar Telegraph

These telegraphic systems use directional current flow to represent binary digits. Current flow in one direction indicates a binary 1 (mark) and current flow in the opposite direction indicates a binary 0 (space).

- Half Duplex (Inhibit Local Copy)

Inhibit local copy is a characteristic of half duplex operation. Output data cannot be received by the input logic of the transmitting line terminal. This feature is not implemented by hardware and if it is desired by the user, he must implement it through the use of software.

- Speed Select

This feature permits manual selection of the modem clock speed. A maximum of three speeds can be selected.

- EIA RS 232B

This is a generally accepted industry standard interface specification with which some CI's are compatible (see Table 3-4).

- TELPAK

As used in the context of the DCS communications environment, it refers to a current interface that is compatible with modems employed in broadband communications.

- MIL Standard 188B

This MIL Standard is a specification for electrical circuit compatibility (circuit compatibility is provided only for data and clock signals).

- Unattended Answer

This is a characteristic of DATA PHONE and TWX service. Compatibility with this characteristic requires the ability to hang up a received call. The DISCONNECT command performs this function.

- DCS TEST Maintenance Aid

This maintenance aid permits testing of the system under program control. The DCS TEST command causes the input and the output logic of the line terminal to be interconnected through the CI for back-to-back testing.

ITEM	F1002-									
	00	03	04	05	See 1.	08	See 2.	10		
FEATURE										
20 ma Neutral D-C Telegraph	X									
20-40 ma Polar D-C Telegraph	X									
60 ma Neutral D-C Telegraph	X									
EIA RS 232B		X	X				X			
Full Duplex	X	X	X	X		X				
Half Duplex	X	X	X				X			
MIL-STD 188B						X				
Simplex	X	X	X		X					
Speed Select						X				
TELPAK				X						
STATUS										
Ring Indicator			X							
CONTROL COMMANDS										
Answer Back Tones (A, B, AB)					X					
DCS Test	X	X	X	X	X	X	X			
Disconnect (Unattended Answering)			X		X		X			
End Test	X	X	X	X	X	X	X			
Local Test		X	X	X						
New Sync		X								
Send Break							X			
TYPICAL USE										
Government Communications Systems						X				
Private Lines, Modems, Broadband				X						
Private Lines, Modems, Voice Grade		X								
Private Line, Telegraph A.T.&T.	X									
Private Line Telegraph Western Union	X									
Public Network, Modems, Voice Grade			X							
Touch-Tone Receive					X					
4-Row TWX						X				
TELEX								X		

NOTES:

1. C/I is integral part of F1006-99
2. C/I is integral part of F1003-96

Table 3-4. Communication Interface Characteristics

MODEM	CI NUMBER	TYPICAL USE			
		SERVICE	SPEED	OPERATION	TIMING
Bell Data Set 103A	F1002-04	DATA-PHONE; Public Network; Auto-calling; Unattended answer	Up to 200 baud	Half or full duplex	Asynchronous
Bell Data Set 103F	F1002-03	Private line	Up to 300 baud	Half or full duplex	Asynchronous
Bell Data Set 201A3	F1002-04	DATA-PHONE; Public Network; Auto-calling; Unattended answer	2000 baud	Half duplex	Internal timing - synchronous
Bell Data Set 201B1	F1002-03	Private line	2400 baud	Half or full duplex	Internal timing - synchronous
Bell Data Set 202C	F1002-04	DATA-PHONE; Public Network; Auto-calling; Unattended answer	Up to 1200 baud	Half duplex	Asynchronous
Bell Data Set 202D	F1002-03	Private line	Up to 1800 baud	Half or full duplex	Asynchronous (synchronous operation at 1200 baud when used with Synchronous Timing Assembly F1011-00)
Bell Data Set 205B1	F1002-08	Private line	600, 1200, or 2400 baud	Full duplex	Internal timing - synchronous
Bell Data Set 301B	F1002-05	Private line	40.8K baud	Full duplex	Internal timing - synchronous
Bell Data Set 303C	F1002-05	Private line	50K baud	Full duplex	Internal timing - synchronous
Bell Data Set 403D5 and 403E3	See 1.	DATA-PHONE (re- ceive only) - parallel 2 out of 8 code; Un- attended answering		Simplex	
Bell Data Aux- iliary Set 811B	See 2.	TWX network interface, A-row TWX only.			
Western Union 12150 Interface	F1002-10	TELEX	50 baud	Half duplex	Asynchronous

NOTES: 1. C/I is integral part of F1006-99

2. C/I is integral part of F1003-96

Table 3-5. Communication Interface/Modem Compatibility

As indicated in Table 3-4, the CI's have the ability to respond to certain commands. These commands are actually directed to the line terminals because the line terminals are addressable and the CI's are not. The line terminal passes the command to the CI.

One of the capabilities of certain CI's is unattended answering. When the CI detects a ringing signal from a remote station, the CI sets a sense bit in the associated line terminal input logic. The input logic of the line terminal then generates a request to input status. Upon acknowledgement of the request, the line terminal inputs a status byte with the UNIT CHECK bit set. The central processor responds with a SENSE command. In answer to the SENSE command, the line terminal inputs two sense bytes; the first sense byte has the RING INDICATOR bit active and the second sense byte is all O's. The line terminals follow the sense bytes with an input of normal ending status (status byte with CHANNEL END and DEVICE END bits active). The central processor should then issue a TURN-ON command to the input logic of the line terminal and the line terminal will input the message. At termination, the line terminal returns normal ending status. The central processor, after examining the message, issues an Answer Back A, B, or AB command to the line terminal logic (parallel LT only) which causes the CI to transmit the appropriate tone to the transmitting station and causes the line terminal to return normal ending status. The central processor may now send either a DISCONNECT command to hang up the call or send another TURN-ON command to allow another message to be received. The meaning of the various Answer Back commands is up to the user. For instance, they could be assigned the following meanings:

- Answer Back A: Message is received and it is valid.
- Answer Back B: Message is received and appears to be invalid.
 Retransmit message.
- Answer Back AB: Message received and it is valid. Send next message.

3.5. LINE TERMINAL CHARACTERISTICS AND OPERATION

Listed below are the functional characteristics which are applicable to all types of line terminals. Characteristics which are peculiar to a particular type of line terminal are discussed in the paragraphs dealing with each type of line terminal.

- Send

Line terminal output logic accepts data bytes from the channel, by way of the controller, and transmits them to the communication line by disassembling the bytes into a bit-serial stream which is sent to the modem by way of the communication interface. In the case of the dialing adapter, the transfer from the communication interface to the modem is in bit-parallel form. Asynchronous line terminals insert the START bit preceding the data bits and a STOP interval after the data bits. Serial characters are transmitted with the least significant bit first.

- Receive

Asynchronous line terminal input logic accepts bit-serial characters from the communication interface, strips the START and STOP pulses, assembles the bit-serial

characters into bit-parallel data bytes, and transfers the data bytes in bit-parallel form to the channel by way of the controller. Synchronous line terminals operate in a similar manner except that they strip off sync characters instead of START and STOP pulses. In addition, both asynchronous and synchronous line terminals strip off the transmission parity if this option is desired by the user.

- Operation

Line terminals can be operated half or full duplex depending upon the application and the desires of the user.

- Timing

Asynchronous line terminal output and input logic receives a timing signal from an asynchronous timing assembly (ATA), which determines the data transmission rate. The synchronous line terminal output logic receives its timing from a synchronous timing assembly (STA). The clock for the input logic of a synchronous line terminal is derived from received data if an STA is used; otherwise, the modem supplies the data clock.

3.5.1. Command, Status Byte, and Sense Byte Repertoire

While all line terminals are capable of returning all status bits, not all line terminals are capable of accepting all commands or returning all of the various sense bits. The limitations in these areas are indicated in Table 3-6.

3.5.2. Summary of Line Terminal Capabilities

Table 3-6 summarizes the functional characteristics, capabilities, and uses of the various line terminals. Note that the functional characteristics are generally applicable to a particular *type* of line terminal, but they are not necessarily applicable to all *models* of that particular type of line terminal.

ITEM	LINE TERMINAL LOW SPEED								LINE TERMINAL MEDIUM SPEED				LINE TERMINAL SYNCHRONOUS						LINE TERMINAL PARALLEL	
	F1003-								F1004-				F1005-						F1006-99	
	99		98		97		96		99		98		99		98		97			
	out (00)	in (01)	out (02)	in (03)	out (06)	in (07)	out (06)	in (07)	out (00)	in (01)	out (02)	in (03)	out (00)	in (01)	out (02)	in (03)	out (04)	in (05)		
FUNCTIONAL CHARACTERISTIC																				
4,5,6,7, or 8-Bit Character																				
5,6,7, or 8-Bit Character																				
5 or 8-Bit Character																				
8-Bit Character																				
Automatic Look for Sync																				
Character Parity Check and Generate																				
Half Duplex																				
Idle and/or Sync Character Check and Generate																				
Inhibit Transmit (Restraint)																				
Longitudinal Redundancy Check and Generate																				
Open Line Detector																				
Pause Character (5-Level Only)																				
Pause Character (4,5,6, or 7-Level Only)																				
Receive																				
Remote Computer																				
Send																				
Simplex or Full Duplex																				
Start-of-Message (SOM) Detection																				
COMMANDS																				
Answer Back A																				
Answer Back AB																				
Answer Back B																				
DCS Test																				
Dial																				
Disconnect																				
End Test																				
Local Test																				
Look For Sync																				
New Sync																				
Parallel Test																				
Send Break																				

Table 3-6. Line Terminal Characteristics (Part 1 of 2)

ITEM	LINE TERMINAL LOW SPEED								LINE TERMINAL MEDIUM SPEED				LINE TERMINAL SYNCHRONOUS						LINE TERMINAL PARALLEL									
	F1003-																F1004-				F1005						F1006-99	
	99		98		97		96		99		98		99		98		97											
	out (00)	in (01)	out (02)	in (03)	out (06)	in (07)	out (06)	in (07)	out (00)	in (01)	out (02)	in (03)	out (00)	in (01)	out (02)	in (03)	out (04)	in (05)										
COMMANDS (Cont.)																												
Send Data	x		x		x		x		x		x		x		x		x											
Sense	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
Test I/O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
Turn-Off	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
Turn-On		x		x		x		x		x		x		x		x		x		x								
FIRST SENSE BYTE																												
Bus Out Check	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x								
Command Reject	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
Data Check	x		x		x		x		x		x		x		x		x		x									
Overrun (Input)		x		x		x		x		x		x		x		x		x		x								
Overrun (Output)													x		x		x		x									
Ring Indicator		x		x			x		x		x		x		x		x		x									
SECOND SENSE BYTE																												
Dial (No Good)	x		x				x		x		x		x		x		x		x									
Error (Carrier Off)				x				x				x				x		x		x								
Line Transition																												
Message Status*				x				x				x				x		x										
Message Status**												x				x		x										
Timeout (150 Milliseconds)						x		x																				
TYPICAL USE																												
4-Row TWX							x	x																				
DATA-PHONE											x	x			x	x												
Interprocessor (Local and Remote)																		x	x									
Medium and Low Speed Data DATA-PHONE			x	x					x	x																		
Synchronous Data													x	x														
Telegraph, Low Speed Data, DATA-PHONE	x	x																										
TELEX					x	x	x	x																				
Touch-Tone or Dial (Rotary) Telephone																												

*Character Parity Error

**Longitudinal Redundancy Check

Table 3-6. Line Terminal Characteristics (Part 2 of 2)

3.5.3. Low Speed Line Terminals

- Transmission Mode: bit-serial;
- Transmission Method: asynchronous;
- Input Rate: is controlled by ATA;
- Output Rate: output timing is provided by ATA (see 3.7);
- Character Compatibility: five or eight bits at option of user;
- Communication Interface: relay or electronic (see Table 3-2).

3.5.3.1. Basic Input Operation

The input logic of the low speed line terminal (LT-L) is activated by the TURN-ON command from the central processor. Upon receipt of this command, the LT-L returns a status byte of all O's to the central processor, by way of the controller and looks at the input data lines. The START bit of the incoming asynchronous character triggers the input clock of the LT-L and the clock, in turn, generates detection pulses timed to coincide with the most linear portion of each subsequent data bit (see Figure 3-6). As the intelligence contained in each bit is sampled, logical components in the LT-L input assembly register are set accordingly. The final slot in the assembly register is filled approximately midway into the last data bit, the LT-L clock stops during the STOP pulse, and a request is generated by the LT-L to input the data character. This START-STOP operation continues until an End-Of-Message (EOM) character is detected by the LT-L. (If an EOM character is not used in the particular application, the operation must be terminated by software.) After detection of the EOM character, which is sent to the central processor, the LT-L generates the normal ending status of CHANNEL END and DEVICE END and then terminates. The input and output EOM characters should be identical and must be unique with respect to all other data and control characters.

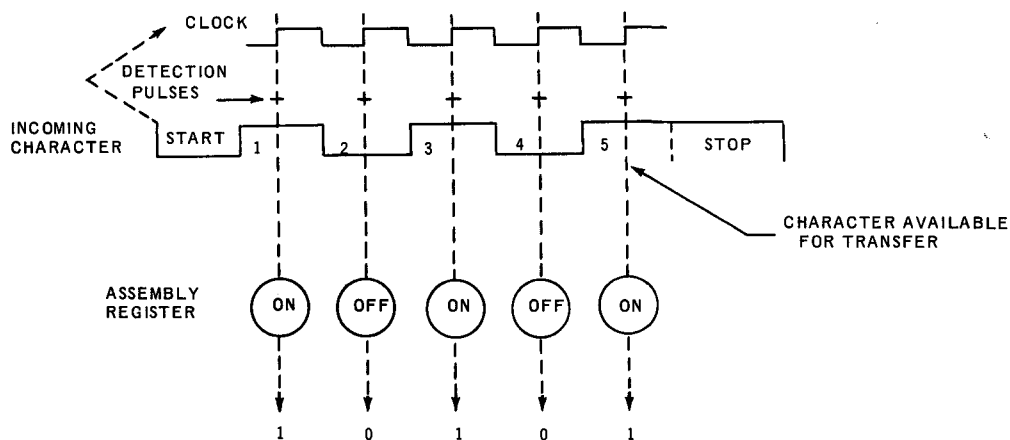


Figure 3-6. Asynchronous Bit-Serial Input Terminals Simplified Logic

3.5.3.2. Basic Output Operation

Output transmission is initiated by the issuance of a SEND DATA command to the LT-L output logic. The LT-L output logic is activated and a status byte of all 0's is returned to the central processor followed by a request for a data character. The bit-parallel character from the channel is stored in the LT-L's shift register and the LT-L generates a unit length START bit. This bit triggers the asynchronous timing assembly (ATA) and the character is shifted out, a bit at a time, onto the communications line, by way of the communication interface, by the ATA clock pulses. The last data bit is followed by an LT-L generated STOP pulse of either 1.0, 1.5, or 2.0 units (length is selected by user). During the STOP pulse interval, a request for the next character is generated by the LT-L. The foregoing action continues until either an EOM character is detected or a software terminate is received. At this time, the normal ending status of CHANNEL END and DEVICE END is returned to the central processor, and the LT-L terminates.

3.5.3.3. Character Parity Check and Generate

This optional functional characteristic enables an LT-L to check character parity on incoming data characters and to generate parity for outgoing data characters. This feature, when incorporated, permits the checking and generation of odd or even parity at the option of the user. When a parity error is detected in an incoming character, the LT-L flags the character by jamming the most significant bit (bit position 0) to a 1. This optional feature can only be incorporated when parity-less data is seven bits or less. On output, the LT-L automatically generates the parity bit and inserts it into the character. The parity generated is odd or even and is selected by the user.

3.5.3.4. Inhibit Transmit (Restraint)

When operating with a TWX network, 4-row to 3-row conversion may be necessary. In this instance, momentary inhibiting of the LT-L data transmission is needed (or the program must time it). This inhibit or restraint permits the TWX network buffer to 'catch up' by dumping its buffer and temporarily inhibiting the filling of the buffer with new data characters. After emptying the buffer to a predetermined level, the inhibit is removed and the LT-L resumes transmission. In this manner, no characters are lost and transmission stops only after a complete character has been transmitted. This inhibit or restraint signal is derived from the modem and it prevents the LT-L output logic from transmitting data characters during the time that the signal is active.

3.5.3.5. Pause Character

When this optional functional characteristic is incorporated in its output logic, an LT-L can generate time delays and coarse timing signals. Under program control, an LT-L operating with five-bit characters can be programmed to transmit a mark in the START bit position instead of a space. Since the STOP pulse is normally a marking signal, a transmitted character consists of all marks if all data bits are also marks. Thus, at 75 baud, with five-bit characters and a STOP pulse of 1.5 units, an all-mark character can be transmitted every 0.1 seconds. Obviously, different baud rates result in different timing. By varying the number of pause characters, delays can be inserted between characters in a message or termination can be programmed

to occur at time intervals desired by the user. This feature is particularly useful in teletype communications. Since an all-mark (pause) character is a nonprinting character, pause characters can be used to insert delays which allow sufficient time for the carriage of the teletypewriter to return to the beginning of a new line. A pause character is indicated to the LT-L by placing a 1 in bit position 0 of the central processor generated byte as a control bit.

3.5.3.6. Open Line Detector

The input logic of all LT-L's is equipped with open line detectors. When an open line is detected, the LT-L completes the input of a probably erroneous character and then terminates all further input data transfers until a new START bit is recognized. No status is generated for an open line condition. An open line is defined as follows:

- (1) open neutral or polar DC loop;
- (2) continuous spacing signal on a neutral or polar DC loop; or
- (3) continuous spacing signal on a receive data line from a modem.

3.5.4. Medium Speed Line Terminals

- Transmission Mode: bit-serial;
- Transmission Method: asynchronous;
- Input Rate: is controlled by ATA;
- Output Rate: output timing is provided by ATA (see 3.7);
- Character Compatibility: four, five, six, seven, or eight bits at option of user;
- Communication Interface: relay or electronic (see Table 3-2).

3.5.4.1. Basic Input Operation

The input logic of the LT-M is activated by the TURN-ON command issued by the central processor. Upon receipt of this command, the LT-M returns a status byte of all 0's and looks at the input data lines. The START bit of the asynchronous character triggers the ATA. The ATA, in turn, generates detection pulses timed to coincide with the most linear portion of each subsequent data bit (see Figure 3-6). As the intelligence contained in each data bit is sampled, logical components of the LT-M's assembly register are set accordingly. The final slot in the assembly register is filled approximately midway into the last data bit, the LT-M clock stops during the STOP pulse, and a request is generated by the LT-M to input a data character. This START-STOP operation continues until an EOM character is detected. (If an EOM character is not used, the operation must be terminated by software.) After the detection of the EOM character, which is sent to the central processor, the LT-M generates a normal end status of CHANNEL END and DEVICE END. The input and output EOM characters must be unique with respect to all other data and control characters.

3.5.4.2. Basic Output Operation

Output transmission is initiated by the issuance of a SEND DATA command to the LT-M. Upon receipt of the command, the LT-M output logic is activated and a status byte of all 0's is returned to the central processor by a request for a data character. The bit-parallel character is first stored in a queuing register in the LT-M and then transferred to the LT-M's shift register. The LT-M generates a unit-length START bit which is triggered by the ATA. The ATA clock pulses shift the character out of the shift register, a bit at a time, and the character is sent to the communications line, by way of the communication interface, in bit-serial format. As the character is being shifted into the line, a data request is made to the channel for the next character, and when it is received, it is temporarily stored in the queuing register until the previous character is completely shifted out. The last data bit is followed by an LT-M generated STOP pulse of 1.0, 1.5, or 2.0 units (length selectable by user). The foregoing action continues until either an EOM character is detected or a software terminate is received. At this time, the LT-M generates one marking character (needed for functional compatibility with 202C or 202D modems), returns normal ending status of CHANNEL END and DEVICE END, and then terminates.

3.5.4.3. Character Parity Check and Generate

The operation is the same as for an LT-L. See 3.5.3.3.

3.5.4.4. Longitudinal Redundancy Check and Generate

This optional functional characteristic enables an LT-M to check block parity on incoming messages and to generate a block parity character for outgoing messages. On input the EOM informs the LT-M to look for the longitudinal redundancy check (LRC) character. (The LRC character should always be positioned immediately following the EOM character.) On output, the LT-M automatically generates and correctly positions the LRC character. If EOM termination is employed, the LT-M generates two marking characters at termination when the LRC option is selected. For software termination, three marking characters are generated by the LT-M. The span of the block checked on for which the LRC character is being generated is selectable and can be any of the following:

- (1) Start-of-message (SOM) character through EOM character;
- (2) SOM character through last data character; or
- (3) first data character through EOM character.

3.5.4.5. Open Line Detector

This is the same as for LT-L. See 3.5.3.3.

3.5.4.6. Pause Character

This is the same as for the LT-L but it can be employed on all character sizes except the eight-bit. See 3.5.3.5.

3.5.4.7. Start-Of-Message (SOM) Detection

This optional functional characteristic must be used whenever the longitudinal redundancy check (LRC) and generate option are selected and sync characters are software generated. SOM detection is also required when the character parity of control characters is opposite that of the data characters and the SOM character is not to be included in the LRC accumulation. The SOM character can be up to eight bits in length; it must be unique, and its bit configuration is at the option of the user. This character is positioned immediately preceding the first data character of the message.

3.5.5. Synchronous Line Terminals

- Transmission Mode: bit-serial;
- Transmission Method: synchronous;
- Input Rate: derived from received data;
- Output Rate: output timing is provided by STA (see 3.8) or modem;
- Character Compatibility: five, six, seven, eight, or ten bits at option of user;
- Communication Interface: electronic (see Table 3-2).

3.5.5.1. Basic Input Operation

The input logic of the synchronous line terminal (LT-S) is activated by the TURN-ON command from the central processor. Upon receipt of this command, the LT-S returns a status of all 0's to the central processor. After being turned on, the input logic requires at least two contiguous sync characters plus a SOM character (optional) to achieve synchronization.

The first bit of the sync character is stored in position one of the assembly register and, as subsequent bits are clocked in, bit one is shifted into position two, two to three, three to four, and so on, with the last bit being shifted off the end. Prior to each shift, the contents of the assembly register is compared to the wired sync character. The input terminal should, in theory, lock-on after N shifts (where N is the number of bits in either sync or data characters) and a comparison to the wired sync character is made. Realistically, it must be assumed that circuit conditions, such as electrical 'noise', could cause sync patterns to be received incorrectly. Even when part of the first sync pattern is missed, a comparison can be established after a minimum of N and a maximum of $N + (N - 1)$ shifts (shown in Figure 3-7), where for simplicity a five-bit pattern is used and it is assumed that all but the last bit of the first sync character is missed.

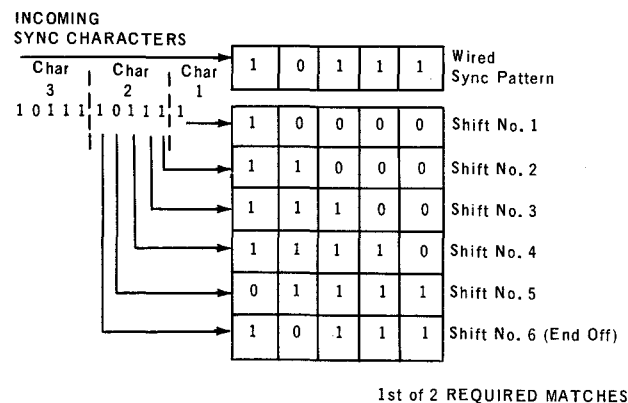


Figure 3-7. Synchronization

The sync character must be unique and its configuration is up to the user. Sync parity is independent of data character parity, that is, it can be the same as or opposite that of the data characters.

The first non-sync character received is assumed to be data (SOM character, if used) and it is assembled in the LT-S assembly register. After assembly, the LT-S input logic generates a request to input data and when acknowledged the character is sent to the channel. Data characters continue to be assembled until an EOM character is recognized by the LT-S input logic. When the EOM (not used on F1005-01) character is received, the LT-S returns a normal ending status of CHANNEL END and DEVICE END to the central processor. The central processor can, at this point, either terminate the LT-S by issuing a TURN-OFF command or instruct it to wait for the next message by issuing a LOOK FOR SYNC command. Whenever the former course is selected, a new TURN-ON command is required to enable the LT-S to receive the next message.

3.5.5.2. Basic Output Operation

The output logic of the LT-S is activated by a SEND DATA command from the central processor. The LT-S returns a status of all 0's to the central processor and then automatically (or by software) generates three sync characters (must be software generated for F1005-00). These sync characters set up the modem and trigger the STA or modem clock which supplies the clock pulses for shifting out the sync characters.

While the last sync character is being shifted out, the LT-S requests the first data character from the channel. This first character can be either an SOM character or a data character; the use of an SOM character is optional. The bit-parallel character from the channel is stored in a queuing register and then transferred to a shift register in the output logic. The clock pulses from the STA or modem clock shift the character out onto the line a bit at a time. As the character is being shifted out onto the communications line, by way of the communication interface, a data request is made to the channel for the next character, which when received is temporarily stored in the queuing register until the previous character has been completely shifted out. The foregoing action continues until either an EOM character is detected or a software terminate is received. At this point, the LT-S transmits the EOM character, returns normal ending status of CHANNEL END and DEVICE END, and it is then ready to transmit another message unless terminated by the central processor.

3.5.5.3. Automatic Look for Sync

The selection of this optional functional characteristic enables the LT-S to automatically look for sync after an error-free message has been transferred to the central processor.

3.5.5.4. Character Parity Check and Generate

The operation is the same as for LT-L. (See 3.5.3.3.)

3.5.5.5. Idle and Sync Characters

The idle character establishes and maintains *bit* synchronization in certain communication applications. Some modems used in privately leased line applications require that the transmitter send a continuous stream of bits between messages. This bit stream must have frequent mark-to-space and space-to-mark transitions in it. The receiving modem uses the bit stream to maintain synchronization with the LT-S output logic. The LT-S output logic, when this option is selected, automatically generates idle characters when messages are not being sent to the modem.

The sync character is used to establish and maintain *character* synchronization. Generally, two or three sync characters are required at the beginning of a message to establish synchronization. Sync characters may also be imbedded in the text of the message. The output logic of the LT-S, when this option is selected, automatically generates three sync characters at the beginning of each message and whenever there is a delay in receiving data characters from the channel (overrun). (The generation of imbedded sync characters is an optional feature.) The LT-S input logic automatically deletes sync characters from the input message once synchronization is achieved.

The idle and sync characters must be unique and their bit configuration is at the option of the user.

3.5.5.6. Longitudinal Redundancy Check and Generate

The operation is the same as for LT-M with one exception. On input, the LRC check is performed on the span indicated in 3.5.5.4. On output, the span of the LRC generate is as follows:

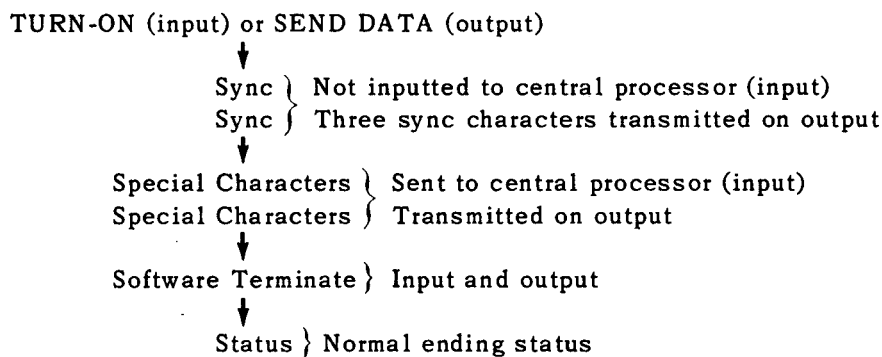
- (1) SOM character through EOM character;
- (2) first data character through EOM character; or
- (3) second sync character through EOM character.

3.5.5.7. Start-Of-Message (SOM) Detection

The operation is the same as for LT-M. (See 3.5.4.7.)

3.5.5.8. Special Acknowledge Messages

All LT-S's, except F1005-97, are capable of handling a special acknowledge message format. This special format is generally used when the input and the output logic are required to detect EOM characters and generate or check LRC on some messages but not on others. The special message does not have SOM or EOM characters and software termination is required. LRC check and generate are not performed on the message nor is automatic look for sync applicable. The special acknowledge message format is as follows:



3.5.6. Parallel Line Terminals

- Transmission Mode: not applicable – input only
- Transmission Method: not applicable – input only
- Input Rate: modem clock fixes rate
- Output Rate: not applicable – input only
- Character Compatibility: eight bits (2 out of 8 code required when operating with 403E3 series modems)
- Communication Interface: electronic (See Table 3-2).

3.5.6.1. General Information

The parallel line terminal (LT-P) operates in the input mode only and performs no serial assembly of bits. Characters are accepted in bit-parallel form and transferred in this form to the channel.

3.5.6.2. Input Operation

The LT-P is activated by a TURN-ON command from the central processor. When the LT-P accepts the command, it returns a status byte of all 0's to the central processor and then looks at the input communication line. As each character is received, the LT-P generates a request to input the character to the channel. This operation continues until the complete message has been transferred. Since the LT-P is incapable of recognizing EOM characters, the operation must be software terminated. Upon receipt of software termination, the LT-P returns the normal ending status of CHANNEL END and DEVICE END.

3.5.7. Error Conditions

The previous discussions assumed that nothing occurred during the receipt or transmission of a message that would cause an error. Thus, at termination, the line terminal initiates a request to input status and, upon acknowledgment of the request, inputs a status byte with the CHANNEL END and DEVICE END bits active (1's).

When an abnormal condition of some type is detected, the status byte returned has the UNIT CHECK bit active as well as the CHANNEL END and DEVICE END bits. The central processor, when it receives a status byte with an active UNIT CHECK bit, must issue a SENSE command to the line terminal to find out the nature of the abnormal condition. The line terminal logic, upon receiving the SENSE command, generates a request to input sense. The channel acknowledges the request and the line terminal transfers two sense bytes to the channel. The interpretation of active bits in the sense bytes is given in 3.1.6. Not all line terminals are capable of returning all the sense variations (line terminal sense repertoire is dependent upon type, use, and optional functional characteristics selected). Table 3-6 indicates the sense repertoire of each line terminal.

Whenever all information needed to identify the condition is contained in the first sense byte, the second sense byte is all 0's. The second sense byte is followed by a normal ending status of CHANNEL END and DEVICE END.

3.6. DIALING ADAPTER

The dialing adapter is used to automatically place calls on Direct Distance Dialing (DDD) or Teletypewriter Exchange Service (TWX) networks under central processor control. It only performs the dialing function and it transfers no data. It is designed to operate with Bell System 801A or 801C4 Automatic Calling Units (ACU). The dialing adapter receives the dial codes (software generated) from the channel, by way of the controller, and when it completes the call, data is sent by way of the line terminal. The dialing adapter operates in conjunction with the output logic of certain line terminals; it cannot operate independently. It can only operate with DCS-4, DCS-4A, and DCS-16 subsystems. The lowest priority should normally be assigned to the dialing adapter (dialing adapter priority is the same as the associated line terminal output logic). The line terminals and communication Interfaces (CI) with which the dialing adapter is compatible are listed in Table 3-7.

	LT-L	LT-M	LT-S	CI	USE
DIALING ADAPTER	F1003-99	F1004-99	F1005-99	F1002-04	DATA-
	F1003-98	F1004-98	F1005-98		PHONE
			F1005-97		
	F1003-96				TWX

Table 3-7. Dialing Adapter Compatibility

The calling sequence is initiated by the central processor when it issues a DIAL command to the line terminal output logic associated with a particular dialing adapter. The line terminal then returns a status byte of all 0's. The channel then sends the dialing bytes to the dialing adapter in a reciprocal request/acknowledge operation. The dialing adapter sends these dialing bytes to the ACU which actually does the dialing. These dialing bytes can be any bit combination between 0 and 9 decimal. The last dialing byte is followed by an End-Of-Dial (EOD) byte (P00001100). When the dialing adapter recognizes this byte, it stops transmitting to the ACU (EOD byte is not sent to ACU).

Prior to issuing the DIAL command, the central processor must have turned on the line terminal input logic. Otherwise, the central processor has no means of determining whether or not the called station answered. If the call is accepted, the called station returns an off-hook signal. Upon receipt of this signal by the ACU, it transfers control to the modem used for data transmission and the modem informs the communication interface that it is now in the data mode. The Communication Interface causes the input logic of the line terminal to return a normal ending status byte indicating that the dialing operation was successful. The central processor then issues a SEND DATA command to the line terminal output logic and the normal message transmission operation for the type of line terminal used occurs. One or more messages may be sent. When all message traffic has been completed, the output logic is terminated in the usual manner followed by a DISCONNECT command to the input logic to hang up the call.

When a station is called, it has between 7 and 40 seconds (set on timer in ACU) to return the Answer Back signal. The minimum recommended waiting period is 25 seconds. If the called station does not answer within the allotted time, the calling attempt is unsuccessful, and the ACU sends an abandon call and retry signal to the dialing adapter. The dialing adapter notifies the line terminal output logic that the dialing attempt was unsuccessful and, as a result, the line terminal inputs a status byte to the central processor that has the CHANNEL END, DEVICE END, and UNIT CHECK bits active. The central processor then issues a SENSE command. Upon receipt of the SENSE command, the line terminal output logic returns two sense bytes followed by the normal ending status byte. The first sense byte consists of all 0's while the second sense byte has the DIAL (NO GOOD) bit active. The central processor must then software terminate the line terminal output logic and issue a DISCONNECT command to the input logic.

3.7. ASYNCHRONOUS TIMING ASSEMBLY

The Asynchronous Timing Assembly (ATA) is a clock source for input and output logic of asynchronous line terminals. These user-selected clocks establish the transmission rates for low and medium speed line terminals. If all line terminal output logics operate at the same rate, a single ATA could drive all output logics. However, when remote stations with differing speeds are employed, separate clocks are required. The input logic of low and medium speed line terminals contain individual, adjustable clocks. The various bit transmission rates of available clocks (F1010-99) are listed below:

CLOCK RATE	
45.45 baud	300.00 baud
50.00 baud	600.00 baud
56.88 baud	1050.00 baud
74.20 baud	1200.00 baud
75.00 baud	1800.00 baud
110.00 baud	100.00 baud
133.20 baud	200.00 baud
150.00 baud	2400.00 baud

3.8. SYNCHRONOUS TIMING ASSEMBLY

The Synchronous Timing Assembly (STA) is a clock source for synchronous communication. Employed with synchronous line terminals, it permits synchronous communication with modems (202C and 202D) which have no clock. The STA supplies separate clocks for transmission and reception. The models available and their baud rates are as follows:

<u>TYPE NO.</u>	<u>CLOCK RATE</u>	<u>USE WITH MODEM?</u>
F1011-00	1200 baud	Yes
F1011-04	600 baud	Yes
F1011-05	1800 baud	Yes

4. SUBSYSTEM PROGRAMMING CONSIDERATIONS

4.1. GENERAL

This section deals with the special considerations involved with using the UNIVAC Data Communication Subsystem (DCS) to link remote data terminals. The specific information required to code individual processors is outlined in the supplement.

4.2. MESSAGE FORMATS

There is, today, no message format which could be described as a consistent standard for all remote terminals. System designers dictate a format and descriptive terminology to meet their anticipated needs or adopt both format and terminology from the system being adapted to the computer. While all messages have a beginning and an end, they may be preceded by sync characters, may include what is generally called a header, will certainly have a text of varying length depending upon the application, may provide a discrete ending character, may include parity (character and block), and may group several text blocks into one transmission. Figure 4-1 outlines a *generalized* format and nomenclature now being recommended (but not yet adopted) as the American Standard by the X3 Sectional Committee of the United States of America Standards Institute (USASI).

Information on formats for specific Univac units, such as the DCT 2000 or UNISCOPE 300 can be found in the Programmers Reference Manual for those particular units.

4.3. DIALING

With the DCS, a central processor may initiate dialed connections, receive dialed calls, or both initiate and receive calls. The programming considerations and required subsystem components are dictated by the mode of operation (placing calls, receiving calls, or both) and the circuit to which the subsystem is linked: the switched telephone, Teletypewriter Exchange (TWX), or TELEX networks. Private line dialing is deliberately excluded from this discussion because:

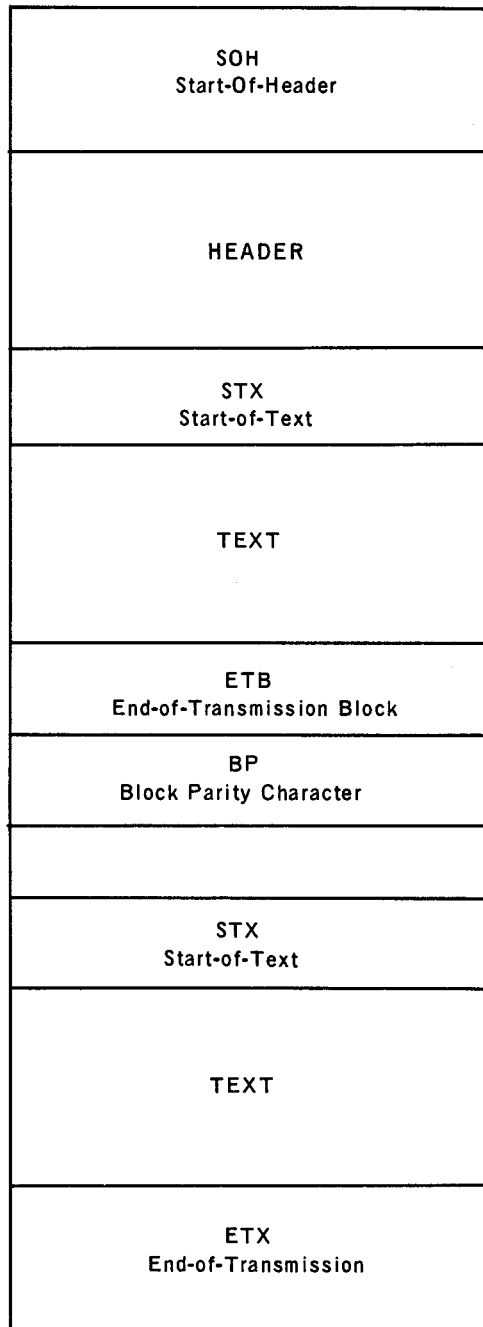


Figure 4-1. Generalized Message Format

- (1) By definition, the private line is continually available to the user. No savings are realized by placing separate calls to single stations on a single line.
- (2) Large volume users who link several remote stations to the same private line would be required to lease the necessary dialing equipment from the communication common carrier. When this approach is taken, dialing is (as far as the processor is concerned) the same as it would be on the switched telephone network.

4.3.1. Switched Telephone Network

The term 'switched telephone network' refers to those circuits, owned and operated by the Bell System, which were initially designed for voice communication. With DATA PHONE service, these same circuits may be used for data communication at transmission rates up to 2000 bits/second. For data communication each terminal must be equipped with a data set and, unless it is to receive calls only, a mechanism for establishing a dialed connection. The data set is selected to match the operating speed of the data terminal and can be equipped for unattended answering: the ability to accept incoming calls without manual intervention. The 'dialing mechanism' is, for attended terminals, a telephone handset equipped with a button marked VOICE (for supervisory conversations) and one marked DATA (for transmission of traffic from or to the terminal). The human operator establishes the connection in the VOICE mode and then switches to the DATA mode for transmission. When a central processor is substituted for the human operator, the requirements for establishing a connection remain the same but the hardware involved must be made automatic. The data set is equipped for unattended answers. The dialing mechanism required is Bell System's Automatic Calling Unit (ACU). The Automatic Calling Unit is required only if the central processor is to initiate calls.

4.3.1.1. Placing Calls

To initiate dialed connections, the DCS must be equipped with one dialing adapter and the user must furnish one ACU for each switched telephone network circuit terminated by the subsystem. Neither the dialing adapter nor the ACU can be shared between several circuits because the Hang-Up function, issued at the end of data transmission, can only refer to the circuit monitored by the ACU. Together, the dialing adapter and the ACU establish the dialed connection. To transmit and receive data, a synchronous line terminal is required. The output and the input logic of a line terminal of this module are connected through the data set to the switched telephone network. Between the ACU and the data set, there is a control line which is used to transfer the circuit to the data set once a dialed connection has been made.

The program stores the telephone number of the station to be called in a dial buffer located in main storage. The size of the dial buffer is dictated by the number of digits required for specifying the telephone number of the remote station. Within the same building a three-digit extension might suffice. If a central processor dials a terminal in another state the buffer may contain up to 11 digits, as the following illustrates.

Bit Positions - P01234567

	000000001	1	- DDD access code
	100000011	3	
	000000001	1	- Area Code
	000000010	2	
	100001001	W	
	000000010	A	- Exchange*
	000000100	4	
	000001000	8	
	100000101	5	- Number
	100000110	6	
End of Buffer	000000111	7	

*The telephone dial provides numeric equivalents for alpha exchange designations.

When the buffer has been prepared, the program issues a DIAL command to the dialing adapter. Digits are conveyed to the ACU until the dialing adapter detects an End-Of-Dial (EOD) character. The ACU forwards the dial digits to the control switching equipment in the form of pulses or tones, depending upon the central office equipment involved. Following the EOD character, the program must wait (up to 40 seconds) to determine whether a connection has been made. If the dialing process is successful, the remote data set answers the call (the unattended answering logic in the data set goes 'off-hook'), pauses for a brief interval, and then returns a fixed frequency tone for approximately 3.5 seconds. When the ACU detects this tone, it transfers control to the data set which is connected to the line terminal. The line terminal input logic returns a normal ending status byte to the central processor indicating that the calling attempt was successful. If the ACU fails to establish a connection, it returns an Abandon Call and Retry (ACR) signal to the dialing adapter. The dialing adapter informs the line terminal output logic that the dialing attempt was unsuccessful. The line terminal, in turn, inputs a status byte with the UNIT CHECK bit active. The central processor must issue a SENSE command and the sense bytes returned to the central processor indicate to it that the dialing attempt was unsuccessful. The written program must contain provisions for the action to be taken when there is an unsuccessful dialing attempt.

When placing calls, the program must also be concerned with the establishment and maintenance of a data buffer. Once the BCW has been set, the program may issue a SEND DATA command to the line terminal output logic. When the line terminal decodes this command, it will submit a Request-To-Send signal to the data set and await the return of a Clear-To-Send signal before requesting output from the processor. The control line, between the data set and the ACU, inhibits a return of this Clear-To-Send signal until the dialed connection has been established. The buffer may contain a polling sequence, a conventional output message, or a single (sentinel) word.

Polling Sequence: When the processor dials a series of remote terminals and solicits traffic, the process is referred to as polling and is, except for the dialing technique, essentially the same as soliciting input from several stations connected to a common, private circuit. In this case, the output buffer contains the control characters required to trigger transmission from the remote terminal. If

the remote terminal responds with input traffic, the processor knows that the polling sequence was properly received. If, after a set time-out, there has been no response, the polling sequence can be repeated or the call abandoned. If the remote terminal responds with no activity, abandon the call.

Conventional Message: The buffer could contain an output message in its entirety. Like the polling sequence buffer, the message buffer could be activated without program interruption if the processor expected an acknowledgement from the remote terminal following each transmission.

Sentinel Word: In some instances the output traffic is of significant length, or requires editing, or both. In this case the program might wish to load the data buffer with a single character. When the ACU indicates that the call was accepted and the interrupt occurs, the program knows that the dialed connection has been established and that it may now proceed to read the output message from peripheral storage and edit the content.

If the remote terminal is not, or cannot be, equipped for unattended answering it would be impossible to determine from the processor that a dialed call had been completed. To accommodate this particular situation the ACU may be wired to automatically transfer control to the data set when it receives the EOD character. When this option is used, it must be remembered that the call has not, in all probability, been completed when control is shifted to the data set. The program must establish a time-out that is equal to or greater than the expected dial time (40 seconds or more) before issuing the SEND DATA command to the output logic.

When a dialed connection has been established and the data has been transmitted, both the processor and the remote terminal must disconnect (go 'on-hook'). The processor causes the circuit to be released by issuing a DISCONNECT command to the line terminal input logic. In most instances, the telephone switching equipment is designed to release both ends of a circuit when the calling station disconnects. However, for ensurance it might be well to advise the called station, either by prearrangement or message content, to terminate the call at the remote end, also.

4.3.1.2. Receiving Calls

Some line terminals are equipped to permit receipt of dialed calls (unattended answer). The associated data set can also be wired for unattended answer. The processor is unaware that the local data set has gone 'hook-off' in response to a dialed call until incoming data traffic or a polling sequence is received. In preparation for dialed calls the program provides main storage buffers and sets BCW's for the anticipated traffic. Once the initial input message has been received, the program either awaits additional traffic or transmits its own messages according to system design. The call is not terminated until the remote calling station goes 'on-hook'.

4.3.2. Teletypewriter Exchange Network

While the mechanics of receiving or placing calls in the TWX network are identical to those of the switched telephone network, the required subsystem configuration differs and there is at least one additional programming consideration. The program must know to which type of TWX station it is connected in order to ensure proper transmission.

TWX service offers both 60 words-per-minute (45.45 bits/sec) and 100 words-per-minute (110 bits/sec) station equipment. The TWX access line, connected to the DCS, can be arranged either as a 60 or as a 100 words-per-minute station. See Figure 7-1. Either arrangement demands a Bell System, 100-series Data Set and Regenerative Repeater. The ACU is included if the station must originate as well as receive calls.

4.3.2.1. 60 Words-Per-Minute Station

In addition to the configuration described above, the 60 words-per-minute station must have a Model 28 TELETYPE keyboard send-receive or an automatic send-receive set. This set is normally used to isolate the processor for circuit test but is available to the user for manual operation of the circuit. Unlike the 100 words-per-minute stations (see 4.3.2.2), the TWX numbers assigned to 60 words-per-minute terminals have the same area codes used as conventional telephones.

If it is used as a 60 words-per-minute station, the processor is expected to transmit, and will receive, at a rate of 45.45 bits/sec. Both transmitted and received traffic will be in Baudot code. As a 60 words-per-minute station, the processor may send to and receive from 100 words-per-minute stations. The TWX central office provides speed and code conversion equipment to facilitate these interspeed transfers.

4.3.2.2. 100 Words-Per-Minute Station

In addition to the common configuration mentioned above, the 100 words-per-minute terminal requires a Model 33 or 35 TELETYPE keyboard send-receive set or automatic send-receive set for use as a station monitor. The 100 words-per-minute stations have special area codes: 510, 610 (Canada), 710, 810, and 910.

As a 100 words-per-minute station, the processor is expected to transmit and to receive 100 bits/sec. Both transmitted and received traffic will be in the USASCII. When transmitting to 60 words-per-minute stations, the processor must observe two programming restrictions:

- To ensure that the TWX central office conversion equipment can maintain the traffic rate, output buffers should be limited to 12 characters or less.
- The transmitted message must avoid those characters which the 60 words-per-minute terminal is incapable of typing: per cent, commercial 'at', ampersand, north arrow, west arrow, pound sign, equals, plus, and quotation marks.

4.3.3. TELEX

The TELEX processor interface (shown in Figure 7-1) is offered by Western Union. It permits dialing access to all remote TELEX stations and, through Western Union switching centers, to the Bell TWX network. With this interface the user may dial calls or both dial and receive calls.

4.3.3.1. Placing TELEX Calls

The remote station's number is transmitted to the TELEX 12150 interface in the form of Baudot-coded numeric characters:

<u>NUMERIC DIGIT</u>	<u>BAUDOT (HEXADECIMAL) EQUIVALENT</u>
0	16
1	17
2	13
3	01
4	0A
5	10
6	15
7	07
8	06
9	18

Because they are numerics, the first digit of the number should be preceded by a FIGS (1B₁₆) character. Both the dial digits and data characters are forwarded to the TELEX 12150 interface at a rate of 50 bits/sec.

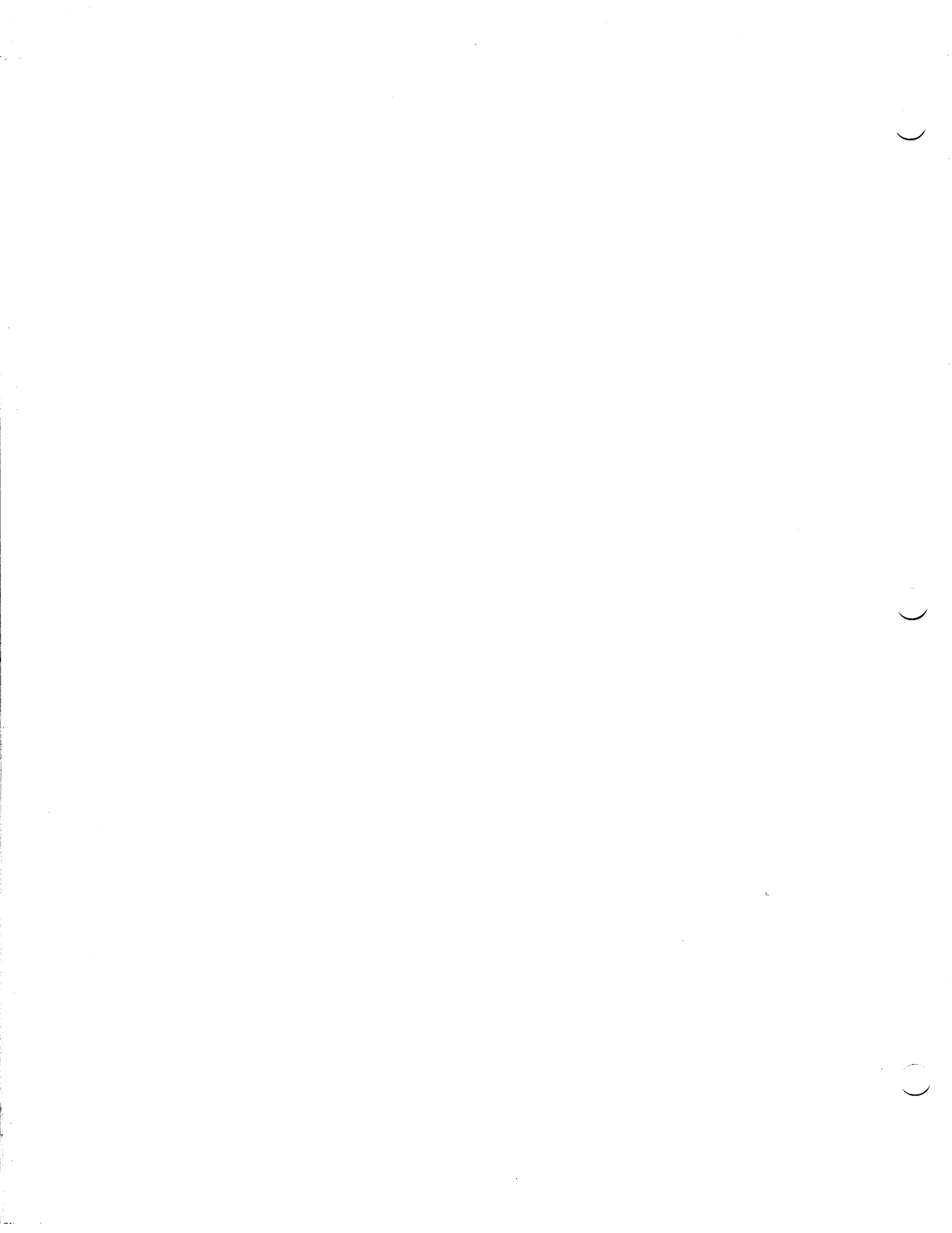
Dial digits must be submitted, one by one, through the TELEX 12150 interface to the TELEX exchange equipment. The program must establish an output buffer for each digit and an input buffer to receive the one-character acknowledgment from the TELEX exchange. For each digit the program must store the appropriate one-word BCW and issue a SEND DATA command. When each of the digits is accepted by the TELEX exchange, an LTRS (1F₁₆) character is returned as an acknowledgment. This LTRS character is returned in a minimum of 300 milliseconds and a maximum of 40 seconds. The process of initiating transmission and timing-out the acknowledgment must then be repeated for each digit. Following the last dial digit, the program transmits a field-specified End-Of-Selection character. When the call is completed to the distant terminal, that terminal responds with a one-character Answer Back of V (1E₁₆) or an LTRS (1F₁₆). If the TELEX exchange cannot accept the first dial digit or if the remote terminal is busy when dialed, an 800-millisecond open line signal is sent to the calling station. This open line would appear to the processor as approximately five 00 characters.

4.3.3.2. Terminating TELEX Calls

To terminate a call, the processor follows the last character of the message with an open line (SPACING) condition for at least one second or a closed (MARKING) line condition for a period of 5 to 40 seconds. If the remote station terminates the call, the processor receives the busy signal of an 800-millisecond open line.

4.3.3.3. Receiving TELEX Calls

The processor establishes an input buffer and awaits either a V (1E₁₆) or an LTRS (1F₁₆) character which indicates that an incoming call has been established.



5. OPERATION

5.1. OPERATOR'S CONTROL PANEL

Each of the various Data Communications Subsystem (DCS) configurations is equipped with an operator's control panel. The configuration and the location of these panels are dependent upon the DCS configuration.

5.1.1. Operator's Control Panel for DCS-1

On the DCS-1, the operator's control panel is the operator's switch card (Figure 5-1) which is located in position 33A of the DCS-1 logic deck. Access to this card can be gained by removing the panel (front) located directly below the central processor operator's console. The switches and their functions are as follows:

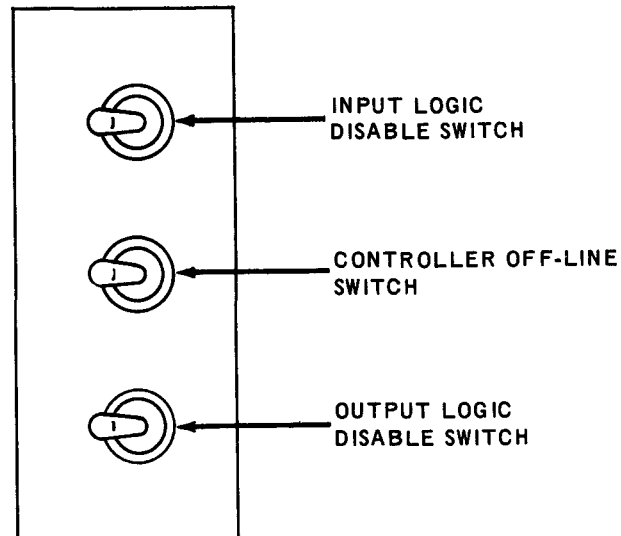


Figure 5-1. Operator's Switch Card

- Input Logic Disable Switch

When set to the up position, the input logic of the line terminal is active and it transfers data. In the down position, the input logic is inactive, it does not transfer data, and when a command byte is issued to it, the status byte returned to the central processor has the UNIT EXCEPTION bit active.

- Controller Offline Switch

When set to the up position, the controller operates normally. In the down position, the controller (and therefore the DCS) is offline and it does not respond to any polling signals from the channel.

- Output Logic Disable Switch

When set to the up position, the output logic of the line terminal is active and it transfers data. In the down position, the output logic is inactive, it does not transfer data, and when a command byte is issued to it, the status byte returned to the central processor has the UNIT EXCEPTION bit active.

5.1.2. Operator's Control Panel for DCS-4 and DCS-16

Figure 5-2 illustrates the DCS-4 operator's control panel, which is located on the front of the DCS-4 cabinet. The DCS-4 operator's control panel mounts nine activity indicators (one for each addressable logic portion of the line terminal plus one for the dialing adapter). The panel also mounts inhibit switches (one for each addressable logic portion for a total of eight) and a designator strip. The DCS-16 operator's control panel is similar to that of the DCS-4 except there are 36 activity indicators and 32 inhibit switches (DCS-16 can have up to 32 addressable logics - input and output halves of line terminals - and four dialing adapters). Since the function of each indicator and switch is identical, the following descriptions are oriented toward the type of control or indicator.

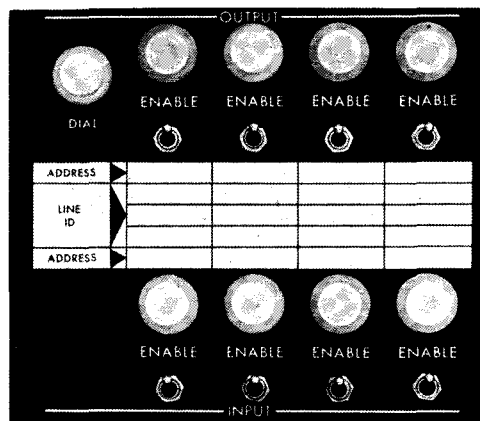


Figure 5-2. DCS-4 Operator's Control Panel

- Activity Indicators

When lit, it indicates that associated line terminal input or output logic is handling data. Each input/output pair of activity indicators corresponds to a line terminal. Line terminal priority proceeds from left to right with the leftmost line terminal having the lowest priority and the rightmost line terminal having the highest priority. Within the line terminal, the input logic has a higher priority than the output logic. For the half-duplex operation, only one activity indicator of the pair can be lit at any one time.

- Inhibit Switches

When set to the ENABLE position, the addressable input or output logic of the associated line terminal is active and it transfers data. Setting this switch to the down

position inhibits the associated input or output logic. In this case, the logic is inactive, it cannot transfer data, and when a command byte is issued to it, the logic returns a status byte to the central processor with the UNIT EXCEPTION bit set. No inhibit is provided for the dialing adapter because it cannot function if its associated output logic (lowest priority output logic) is inactive.

- Designator Strip

The designator strip provides room to write in the device address for each of the addressable logic halves of the line terminals and also to write in the line identification of each communication line connected to the DCS. The strip is fabricated of erasable material to permit repeated usage. Entries on the strip must be made in pencil.

5.1.3. Operator's Control Panel for DCS-4A

No information concerning the DCS-4A operator's control panel is available at the present time. When this information becomes available, it will be provided.

5.2. POWER CONTROL PANEL

Power and cooling for the DCS-1 and DCS-4A are supplied by the central processor; however, the DCS-4 and DCS-16 are housed in freestanding cabinets. These are self-contained cabinets with their own power supplies and blowers. These power supplies and blowers are controlled from a power control panel located inside the cabinet behind the front access doors. The power control panels for the DCS-4 and the DCS-16 are identical. Figure 5-3 illustrates the power control panel. The function of each control and indicator is given in Table 5-1.

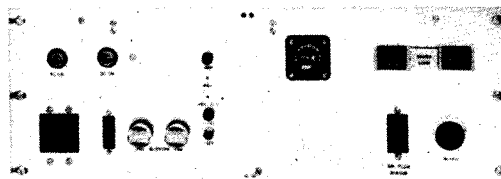


Figure 5-3. DCS-4/DCS-16 Power Control Panel

NAME	FUNCTION
AC ON indicator	When lit, indicates AC power is being applied to DCS. When extinguished, indicates absence of AC power.
DC ON indicator	When lit, indicates DC power is being applied to DCS. When extinguished, indicates absence of DC power. DC power will not come up until after AC power is applied.
AC circuit breaker (located directly below AC ON indicator)	Controls application and removal of AC power to DCS. If this circuit breaker is set to position OFF while DC power is on, all power is removed from DCS.
DC circuit breaker (located directly below DC ON indicator)	Controls application (press plunger) and removal (pull plunger forward) of DC power to DCS. DC power does not come up until after AC power is applied.
F01 BLOWER fuse indicator	When lit, indicates fuse F01 is blown and blower No. 1 is inoperative.
F02 BLOWER fuse indicator	When lit, indicates fuse F02 is blown and blower No. 2 is inoperative.
GRD test point	Provides connection point for ground lead of external test equipment used to check power supply voltages.
+6V test point	Provides connection point for hot lead of external test equipment used to check +6 volt power supply output.
+6V SEQ test point	Provides connection point for hot lead of external test equipment used to check sequenced +6V power supply output.
+24V test point	Provides connection point for hot lead of external test equipment used to check +24V power supply output.
-12V test point	Provides connection point for hot lead of external test equipment used to check -12V power supply output.
Running time meter	Provides continuous display of number of hours DC power has been on.
FAULT/ALARM OFF pushbutton/indicator	When pressed, silences excessive temperature audible alarm. Indicator remains lit until excessive temperature condition is corrected.
MASTER CLEAR pushbutton/indicator	If there is no AC or DC power fault and temperature is within operating limits, indicator is lit.
READY pushbutton/indicator	Pressing pushbutton while indicator is lit places DCS in operation. The presence of any of the above conditions extinguishes indicator and places DCS in standby condition.
AIR FLOW SENSOR switch	When set to ON position, activates air flow temperature sensor. Sensor sounds an audible alarm and lights FAULT/ALARM OFF pushbutton/indicator when internal cabinet temperature reaches 95°F. If internal cabinet temperature rises to 105°F, AC power and DC power are automatically shut down and READY indicator is extinguished.
ALARM	Provides audible indication of excessive temperature condition.

Table 5-1. Controls, Indicators, and Test Points on Power Control Panel

5.3. PHYSICAL SPECIFICATIONS

Table 5-2 indicates the packaging of the DCS and its use with particular UNIVAC 9000 Series Central Processors. Table 5-3 lists the specifications of the various DCS's and Table 5-4 gives information on the interunit cabling.

Used With	DCS-1 HOUSED IN CENTRAL PROCESSOR	DCS-4A HOUSED IN CENTRAL PROCESSOR	DCS-4 HOUSED IN FREESTAND- ING CABINET	DCS-16 HOUSED IN FREESTAND- ING CABINET
UNIVAC 9200 Central Processor	X		X	
UNIVAC 9300 Central Processor	X		X	
UNIVAC 9400 Central Processor	X	X	X	X

Table 5-2. DCS Packaging

ITEM	PHYSICAL CHARACTERISTICS			
	DCS-1	DCS-4	DCS-4A	DCS-16
Physical Dimensions	Height: 18 $\frac{3}{4}$ inches	64 inches	13.00 inches	64 inches
	Width: 20 inches	24 inches	22.50 inches	48 inches
	Depth: 9 $\frac{1}{4}$ inches	24 inches	9 $\frac{1}{4}$ inches	24 inches
Clearance	N. A.	36 inches	N. A.	36 inches Front & Rear Only
Weight (includes cabinet where applicable)	45 pounds	550 pounds	70 pounds	725 pounds
Power	Supplied by central processor	60HZ 120/208 volt or 50HZ 220/230/240 volt, 2-phase, 3-wire, .45 KVA	Supplied by central processor	To be supplied
Heat Dissipation	238 BTU/hour	1364 BTU/Hr.	1364 BTU/Hr.	

Table 5-3. Physical Specifications

FROM	TO	MAXIMUM LENGTH
	DCS-1	
UNIVAC 9200/9300 CENTRAL PROCESSOR	CONTROLLER	5 FEET
UNIVAC 9400 CENTRAL PROCESSOR	CONTROLLER	5 FEET
COMMUNICATION INTERFACE	MODEM	50 FEET
	DCS-4	
UNIVAC 92/93/9400 CENTRAL PROCESSOR	CONTROLLER	200 FEET
COMMUNICATION INTERFACE	MODEM	50 FEET
	DCS-4A	
UNIVAC 9400 CENTRAL PROCESSOR	CONTROLLER	5 FEET
COMMUNICATION INTERFACE	MODEM	50 FEET
	DCS-16	
TO BE SUPPLIED		

Table 5-4. Interunit Cabling

6. TIMING

6.1. GENERAL

For asynchronous output a time delay may be expressed in terms of system efficiency but there will be no data loss. Timing is inherent in each transmission and the remote device will only cycle when a START bit signals the advent of a new character.

Asynchronous input must be transferred within a specified interval or be overlaid by subsequently arriving data. Character availability should not be confused with character length. Low speed line terminals indicate that they have an assembled character ready to transfer at the same time the last information bit of the data character is transferred from the line to the assembly register. This leaves a time interval corresponding to one-half of an information bit plus the stop time before the terminal recognizes the START bit of the next character. Characters must be transferred during the interval provided as shown in Table 6-1.

TRANSMISSION RATE BITS/SECOND	STOP BITS			
	1.00	1.42	1.50	2.00
45.45	33.0	42.2	44.0	55.0
50.00	30.0	38.4	40.0	50.0
56.88	26.4	33.8	35.2	44.0
74.20	20.3	26.0	27.0	33.8
110.00	13.7	17.5	18.3	22.8
133.20	11.3	14.4	15.0	18.8
150.00	10.0	12.8	13.3	16.6
300.00	5.0	6.4	6.7	8.3

USING:

$$\frac{1}{\text{bits/second}} = \text{TIME for 1 bit} = b$$

$$\text{AVAILABILITY TIME} = .5b + S_b$$

S_b = STOP BITS

Table 6-1. Character Availability in Milliseconds Low Speed Terminals

Medium speed, asynchronous line terminals indicate character availability when a character is moved from the assembly register to the queuing (buffer) register. Data from these terminals must be transferred before the last bit of the following character enters the assembly register. Availability intervals for various speeds are shown in Table 6-2.

TRANSMISSION RATE BITS/SECOND	UNIT CODE										
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
600	10.00	10.83	11.67	12.50	13.33	14.17	15.00	15.83	16.67	17.50	18.33
750	8.00	8.67	9.33	10.00	10.67	11.47	12.00	12.67	13.33	14.00	14.67
1000	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00
1050	5.71	6.19	6.67	7.14	7.62	8.10	8.57	9.05	9.52	10.00	10.48
1200	5.00	5.42	5.83	6.25	6.67	7.08	7.50	7.92	8.33	8.75	9.17
1600	3.75	4.06	4.38	4.69	5.00	5.31	5.63	5.94	6.25	6.56	6.88

USING:

$$\text{CHARACTERS/SEC} = \frac{\text{bits/sec}}{\text{UNIT CODE}}$$

$$\frac{1}{\text{CHARACTERS/SEC}} = \text{TIME for 1 CHARACTER}$$

$$\text{AVAILABILITY TIME} = 1 \text{ CHARACTER TIME} = \frac{\text{UNIT CODE}}{\text{bits/sec}}$$

Table 6-2. Character Availability in Milliseconds Medium Speed Terminals

The synchronous transmission method demands that character availability deadlines be met by both input and output data transfer. Input rates must be maintained to avoid overlay. Output availability must be assured to avoid idle line time which the synchronous receiver would treat as data. Table 6-3 gives examples of transfer intervals for some typical transmission rates.

TRANSMISSION RATE BITS/SECOND	BITS/CHARACTER			
	5	6	7	8
2000	2.50	3.00	3.50	4.00
2400	2.08	2.50	2.92	3.33
3000	1.67	2.00	2.33	2.67
4800	1.04	1.25	1.46	1.67
40,800	.12	.15	.17	.20

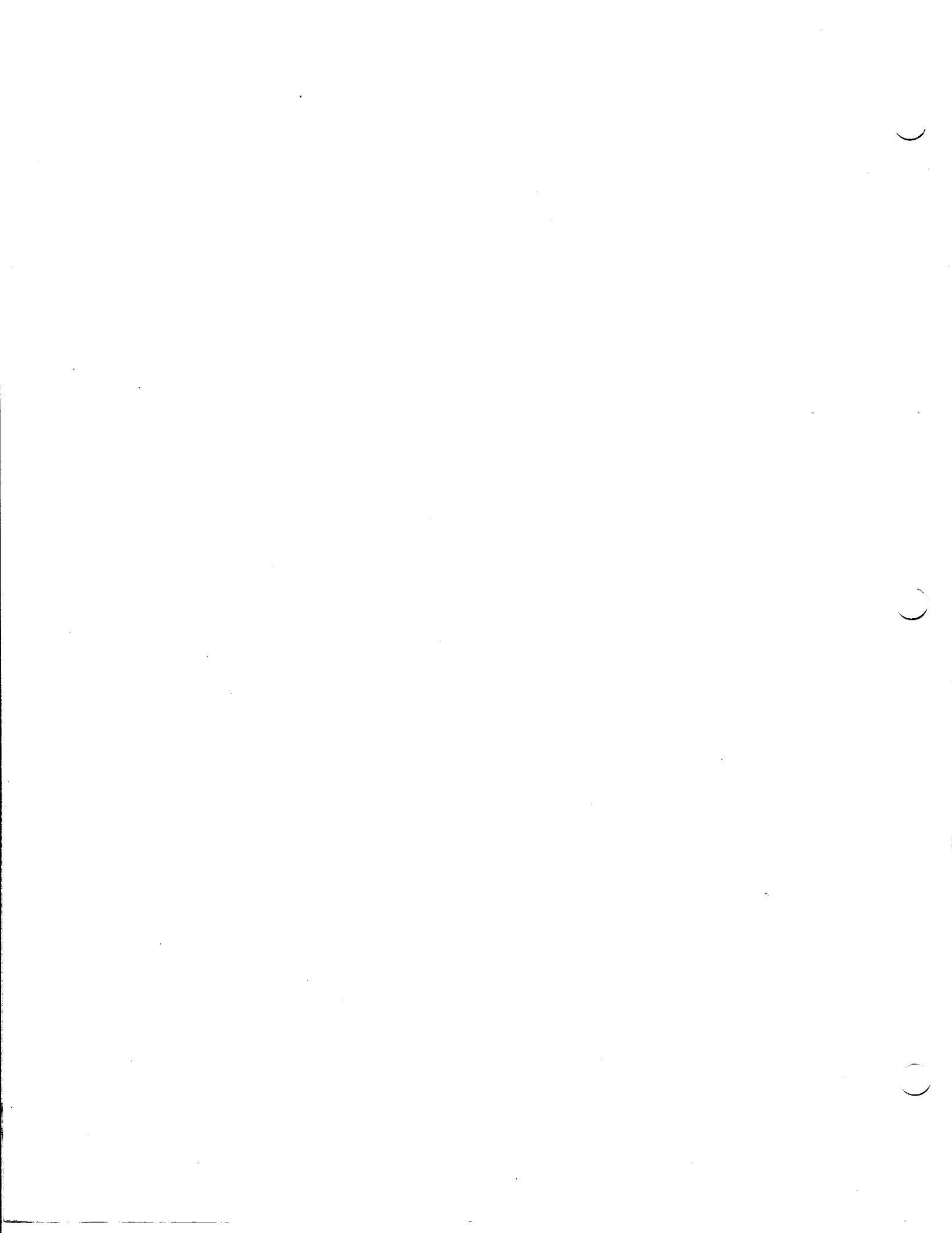
USING:

$$\text{CHARACTERS/SEC} = \frac{\text{bits/second}}{\text{bits/character}}$$

$$\frac{1}{\text{CHARACTERS/SEC}} = \text{TIME for 1 CHARACTER}$$

$$\text{AVAILABILITY TIME} = 1 \text{ CHARACTER TIME} = \frac{\text{bits/character}}{\text{bits/second}}$$

Table 6-3. Character Availability in Milliseconds High Speed Terminals



7. SAMPLE CONFIGURATIONS

7.1. GENERAL

Certain communication common carrier services specify both the terminal hardware and circuit required. Other common carrier offerings stipulate minimum grade transmission facility and/or demand the inclusion of data sets. In most instances, the user may operate a remote data terminal at a speed determined either by circuit availability or machine efficiency. Therefore, some terminals may operate at two or three different transmission rates on as many different types of facilities. The TWX and TELEX terminations (shown in Figure 7-1) are examples of prescribed configurations. The Application Summary (Table 7-1) attempts to assign to a given device the most frequently used circuit arrangement.

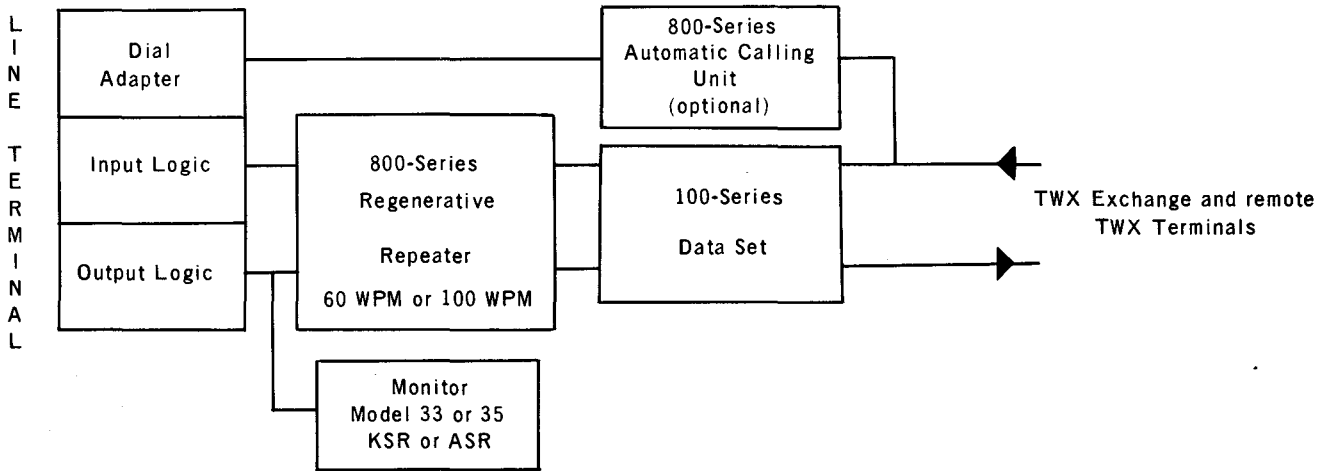
DEVICE OR APPLICATION	REQUIRED FACILITY GRADE	EQUIPMENT DATA SETS ^①	LINE TERMINAL
DATASPEED	Voice	yes	Medium Speed
DIAL-O-VERTER* D505	Voice	yes	SYNCHRONOUS
DIAL-O-VERTER* D520/521	Voice	yes	SYNCHRONOUS
TELEDATA	Telegraph	no	Low Speed
COLLECTADATA	Voice	yes	Low Speed
IBM 1001	Voice	yes	Medium Speed
IBM 065/006	Voice	no ^②	SYNCHRONOUS
IBM 1050	150 bit/sec	yes	Low Speed
Switching Systems (5-level)	Telegraph	no	Low Speed
Switching Systems (8-level)	150 bit/sec	yes	Low Speed
Teletype Model 28	Telegraph	no	Low Speed
Teletype Model 32	Telegraph	no	Low Speed
Teletype Model 33	150 bit/sec	yes	Low Speed
Teletype Model 35	150 bit/sec	yes	Low Speed
UNIVAC DCT 2000	Voice	yes	SYNCHRONOUS
UNIVAC 1004-DLT	Voice	yes	SYNCHRONOUS
Video Display	Voice	yes	SYNCHRONOUS

^① When data sets are required they are situated at both ends of the transmission facility.

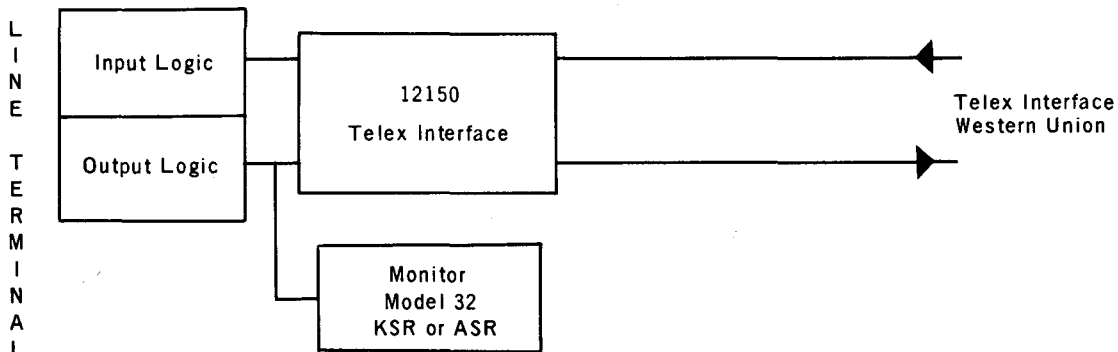
^② Data set is included with equipment.

* Trademark of the Digitronics Corporation

Table 7-1. Application Summary



Teletypewriter Exchange Service (TWX) Access Line Bell System



8. STANDARDS

8.1. GENERAL

The accepted interface standard for serial data transmission which is adhered to by the communication common carriers and specified in the design of all UNIVAC communication equipment was framed by the Electronic Industries Association and issued as specification, RS-232. The current version, RS-232-B, is here reproduced with the consent of the Electronic Industries Association.

**INTERFACE BETWEEN DATA PROCESSING
TERMINAL EQUIPMENT AND DATA
COMMUNICATION EQUIPMENT**

EIA STANDARD

RS-232-B

(Revision of RS-232-A)

OCTOBER 1965

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ELECTRONIC INDUSTRIES ASSOCIATION

Engineering Department

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(From EIA Standard RS-232-A and Standards Proposal No. 879, formulated under the cognizance of Committee TR-30 on Data Transmission Systems and Equipment)

1. SCOPE

1.1 This standard is applicable to the interconnection of data processing terminal equipment and data communication equipment. It defines a means of exchanging control signals and binary serialized data signals between data processing terminal equipment and data communication equipment, and is of particular importance when each is furnished by a different company.

1.2 This standard is applicable for data transmission when used in conjunction with electronic terminal equipment. There is no implication that the speeds in the two directions of transmission are necessarily the same.

1.3 This standard applies to all classes of data communication, both synchronous and asynchronous, including the following:

- A. Private line service, either two-wire or four-wire. Consideration is given to multipoint operation.
- B. Switched network service, either two-wire or four-wire. Consideration is given to automatic answering of calls, but it should be noted that this standard may not include all the interchange circuits that may be required for establishing the connection.
- C. It also applies equally to both sides of separate equipments which provide other functions required by the communications system and which may be inserted between the data processing terminal equipment and the data communication equipment.

1.4 It is intended that the signal interchange point shall be located on the customer's premises and that the interchange circuits shall convey signals over relatively short distances (i.e., less than fifty feet).

1.5 The data communication equipment may include transmitting and receiving signal converters. The term "signal converter" refers to the equipment which changes the data signal into a form suitable to the transmission medium, or the reverse. In general, separate signal converters are provided for transmission and for reception. A data set may include signal converters and control circuits. Other functions, such as pulse regeneration and error control, may or may not be provided. Equipment to provide these other functions may be included in the data processing terminal equipment or in the data communication equipment, or it may be separate equipment, as described in paragraph 1.3(C). It is not intended that when other functions are provided within the data processing terminal equipment or data communication equipment, that this interface standard apply other than to the interchange circuits between the two classes of equipment.

2. INTERCHANGE CIRCUITS

2.1 Seven basic interchange circuits are defined for all systems:

2.1.1 Ground

Circuit AA – Protective Ground

This conductor shall be electrically bonded to the machine or equipment frame. It may be further connected to external grounds as required by applicable regulations.

Circuit AB – Signal Ground

This conductor establishes the common ground reference potential for all interchange circuits except circuit AA (Protective Ground). In the data communication equipment this circuit shall be brought to one point, and it shall be possible to connect this point to circuit AA by means of a wire strap.

This wire strap can be connected or removed at the installation, as may be required to meet applicable regulations or to minimize the introduction of noise into electronic circuitry.

2.1.2 Data Signals

Circuit BA – Transmitted Data

Direction: TO data communication equipment.

Signals on this circuit are generated by the data processing terminal equipment and are connected to the transmitting signal converter for transmission to remote data processing terminal equipment.

The data processing terminal equipment shall hold Circuit BA in marking condition during any time interval between characters or words, or at such other times when no signals are to be transmitted. Data processing terminal equipment designed for Receive-Only service shall hold this circuit in marking condition at all times.

The marking or spacing condition shall be held for the total duration of each signal element.

Circuit BB – Received Data

Direction: FROM data communication equipment.

Signals on this circuit are generated by the receiving signal converter in response to data signals received from remote data processing terminal equipment.

In half-duplex service, the receiving data set shall hold marking condition on Circuit BB when the remote data processing terminal equipment has its Circuit CA (Request to Send) in the OFF condition (see Section 5.7). Alternatively, in half-duplex service, the Received Data circuit may be used to monitor transmitted signals (e.g., for local copy).

A data set equipped for Transmit-Only service shall hold Circuit BB in the marking condition at all times.

The marking or spacing signal condition shall be held for the total duration of each signal element.

2.1.3 Control Signals

Circuit CA – Request to Send

Direction: TO data communication equipment.

Signals on this circuit are generated by the data processing terminal equipment to condition the local data set to transmit. For example, if the data set contains a modulator, the carrier signal shall be transmitted during the ON condition of Circuit CA.

The ON condition is maintained whenever the data processing terminal equipment has information ready for transmission or being transmitted. The signal converter shall transmit all data on Circuit BA (Transmitted Data), while the ON condition is maintained on Circuit CA, Circuit CB (Clear to Send), and Circuit CC (Data Set Ready).

In half-duplex service, the OFF condition shall hold the data set in the receive-data condition, and the ON condition shall hold the data set in the transmit-data condition. The above conditions shall be established without regard to signals on Circuits BA (Transmitted Data) and BB (Received Data).

Data processing terminal equipment designed for Receive-Only service shall hold Circuit CA in the OFF condition at all times.

Data processing terminal equipment designed for either Transmit-Only or Full-Duplex service may hold Circuit CA in the ON condition at all times. Similarly, data communication equipment used for Transmit-Only or Full-Duplex service may be arranged to be in transmit condition at all times, regardless of the signal condition on Circuit CA.

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

Circuit CB – Clear to Send

Direction: FROM data communication equipment.

Signals on this circuit are generated by the transmitting data set to indicate that it is prepared to transmit data. The ON condition is a response to the ON condition on Circuit CA (Request to Send), delayed as may be appropriate to the data communication equipment for establishing a communication channel to a remote data processing terminal. When Circuit CA is turned OFF, Circuit CB shall also be turned OFF.

In Receive-Only service, the data set shall hold Circuit CB OFF at all times.

In Transmit-Only or Full-Duplex service, if the data communication equipment is arranged to be in transmit condition at all times, then Circuit CB shall be held in the ON condition at all times.

Circuit CC – Data Set Ready

Direction: FROM data communication equipment.

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

The OFF condition shall be used to indicate either:

- A. Any abnormal or test condition which disables or impairs any normal function associated with the class of service being furnished.
- B. That the communication channel is switched to an alternate means of communication (e.g., alternate voice telephone).
- C. That the local data set is not connected to a communication channel (i.e., the data set is "on hook").

The ON condition shall appear at all other times.

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

2.2 Additional interchange circuits may be required in some systems:

2.2.1 Control Signals

Circuit CD – Data Terminal Ready

Direction: TO data communication equipment.

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

The OFF condition removes the signal converter from the communication channel, for such reasons as:

- A. Freeing the line for alternate use (e.g., voice or use by other terminal stations).
- B. Permitting use of the data processing terminal equipment for an alternate function.
- C. Terminating a call (i.e., going "on hook").

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

Circuit CE – Ring Indicator

Direction: FROM data communication equipment.

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

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

Operation of this circuit shall not be disabled by the OFF condition on Circuit CD (Data Terminal Ready).

Circuit CF – Data Carrier Detector

Direction: FROM data communication equipment.

Signals on this circuit are used to provide an indication that the data carrier is being received. When the data carrier is lost because the transmitting signal converter is turned OFF or because of a fault condition, the OFF condition follows after an appropriate guard time delay.

In Half-Duplex service where the signal converter is arranged for local copy (see Circuit BB, Received Data), Circuit CF may respond to carrier signals from either the local or remote transmitting signal converter.

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

Circuit CG – Data Modulation Detector

Direction: FROM data communication equipment.

Signals on this circuit are used to monitor proper demodulation of the data carrier received in the signal converter.

An ON condition is maintained only when the data carrier is being properly demodulated. When the demodulated data signal indicates that the degree of modulation has been reduced to a point below a reasonable preset threshold, the OFF condition occurs before the next signal element.

The ON condition indicates proper demodulation of the received data carrier signal. The OFF condition indicates that a possible error has been detected in the data communication equipment. It may, in some instances, be used to call automatically for a retransmission of the previously transmitted data signal.

Circuit CH – Speed Selector (Data Processing Terminal Equipment Source)

Direction: TO data communication equipment.

Signals on this circuit are used to provide selection of signaling speed. The rate of timing signals (see Section 2.2.2), if included, shall be controlled by this circuit as may be appropriate.

An ON condition shall select the higher signaling speed.

Circuit CI – Speed Selector (Data Communication Equipment Source)

Direction: FROM data communication equipment.

Signals on this circuit are used to provide selection of signaling speed. The rate of timing signals (see Section 2.2.2), if included, shall be controlled by this circuit as may be appropriate.

An ON condition shall select the higher signaling speed.

2.2.2 Timing Signals

Circuit DA – Transmitter Signal Element Timing (Data Processing Terminal Equipment Source)

Direction: TO data communication equipment.

Signals on this circuit are used to provide the transmitting signal converter with signal element timing information.

The waveform shall nominally be ON and OFF for equal periods of time, and a transition from ON to OFF shall nominally indicate the center of each signal element on Circuit BA (Transmitted Data).

Circuit DB – Transmitter Signal Element Timing (Data Communication Equipment Source)

Direction: FROM data communication equipment.

Signals on this circuit are used to provide the data processing terminal equipment with signal element timing information.

The waveform shall nominally be ON and OFF for equal periods of time. The data processing terminal equipment shall provide a data signal on Circuit BA (Transmitted Data) in which the transitions between signal elements nominally occur at the time of the transitions from OFF to ON condition of the signal on Circuit DB.

Circuit DC – Receiver Signal Element Timing (Data Processing Terminal Equipment Source)

Direction: TO data communication equipment.

Signals on this circuit are used to provide the receiving signal converter with signal element timing information.

The waveform shall nominally be ON and OFF for equal periods of time, and a transition from ON to OFF shall nominally indicate the center of each signal element on Circuit BB (Received Data).

Circuit DD – Receiver Signal Element Timing (Data Communication Equipment Source)

Direction: FROM data communication equipment.

Signals on this circuit are used to provide the data processing terminal equipment with signal element timing information.

The waveform shall nominally be ON and OFF for equal periods of time, and the transition from ON to OFF condition shall nominally indicate the center of each signal element on Circuit BB (Received Data).

2.3 Additional interchange circuits are required in those systems which provide supervisory signaling channels (e.g., for feedback error control or other purposes). In this case, a second set of interchange circuits shall be used to duplicate the functions defined in Sections 2.1 and 2.2 as required, and the word "Supervisory" shall precede the circuit name.

2.4 Additional interchange circuits not defined here may be provided by mutual agreement to perform special functions. (See Section 5.6)

3. LINE OF DEMARCATION

3.1 The interface between the data processing terminal equipment and data communication equipment is located at the signal interchange point between the two equipments. The interchange point shall be a pluggable connector. The female connector shall be associated with the data communication equipment and should be mounted in a fixed position near the data processing terminal equipment. An extension cable with a male connector shall be provided with the data processing terminal equipment. The total length of cable should be short (less than approximately 50 feet – see Sections 1.4 and 4.5).

3.2 (It is intended to specify a 25 pin connector in a future revision of this standard).

3.3 (It is intended to specify a minimum area of access around the connector in a future revision of this standard).

3.4 Pin Identification

3.4.1 The pin assignments listed in the table below shall be used:

<u>Pin Number</u>	<u>Circuit</u>	<u>Description</u>
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground
8	CF	Data Carrier Detector
9	-	Reserved for data set testing. These two pins shall not be wired in the data processing terminal equipment.
10	-	
11	-	Unassigned
12	-	Unassigned
13	-	Unassigned
14	-	Unassigned
15	DB	Transmitter Signal Element Timing (Data Communication Equipment Source)
16	-	Unassigned
17	DD	Receiver Signal Element Timing (Data Communication Equipment Source)
18	-	Unassigned
19	-	Unassigned
20	CD	Data Terminal Ready
21	-	Unassigned
22	CE	Ring Indicator
23	-	Unassigned
24	DA	Transmitter Signal Element Timing (Data Processing Terminal Equipment Source)
25	-	Unassigned

Unassigned: These circuits may be assigned by mutual agreement of the parties on both sides of the interface.

3.4.2 Note that there are no pin assignments for Circuits CG, CH, CI, and DC. Pin assignments for these circuits and for the optional circuits in Sections 2.3 and 2.4 are to be made by mutual agreement.

3.5 A functional diagram is shown in Figure 1 to summarize the information in Sections 2 and 3.

4. ELECTRICAL SIGNAL CHARACTERISTICS

4.1 The maximum open-circuit voltage to either Circuit AA (Protective Ground) or Circuit AB (Signal Ground) on any interchange circuit shall not exceed 25 volts, and the maximum short-circuit current flow between any two conductors (including grounds) shall not exceed one-half ampere.

4.2 Any circuitry used to generate a signal voltage on an interchange circuit shall be so designed that no damage will be caused by either an open circuit condition or a short circuit to either Circuit AA (Protective Ground) or Circuit AB (Signal Ground). Any circuitry used to receive signals from an interchange circuit shall be designed for continuous operation with any input signal within the maximum voltage limits specified in Section 4.1.

4.3 For Circuit BA (Transmitted Data) and Circuit BB (Received Data), the signal shall be considered in the marking condition when the voltage on the circuit is more negative than minus three volts with respect to Circuit AB (Signal Ground), and the signal shall be considered in the spacing condition where the voltage is more positive than plus three volts with respect to Circuit AB (Signal Ground). During transmission of data, the marking condition shall be used to denote the binary state ONE (e.g., hole punched in paper tape), and the spacing condition shall be used to denote the binary state ZERO. Note that marking is the normal condition on a data circuit when no signals are present.

Summary of Data Circuit Interface Terms

Binary state	ONE	ZERO
Signal condition	Marking	Spacing
Voltage	Negative	Positive
Paper tape	Hole	No hole

For all control circuits shown in Section 2, the control function shall be considered ON when the voltage on the circuit is more positive than plus three volts with respect to Circuit AB (Signal Ground), and shall be considered OFF when the voltage on the circuit is more negative than minus three volts with respect to Circuit AB (Signal Ground).

Summary of Control Circuit Interface Terms

Control Function	OFF	ON
Voltage	Negative	Positive

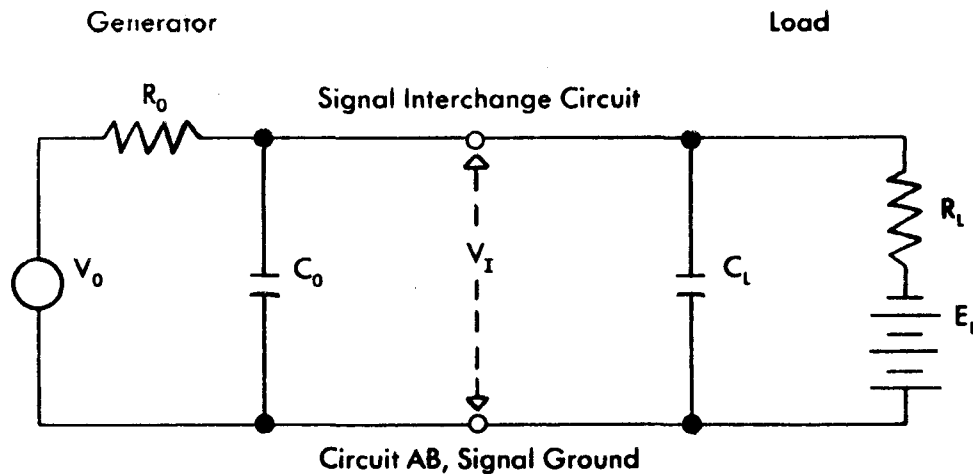
4.4 The operation of the circuitry that receives signals from an interchange circuit shall be dependent only on the signal voltage, as specified in Section 4.3, and should, therefore, be insensitive to the rise time, fall time, presence of signal overshoot, etc. The design of this circuitry shall minimize the effects of any circuit time constants which would delay the circuit response, thus introducing time distortion in the signals.

4.5 The terminating impedance at the receiving end of an interchange circuit shall have a dc resistance of not less than 3000 ohms or more than 7000 ohms, and the voltage in open-circuited condition shall not exceed two volts. The effective shunt capacitance at the receiving end of a signal interchange circuit, measured at the interchange point and including any connecting cable, shall not exceed 2500 picofarads.

4.6 The source impedance of the sending end of an interchange circuit is not specified.

4.7 For both data circuits and timing signal circuits (Circuits BA, BB, DA, DB, DC, and DD), neither the rise time nor the fall time, through the six volt range in which the signal condition is not defined, shall exceed three per cent of the nominal duration of a signal element. The circuitry used to generate a signal voltage on an interchange circuit shall meet this specification with any receiving termination which complies with Section 4.5.

4.8 Equivalent Circuit



INTERFACE

V_0 is the open-circuit generator voltage.

V_I is the interface voltage.

R_0 is the generator internal impedance.

R_L is the load impedance.

E_L is the load open-circuit voltage (bias).

C_L is the total effective load capacitance, measured at the interchange point and including any cable.

C_0 is the capacitance associated with the generator, including any cable to the interchange point.

The following conditions shall apply:

- (1) V_0 shall not be greater than ± 25 volts.
- (2) When the interchange circuit is short-circuited, the circuit shall not be damaged and the short-circuit current shall not be greater than one-half ampere.
- (3) R_0 is not otherwise specified, except that, when R_L is 3000 ohms and E_L is zero, V_I shall not be less than ± 5 volts. Good design practice indicates that R_0 should be made small.
- (4) E_L shall not be greater than ± 2 volts.
- (5) R_L shall not be less than 3000 ohms or more than 7000 ohms.

- (6) C_L shall not be greater than 2500 picofarads.
- (7) C_0 is not specified, but must be considered in determining the ability of the generator to comply with the rise times and fall times specified in Section 4.7.
- (8) The circuitry that receives signals from an interchange circuit shall recognize the binary signal when V_I equals ± 3 volts. (See Section 5.4). The signal condition is not defined when V_I is in the range between +3 and -3 volts.

4.9 In some applications, it may be necessary for fail-safe operation to detect either the power-off condition in the equipment connected across the interface or the disconnection of the interconnecting cable.

Circuit CA (Request to Send), Circuit CC (Data Set Ready), and Circuit CD (Data Terminal Ready) shall be used for this purpose. The power-off source impedance of the sending end of these circuits shall not be less than 300 ohms, measured at an applied voltage not greater than plus or minus two volts referenced to Circuit AB (Signal Ground). (See Section 5.4)

5. RECOMMENDATIONS AND EXPLANATORY NOTES

5.1 The data are to be serialized by the data processing terminal equipment so that the design of the data communication equipment may be independent of the character length and code used by the data processing terminal equipment.

5.2 The control circuits at the signal interchange are arranged to permit the alternate use of a higher class of communication service, as follows:

- A. Data processing terminal equipment designed for Transmit-Only service may also use either Half-Duplex or Full-Duplex service.
- B. Data processing terminal equipment designed for Receive-Only service may also use either Half-Duplex or Full-Duplex service.
- C. Data processing terminal equipment designed for Half-Duplex service may also use Full-Duplex service.

The substitution of a higher class of communication service does not require a change in the operation of the control circuits.

5.3 This standard is intended for use at transmission speeds in the range from zero to an upper limit which is approximately 10,000 to 30,000 bauds.

5.4 The electrical specifications are intended to provide a two-volt margin in rejecting noise introduced either on signal interchange circuits or by a difference in reference ground potential across the interface. The equipment designer should maintain this margin of safety in all interchange circuitry.

5.5 Interchange signals should have approximately rectangular waveforms.

5.6 In order to avoid inducing voltage surges on interchange circuits, signals from interchange circuits should not be used to drive inductive devices, such as relay coils. (Note that relay or switching contacts may be used to generate signals on an interchange circuit.)

5.7 It should be noted that, on some types of communications channels, it may not be economically feasible to provide a "mark hold" on Circuit BB (Received Data) as specified in Section 2.1.2. It may, therefore, be desirable for the operation of the data processing terminal equipment to be independent of this specification for "mark hold."

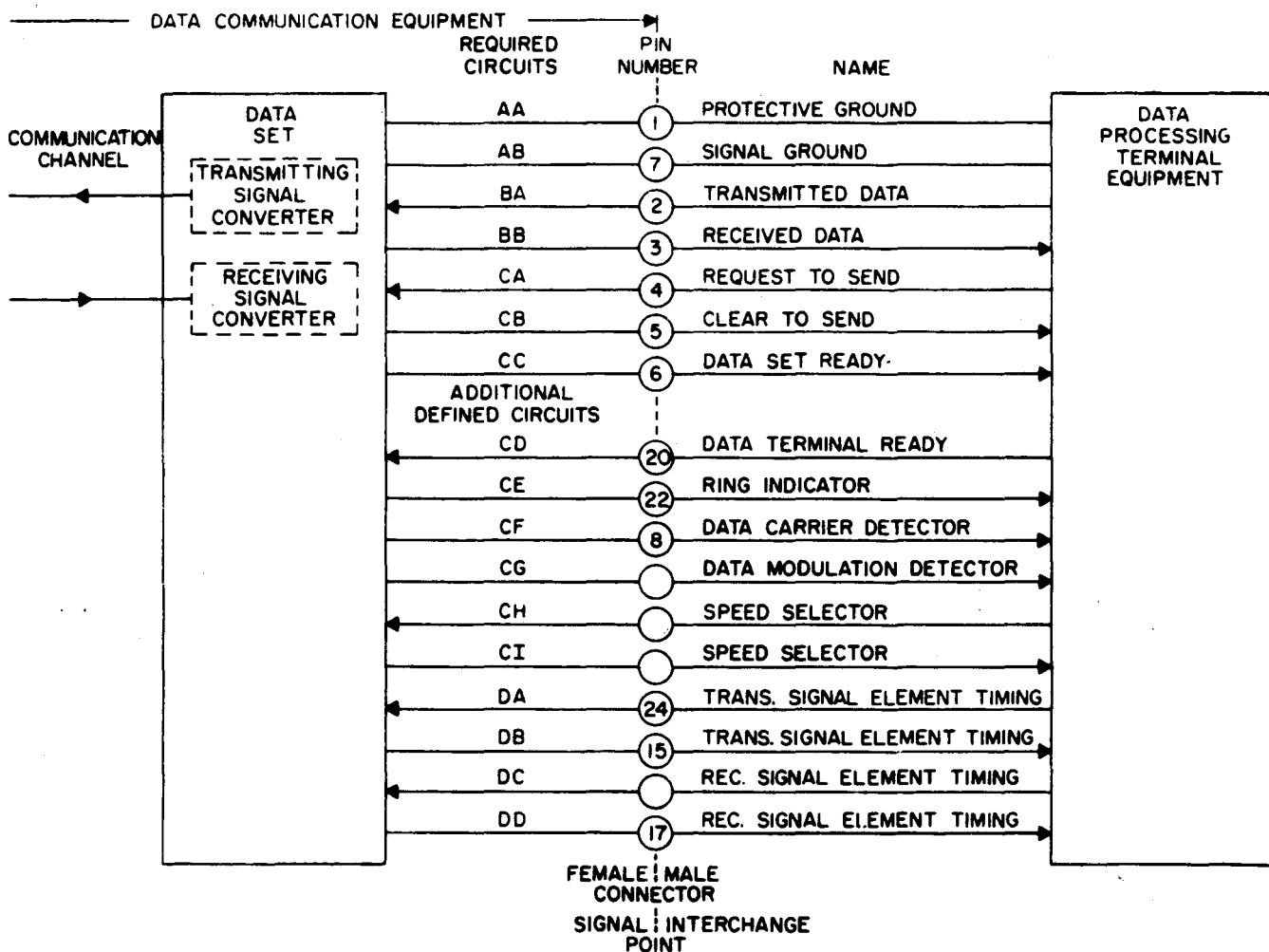


FIG. 1 FUNCTIONAL DIAGRAM

9. GLOSSARY

A-TO-D CONVERTER

Analog-to-digital converter. A device which translates the electrical variations of analog measuring equipment into binary (bit) format. This converter may be an integral part of the analog device or a separate interface unit.

ACCESS CODE

A digit (1) added to telephone numbers in order to reduce inadvertent connection to the long distance dialing circuits.

ACU

See Automatic Calling Unit.

AM

Amplitude Modulation.

AMERICAN STANDARD CODE (FOR) INFORMATION INTERCHANGE

An 8-level (7-bits plus parity) code developed by a subcommittee of the USASI. This code is intended to replace the Baudot code as the American communication standard and, ultimately, to replace the various codes now used by data processing equipment.

AMPLITUDE MODULATION

The modulation process which modifies the amplitude of a carrier frequency in response to variations of the applied intelligence signal. When a digital intelligence signal is applied, the carrier frequency is switched on and off in response to the marks and spaces (1's & 0's) of each character. When alternating current is applied (a voice signal), the amplitude of the carrier changes correspondingly and the outline of the modulated carrier assumes the form of the intelligence signal. Amplitude modulation is more often found on voice communication carrier systems. Digital (data) communication is usually accomplished by frequency modulation.

ANALOG, ANALOGUE

1. A method of defining a measurable physical property in terms of varying electrical potential or frequency. 2. A device which creates an electrical analogy to physical characteristics such as heat, pressure or velocity. The output of an analog device may be fed directly to an analog computer or applied to a transmission facility through an analog MODEM. In many applications an analog signal will be translated to digital form by an A-to-D Converter.

ANGLE MODULATION

The term applied to both phase modulation and frequency modulation.

ASCII

See American Standard Code (for) Information Interchange.

ASR, AS&R

Automatic send-receive or automatic send and receive (teletypewriter).

ASYNCHRONOUS

Nonsynchronous. Descriptive of the transmission method, or the terminal equipment employed, which demands that requisite timing information be included in each transmitted character. The operating response of an asynchronous communications receiver (within minimum and maximum speed limitations) is determined by the frequency of input rather than internally generated timing.

ATR

Automatic Tape Reader or Automatic Transmitter.

ATTENUATION

Loss of electrical energy (power) due to resistance inherent in the transmission facility.

AUTOMATIC CALLING UNIT

A unit which will generate dial pulses (or tones) to a telephone network in response to signals from a computer or business machine.

The use of this unit, to connect a computer to a remote terminal device, presumes that the remote device is capable of unattended answering.

AUTOMATIC SEND-RECEIVE SET

A teletypewriter with typing unit, keyboard, tape reader(s) and tape punch(es) all contained within the same cabinet.

BANDPASS

The range of frequencies a given transmission facility is capable of handling or the range of frequencies it may be required to transmit.

BANDWIDTH

An expression of frequency range in cycles- or kilocycles-per-second.

BAUD

From Baudot. 1. A unit impulse length in telegraph signaling. The minimum length of any binary code element, at a given speed, of a transmitted character. In START-STOP transmission (asynchronous), the START pulse is used as the unit impulse length reference. Sometimes used interchangeably with bauds or bits-per-second.

BAUDS

The maximum number of unit length code elements per second that may be generated by a communication device and/or applied to a transmission facility. Bauds and bits-per-second are often used interchangeably. Bauds is somewhat more descriptive of the asynchronous signaling method (START-STOP) in which not all code elements are of equal length.

$$\text{Bauds} = \text{Unit code} \times \text{Characters-per-second}$$

BAUDOT, EMILE JEAN

Engineer for the French Postal Telegraph Administration who installed the first commercially widespread printing telegraph service in 1882. The five-level teletypewriter code, developed by Murray, and later, by Krumm, is named in his honor.

BIAS

The measurable time displacement of a transmitted code element (bit) as seen by the receiving device. A bias condition results from the transmission facility's characteristic distortion and adjustments of the receiver's input circuitry. The degree of time displacement is expressed as 'N' milliseconds MARKING or SPACING bias. If marking and spacing time displacements are equal, the result is expressed as "zero, no bias".

BIT

From Binary Digit. An electrical impulse that may assume one of two possible conditions. These states are variously expressed as 1&0, MARK & SPACE, +&-, Yes & No, On & Off.

Bit Length – (Asynchronous) Character length divided by unit code.
– (Synchronous) Character length divided by number of bits-per-character.

BIT-PARALLEL

See Parallel.

BIT-SERIAL

In Order. Descriptive of a character transmitted on a single pair of wires in which each bit is presented successively.

BITS/SEC. B/S

Bits-per-second. Sometimes expressed in thousands as KB/S or Kilobits/Sec.

BITS-PER-SECOND

Maximum number of discrete coded character elements per second that may be generated by a communications transmitter and/or applied to a transmission facility.

(Asynchronous) Unit code \times characters-per-second.

(Synchronous) Bits-per-character \times characters-per-second.

BLIND

To prevent operation of a communications receiver either by electrically relaying the signal circuit around the unit's input terminals or mechanically blocking the device's typing mechanism.

BLOCK PARITY

See Horizontal Parity.

BROADBAND

The generic term for any and all transmission facilities capable of speeds higher than voice-grade circuits. The name given by Western Union to its high speed (microwave) transmission offering.

CALL DIRECTING CHARACTER(S)

A character or sequence of characters which identifies a single communication receiver connected to a common transmission facility. The selection and assignment of CDCs in a given system may be arbitrary if certain restrictions are observed. These restrictions are: 1. If the CDC is not protected by END-OF-ADDRESS or END-OF-MESSAGE codes, care must be taken to insure that the characters selected would not normally appear in ordinary message traffic ("ZCZ" rather than "THE"). 2. A minimum of two characters is usually desirable both to permit later addition of stations on the circuit and to prevent random selection. 3. M, O, T, V and the function character LTRS should not be used as the first character of a CDC. (In Baudot code, these characters all end in one or more MARKING pulses. As a machine is turned on or as a result of a hit on the signal line, it is possible to generate any one of these characters.)

CARD-DIALER

A combined manual and automatic telephone handset, developed by the Bell System, which will permit the user to manually dial a number or, through the use of prepunched cards, automatically establish a connection. Automatic dialing consists of selecting a particular card, placing it in the slot provided, lifting the telephone receiver and depressing the START bar. The required dialing information is then read from the card.

CARRIER

A transmission method which reduces the number of communication facilities required by simultaneously applying many voice and/or data signals to the same channel, through the use of modulators and demodulators.

CARRIER FREQUENCY

The transmission frequency which is modulated by a data character or voice signal.

CCITT

"Comite Consultatif International Telegraphique et Telephonique". A European group which recommends communication standards.

CDC

Call Directing Character(s) or Call Directing Codes.

CENTREX

A Bell System telephone switching arrangement which permits direct dialing (in-dialing) to a particular extension of a corporate system. A large corporation could have a single number such as EX 3-9900. If the desired extension was not known, an incoming call could be directed to that number and the extension found and dialed by the switchboard operator. Or, if the extension were known, the call could be placed directly by dialing EX 3-NNNN(NNNN = the extension).

CHAD

The material displaced as a punch pin penetrates a tape. See CHADDED TAPE and CHADLESS TAPE.

CHADDED TAPE

A seldom-used equivalent of the more descriptive term, "Fully Perforated Tape". The opposite of Chadless Tape. A tape in which code elements appear as completely punched-out (round) holes.

CHADLESS TAPE

The (often confusing) name given to a tape which has the code holes only partially perforated. It is called chadless because the paper residue (CHAD) does not require manual disposal — a distinct advantage in automatic, unattended tape-to-tape systems despite the fact that chadless tape multiplies tape storage problems. Newer designs permit typing along the feed hole of a fully perforated tape (Bell System) or along the margin of a wider tape (Klienschmidt). This innovation combined with the demand for higher speeds (which preclude partial punching) and the inability of higher speed readers to readily accept chadless tape will probably inhibit continued usage of this type of tape.

CHANNEL

1. One of the paths (as defined by the assigned frequencies) of a carrier transmission system. 2. Occasionally used to define the number of bits required to encode a character. Baudot code is referred to as five-channel code because, when seen as characters punched in tape, there are five separate horizontal lines or channels.

CHARACTER

A series of binary coded elements or electrical impulses, with (asynchronous) or without (synchronous) inherent timing information, which define an alpha character, numeric digit, or special symbol to a communications receiver.

CHARACTERISTIC DISTORTION

The effect upon a transmitted character caused by the inductance and capacitance inherent in a communication circuit.

CHARACTER PARITY

One form of error detection which provides for the addition of an extra bit to each character transmitted. See Vertical Parity.

CHARACTER SERIAL

See Serial-by-Character.

CHECK BIT

The parity bit added by the character parity process.

CHECK CHARACTER

The bit configuration (block or message parity character) used to summarize the frequency of one-bit occurrence in successive characters. See Horizontal Parity.

CLIMBING HEAD READER

See Pivoted Head.

COAX

Coaxial Cable.

COAXIAL CABLE

A common enclosure containing 2, 3, 6, or 8 coaxial conductors.

COAXIAL CONDUCTOR

A transmission facility composed of a cylindrical tube in which is centered a wire. Both are electrical two-conductor medium. The characteristics of the Coax permit Conductor to function as a two-conductor medium. The characteristics of the Coax permit application of much higher frequencies than ordinary parallel wires.

CODE

An arrangement of binary digits (bits) which define an alpha character; numeric digit, special symbol, or machine function.

CODE READING CONTACTS (CRC)

One, or usually more, electrical contacts mounted on an electromechanical communications device (a tape punch or page printer) which senses the incoming signal as it is translated from electrical to mechanical form. CRC(s) are used in addition to, or in lieu of, the device's normal output (tape or printed page) to provide a serial-to-parallel signal conversion.

COLLECTADATA

Trademark for a data collection system manufactured by Friden, Inc.

COMPANDOR

A combination of the two terms, compressor and expander.

COMPRESSOR

A control device, installed at the input to a voice transmission system, which reduces the level of loud tones and increases the level of softer tones to provide an even volume of transmission.

CRC(s)

Code Reading Contact(s).

CROSSBAR (SWITCH)

An electromechanical switch used to connect input and output lines in (typically) a telephone office. Its matrix design permits a high degree of flexibility in establishing line connections.

CROSS OFFICE

A literal term used to denote the transfer of data (usually in a message switching center) from one side of a room where incoming lines terminate, to the other side where outgoing lines are connected. Because of the limited distances involved, a cross office transfer of traffic is usually at higher speeds than either the incoming or outgoing lines.

CROSSTALK

Interference created by the inductive effect of one transmission facility upon another, lying in a parallel path. The degree of crosstalk is a function of facility length, strength of transmitted current and signaling frequency, and may vary from background noise to an inability to hear another's conversation.

DATA SET

A generic term for a device which serves as either a modulator or demodulator or a combination of both (MODEM).

DATA-PHONE

A Bell System transmission offering. This service utilizes data modems to provide an electrical interface between transmission facilities and business machines.

DATASPEED

A Bell System tape-to-tape transmission offering. The system consists of a tape reader which will accommodate five- through eight-level chadless or fully perforated tapes, a DATA-PHONE data set (for each terminal) and a tape punch which produces non-interpreted, fully perforated paper tape. The system operates at a speed of 1050 bits/second. It does not include error detection or correction circuitry.

DB

Decibel.

DDD

Direct Distance Dialing.

DECIBEL

A unit of measurement used to describe the difference in electrical energy between any points (usually input and output) of a transmission facility. Because attenuation (power loss) varies with frequency, it is necessary to use a term which encompasses both power and frequency. Usually the term is used to express the power loss between the input and output of a circuit but it may also be used to denote the gain of power following a line repeater. The number of decibels is equal to:

$$10 \text{ Log } \frac{\text{Power In}}{\text{Power Out}}$$

DEMODULATION

The process of removing the intelligence contained in a modulated signal.

DEMODULATOR

A device used in carrier systems which selectively discriminates between the various signaling frequencies appearing on a common transmission facility. The demodulator strips off the carrier frequency and restores the signal to its input form.

DIGITAL SUBSET

A term once used as the generic description of the modulator-demodulator equipment which Bell System employed for data transmission. Now referred to as DATA-PHONE Data Sets.

DIRECT DISTANCE DIALING

A numbering plan and switching arrangement which permits a telephone subscriber to dial any number, within the system, without operator intervention.

DOT

The minimum or unit length of a character element — as opposed to the DASH in Morse Telegraphy. Occasionally oldtime telegraphers will use the term Dots-Per-Second as the equivalent of Bauds or Bits/Second.

DOT CYCLE FREQUENCY

The fundamental signaling frequency of a rectangular wave represented by a single MARK bit followed by a single SPACE bit. It is expressed in cycles-per-second and is used to calculate the required bandpass for the transmission facility. The dot cycle frequency for a given operating speed is determined by dividing the bit rate (Baud Rate) by two.

ECHO SUPPRESSOR

A relay device which will block one side of a two-way telephone circuit. With the return path blocked, the speaker will not be annoyed by the echo of his own voice being relayed through the receiving telephone nor, for that matter, would he hear the person speaking at the other end. The operating speed of the echo suppressor relay is fast enough (35 to 275 ms) so that it goes unnoticed in ordinary conversation. This "turn around" time, however, can be a significant hindrance to high speed data communications. For this reason, echo suppressors are removed from circuits devoted to data usage.

ED&C

Error Detection & Correction.

EDGE PUNCH(ED)

The encoding of information along one margin of a document. The size of the document varies widely and the code hole punching (generally in five-level teletypewriter code) may or may not be interpreted.

END DISTORTION

An artificially introduced reduction in length of a character code element, used in factory test, to determine the receiving teletypewriter's performance limitations (margin). It is not a part of and should not be confused with the three elements of total distortion: bias, characteristic distortion, and fortuitous distortion.

END-OF-ADDRESS

A character or, more often, a series of characters which indicate to all receiving devices that the selecting codes have been transmitted and, consequently, no other characters, even if they are the same as the selecting characters, should be considered as a part of the selective calling sequence.

END-OF-MESSAGE

A character or series of characters which indicate to all receiving devices that the given message has been completed.

ENVELOPE DELAY

The degree of envelope distortion expressed in milliseconds (ms).

ENVELOPE DISTORTION

Change in shape of a signal wave caused by the transmission facility's differing response to varying frequencies. This effect is more noticeable at higher frequencies and would be objectionable in wirephoto (facsimile) or video transmission whereas it would go unnoticed in voice transmission.

EOA

End-of-Address.

EOM

End-of-Message.

EXPANDOR

A control device installed at the output of a voice transmission system which restores both loud and soft tones to their input level. The device which compensates for the effect of the compressor at the input terminal.

FDX

Full-duplex.

FLEXOWRITER

Trademark for automatic typewriters manufactured by Friden, Inc.

FM

Frequency Modulation.

FOREIGN EXCHANGE

1. Termination of a transmission facility in a remote service area (foreign exchange).
2. A Bell System service which provides long distance telephone connection from one city to another at local call rates. A supplier, in city "A" would lease a facility to be terminated in city "B". Customers could then access this long distance line and only be charged for local calls.

FORTUITOUS DISTORTION

A component of total distortion. Any random disruption of characters being transmitted.

FOUR-WIRE

The transmission facilities required to permit simultaneous, two-way transmission of voice or data. The term is used as the equivalent of full-duplex.

FREQUENCY MODULATION

A form of, although often used as the equivalent of, angle modulation in which the applied intelligence signal causes variations in the carrier frequency. Digital communications are handled by a form of frequency modulation called frequency shift keying.

FREQUENCY SHIFT KEYING

Process of frequency modulating digital information used in many communications systems. In FSK modulation, the intelligence bit causes the carrier frequency to shift a fixed increment up or down, depending upon whether the intelligence bit was 1 or 0.

FSK

Frequency Shift Keying.

FULL-DUPLEX

1. Simultaneous, two-way transmission.
2. The termination of two communication facilities which permits this method of transmission.

FUNCTION

Machine control operations as opposed to the printing of a received character. Standard teletypewriter functions are: carriage return (CR), line feed (LF), space, letters shift (LTRS), figures shift (FIGS), blank. Symbols representing these functions are not normally printed on page copy. They are usually printed on interpreted, punched tapes.

FX

Foreign Exchange.

GROUP

The name applied to the various levels of carrier frequencies employed in a carrier system. The intelligence signals are applied to the basic carrier frequencies which are then applied to a group of frequencies and, in some cases, this group is again modulated and applied to a super group prior to application to the transmission facility.

GROUP ALERTING

A telephone switching arrangement offered by Bell System to permit automatic connection of a master telephone to a group (or selected telephones of a group) of telephones. When used by a volunteer fire department, for example, the master telephone at the fire department could be automatically connected to the home telephones of all the volunteers or to a selected group of volunteers who specialize in a particular type of fire fighting. The system provides for tape recording of the message (so that it may be repeated after the call is placed) and a special tone to the home telephones.

HALF-DUPLEX

1. Nonsimultaneous, two-way transmission. 2. The facility termination which permits this method of transmission.

HARD COPY

Data typed or printed.

HDX

Half-Duplex.

HORIZONTAL PARITY

1. Message Parity. 2. Block Parity. The error detection method which summarizes the data bits in successive characters and expresses this summary as an additional code pattern — variously referred to as the parity pattern, message parity character, check character, etc. How many characters are to be summarized is known to both transmitter and receiver. It may be all characters of a message, a specific and consistent quantity (a block), or it may be all characters preceding each carriage return, and line feed series. The check character is formed by scanning the 1 bits in a given level or bit position of successive characters. The check character then includes a 1 bit or 0 bit, in the corresponding level, to make the total number of 1 bits either even or odd — depending upon the system convention. This check character is transmitted with the data and presumably checked by the receiver. "Summary" parity might better express this method than horizontal which is receiver. "Summary" parity might better express this method than horizontal which is receiver. The term stems from the use of paper tape where the scan is thought of as being from left-to-right as opposed from top-to-bottom (vertical parity).

IN-DIALING

See CENTREX.

INTERCEPT

1. The process of receiving or, more frequently, the communication device which accepts undeliverable traffic in message switching systems. A master station could direct messages to an intercept (willful intercept) in order to reduce backlog on an overloaded circuit or the traffic could be automatically routed to an intercept if the designated recipient is out of service (miscellaneous intercept). 2. The human or recorded message function of accepting telephone calls placed to incorrect numbers.

INTERFACE

1. Any combination of input or output terminations which must be matched in order for a device to interoperate either with another machine or with a transmission facility. 2. A separate device which adapts one unit for operation with another. 3. A physical medium (a punched tape) which represents the input or output of a business machine. Recommendations for standard electrical interface connections are detailed in the Electronic Industries Association (EIA) specification RS-232-B. This specification recommends both the nature of the intelligence to be presented (REQUEST-TO-SEND, for example) and the voltage levels to be applied. It is widely used by both the communications common carriers and manufacturers of terminal equipment.

ISO

Pronounced \bar{E} SO. The European version of ASCII.

IXC

Interexchange channel. A transmission circuit between two exchange areas.

KEYBOARD SEND-RECEIVE

A teletypewriter set with keyboard and page printer.

KILOBITS

1000 bits — usually Kilobits/Sec.

KSR

Keyboard Send-Receive (teletypewriter).

LINE SWITCHING

A data or message forwarding system in which a circuit is established between sender and receiver before transmission is initiated. This is opposed to a Message Switching System in which a central site accepts all messages, stores them if necessary, and forwards them to the addressees when a circuit becomes available.

LOCK-ON

To come into synchronism with. (Locked-on: Synchronized)

LOOP

1. A catch-all expression for a transmission circuit. Usually used to refer to a closed, series circuit containing a number of terminal points. 2. That portion of a circuit which extends from the telephone central office to the subscriber's premises. Intrastate circuits are priced from Central Office to Central Office. There is an additional charge (based on 1/4 mile measurements) from Central Office to subscriber, referred to as loop mileage.

LOOP GATE TRANSMITTER

A special tape reader, manufactured by Western Union, which holds the forward edge of the tape within proximity of the sensing mechanism as the tape is being read. This forms a loop of tape above the reading head. This is a valuable feature when sorting, switching or when control characters are not precisely at the beginning of a message. When control characters have been read and acted upon, the first character of the message is moved back over the sensing mechanism and the entire tape is then transmitted to its destination.

MARGIN

The degree, usually expressed as a percentage, of signal distortion that a teletypewriter will accept and still produce correct copy. A margin of "35%-30%" would indicate that the teletypewriter could (or should, if stated as a requirement) be able to operate if 35% of the leading and 30% of the trailing portion of any code element (bit) were destroyed.

MARK

One of two possible conditions which elements of a coded character may assume. A 1 bit as opposed to a 0 bit.

MESSAGE PARITY

See Horizontal Parity.

MESSAGE SWITCHING

The general classification of a switching system in which the destination address(es) of a given message is included as a portion (normally the leading characters or header) of the message itself. It is contrasted to a Line Switching System.

MICROWAVE

1. The somewhat arbitrary classification of electrical waves with frequencies between 10^9 and 10^{11} cycles/sec. 2. The name applied to transmission (radio relay) systems utilizing carrier frequencies in the microwave range.

MISCELLANEOUS INTERCEPT

See Intercept.

MF

Multifrequency Pulsing.

MODEM

A MOdulator and DEModulator combined in the same housing.

MODULATION

The process of superimposing an intelligence signal on a carrier frequency. The most commonly employed methods of modulation are Amplitude Modulation and Frequency Modulation.

MODULATOR

A device used in carrier transmission systems which modulates the intelligence signal. Often the modulator is physically packaged with a demodulator and called a Modem.

MOTOR CONTROL

1. An optional control mechanism for teletypewriters which provides remote turn-on/turn-off of a set's motor. 2. The relay that provides the control.

MULTIFREQUENCY PULSING

A digital transmission method which utilizes a multifrequency key set to generate two out of five frequencies (between 700 and 1700 cps) for each numeric digit.

MULTIWIRE

1. Separate conductors. 2. Descriptive of a device which transmits or accepts each bit of a character on a separate wire.

MULTIWIRE DISTRIBUTOR

A device which translates the parallel wire output of a multiwire device into serial characters.

MULTIPLIXING

The process of electronically combining two or more intelligence signals into a single signal in order to conserve transmission facilities. The process is one of allotment — either time allotment (time division multiplexing) in which information appearing on the system's input channels is periodically time sampled or allotted a certain portion of the composite signal or frequency allotment in which each input channel is assigned a separate frequency.

NEUTRAL

Descriptive of a signaling method in which line current is shifted from a positive value (+60ma) to zero as the transmitting device's contacts open (during the interval in which a SPACING or 0 bit is to be generated).

ON/OFF HOOK

Capable (Off-Hook) or incapable (On-Hook) of transmitting or receiving communications.

ON/OFF LINE

ON LINE indicates that the terminal device is in a position to transmit to or receive from the signaling circuit. OFF LINE implies that the device has been switched away from the signaling circuit and is in a position to use local power for preparing tapes, testing, or printing copy entered via the keyboard.

OPERATIONS-PER-MINUTE (OPM)

The maximum number of character generations which a communications transmitter may make in one minute. In most devices, OPM is the equivalent of transmitting shaft revolutions-per-minute (RPM). Exceptional devices, however, cause a single character to be generated for each half cycle of shaft revolution.

PAGE PRINTER

A device which translates electrically encoded characters into mechanical action in order to type the defined character or symbol on paper. Also Typing Unit.

PARALLEL

Presentation of each element of an encoded character on separate wires either simultaneously or, occasionally, nonsimultaneously. Sometimes referred to as serially-by-character, character-serial or bit-parallel.

PARITY

Equality. Correctness. Freedom from error. The general term applied to the various methods of detecting errors in data transmission. See Horizontal and Vertical Parity.

PBX

Private Branch Exchange. A telephone switchboard located on a customer's premises as opposed to a central office. The equipment utilized ranges from simple-to-operate desktop units to elaborate semi-automatic switchboard.

PHANTOM

A third telephone circuit derived from two others through the use of a repeating coil.

PIVOTED HEAD READER

Also Climbing-Head Reader. A special type of reader, manufactured by Teletype Corporation, which has the tape sensing mechanism on a pivotal axis. This reader, a standard component of some RT sets or an optional feature for ASR sets, is mounted directly in line (the line of tape movement) with an associated tape punch. In some applications, it is either undesirable (when all traffic must remain intact on a single tape) or impossible (automatic store-and-forward tape systems) to tear the tape when the final character has been punched. When this condition occurs, the tape between the reader and punch becomes tight and the reader's sprocket (feed) wheel permits the sensing mechanism to pivot about its axis and "walk" up the tape to read the final character which is, at this point, 0.1" ahead of the punch block. In some systems, with a Fixed-Head Tape Reader, an automatic feed-out mechanism will, at the end of the message, provide sufficient tape loop to permit sensing of the last character.

PL

Private Line.

POLAR

A transmission method in which signaling current is shifted from a negative value (SPACE) to a positive value (MARK) in response to the elements of a character as generated by the transmitter. The usual range of values is -30MA to +30MA.

POLLING

Automatically inquiring whether a remote communications device has traffic to transmit. The polling process involves transmission, from a computer or electromechanical device, of one or more poll characters which either trigger the remote unit (transmitter start codes) or advise the operator (by lighting a lamp) that manual transmission will be accepted. If there is no traffic, a system or hardware specified response (a series of special characters or the lack of any traffic for a certain interval) tells the polling transmitter to proceed to the next unit. Polling implies the exclusion of all but one device and, by extension, the necessity for Selective Calling to isolate this unit from others connected into a common circuit.

PRIVATE LINE

Also "Tie Line". A communication circuit (telegraph or voice-grade) between two points which is reserved for the use of the subscriber.

PWS

Private Wire Service (of the Western Union Telegraph Co.).

RAPIDIAL

An automatic dialing device offered by Bell System. Frequently used numbers are recorded in this unit by use of an associated dial. When a call is to be placed to one of these numbers, the user rotates the dial to the desired number, lifts the receiver of the associated (conventional) telephone and, when he hears a dial tone, depresses the START bar and automatically generates the required dial tones.

REGENERATIVE REPEATER

See Repeater.

REPEATER

1. A device installed at regularly spaced intervals in a transmission facility which provides audio amplification of voice signals. 2. An electromechanical or, more often, an electronic amplifier of teletypewriter signals used to compensate for line distortion inherent in long-haul facilities. Also called a Regenerative Repeater.

REPERFORATOR

An online tape punch. One that will punch tape in response to electrical signals as opposed to one which is driven by mechanical linkage to a keyboard. The output tape may or may not be interpreted.

R/O

Receive Only. A teletypewriter which may receive traffic but not transmit.

ROTR

Receive-Only Typing Reperforator (tape punch).

RT (or TR - TRANSMIT RECEIVE)

Receive-Transmit. A communications device which is capable of receiving and transmitting.

RT (TR) SET

A communications device which translates electrical signals into punched paper tape, temporarily stores the tape and, upon command, reads the intelligence from the tape.

SCATS

Sequentially Coded Automatic Transmitter Start (System). A semi-automatic, teletypewriter, message switching system offered by Bell System.

SELECTIVE CALLING

The specification of one or more remote terminals and, by implication, the exclusion of all other stations connected to a common transmission facility. This selection may be for polling purposes or it may be used to direct output messages which do not concern other stations on the circuit. A Selective Calling System presumes that each remote station is prepared to detect and operate upon the control signals used to effect the process. The term is most frequently applied to teletypewriter networks where the control device is the Stunt Box found in Teletype's Model 28 or Model 35 equipment. Selection and exclusion involve three sets of control characters transmitted from a computer or electromechanical device:

- **Call Directing Codes (CDCs):** Normally two or more characters which identify a particular station. Discrete CDCs are transmitted for each station to be addressed.
- **End-of-Address (EOA):** After all CDCs have been sent, this sequence causes the exclusion of the remaining units on the circuit. (If not previously selected, their typing mechanisms remain blocked.)
- **End-of-Message (EOM):** After a polled unit has had an opportunity to transmit or following delivery of an output message, the EOA sequence prepares all units previously selected or unselected to receive the next CDCs transmitted.

SELECTOR

The mechanism (or electronic circuitry) which receives the incoming serial signal and translates it into parallel (mechanical or electrical) form.

SEQUENCE SELECTOR

A device which routes teletypewriter traffic by sensing coded characters and operating contacts which switch the circuit to the directed destination. Typically, Teletype's Stunt Box, assembled as a separate unit.

SEQUENTIAL

See bit-serial.

SERIAL-BY-CHARACTER

1. A transmission method in which all bits, of each character, are transmitted simultaneously on separate transmission facilities.
2. Parallel.
3. Simultaneous.
4. Descriptive of a device, typically a paper tape reader, which senses all bits of each successive character at the same time. Subsequent transmission, depending upon the device, may be serial-by-character or serial-by-bit.

SIMPLEX

1. A method, used before the advent of carrier transmission and similar to the Phantom Group, of deriving an additional telegraph circuit from either a voice-grade or telegraph -grade facility. 2. Sometimes used to describe a communications circuit which is limited to one-way transmission, not by the communication facility, but by a characteristic of the terminal unit employed.

SIMULTANEOUS

Serial-by-character.

SINGLE SIDE BAND

Name given to a system which transmits only one of the products of modulation.

SPACE

One of the two possible conditions which elements (bits) of a coded character may assume. A 0 bit.

SPIRAL PARITY

A somewhat complex variation of the horizontal method of error checking. A spiral parity count is obtained by checking individual bits, at increasing levels, in each successive character. This method reduces to a minimum the possibility that complementing errors will cancel the effect of error checking.

SSB

Single Side Band.

START-STOP

The asynchronous, serial transmission method. In START-STOP transmission, the bits which define a particular character are preceded by a START pulse and followed by a STOP interval.

STEP-BY-STEP

The name given to a method of line switching now being supplanted by the crossbar system. The basic component of step-by-step switching system is an electromechanical switch, typically the Strowger Switch which is assigned one of three functions and labeled accordingly. The three labels are the line finder, the selector, and the connector. This switch may be stepped in a vertical direction and, subsequently, in a rotary direction under control of electromagnets.

STORE-AND-FORWARD

A literal term used to describe handling (by a computer or electromechanical central station equipment) of I/O traffic in a Message Switching System. Input messages are stored, when necessary, and forwarded to the addressees when outgoing circuits become available.

STUNT BOX

An integral component of M28 and M35 typing units manufactured by Teletype Corporation. The stunt box, through mechanical interpretation of the received character, controls internal functions (CR & LF, for example) of the typing unit and/or provides switch-operation control of external circuitry. The stunt box will accommodate a maximum of 42 sensing mechanisms which may be coded to respond to any bit configuration.

SUBSET

Subscriber's Set. 1. The telephone handset installed on a customer's premises. 2. Once used (now incorrectly) to describe the data sets used in DATA-PHONE Service.

SWITCHING SYSTEM

A means of routine message traffic from a sending station to one or more receiving points. Switching systems are variously classified, singly or in combination, as manual, torn-tape, automatic, store-and-forward, message or line.

SX

Simplex.

SYNCHRONOUS

A method of transmission which establishes the required time-base prior to the transfer of data. This may be accomplished by first transmitting a series of synchronizing characters. The receiver electronically searches until the characters it is generating match the identical, synchronizing character(s) being received. Once the transmitter and receiver are in step with each other, a separate "ready" signal may or may not be sent before transmission proceeds.

TAPE READER

A device which translates information, encoded in punched tape, to a sequence, or simultaneous set, of contact operations. This generic term is subdivided according to the device's distinctive characteristics, either by the use of modifying adjectives (pivoted head tape reader) or by more definitive, separate terminology (transmitter distributor).

TCVR

Transceiver.

TD

Transmitter Distributor or Transmitting Distributor.

TELEMETRY (TELEMETERING)

1. Sensing of remote terminal (frequently analog) device's status or condition via communication between the device and a central, recording point. 2. By implication, control of the remote unit's subsequent action.

TELEPRINTER

Contraction of teletypewriter and page printer.

TELETYPE

Teletype Corporation, subsidiary of Western Electric. Manufacturer of page and tape teletypewriters. Trademark for equipment produced by the Teletype Corp.

TELETYPEWRITER

Generic term for a transmitter which generates electrical signals in response to keyboard entry or tape reading and a receiver which converts received electrical signals into typed copy or punched tape.

TELETYPEWRITER EXCHANGE (SERVICE)

A Bell System Service offering which provides teletypewriter communication between subscribers. The teletypewriter equivalent of ordinary telephone service. A keyboard send-receive set (or at additional monthly charge, virtually any page or tape teletypewriter) is installed on the subscriber's premises. By using the associated dial, the subscriber may connect to any teletypewriter (singly or arranged on a conference basis) listed in the TWX directory.

TELEX

The name given to the teletypewriter message service offered by Western Union.

TELPAK

A Bell System package offering which provides unlimited access to a fixed frequency bandwidth (equated to telephone circuits) for 24 hour/day service.

TIE-LINE

Private Line.

TORN TAPE

Descriptive of a teletypewriter message system in which the attendant tears the tape from the punch associated with the incoming line, reads the destination from the tape and either places the message tape in a reader connected with the proper outgoing line or temporarily stores it for a busy circuit.

TOTAL DISTORTION

The cumulative effect, upon signal transmission, of characteristic distortion, bias distortion, and fortuitous distortion.

TR

See RT.

TRANSCEIVER

A communications device which may, separately or simultaneously, both transmit and receive.

TRANSMITTER DISTRIBUTOR

A paper tape reader which serializes the bits, of each character, adds a START pulse and insures a STOP interval.

TRANSMITTER START CODE

A series of control characters which, when interpreted by a selecting device, causes a remote paper tape reader to begin transmitting.

TRUNK

A line common to many telephone handsets which terminates in a switchboard. This is as opposed to a simple line termination which connects only one telephone handset. A trunk may be the line which connects a telephone on a desk to the company's private branch exchange (PBX) or an interoffice trunk which connects two telephone exchange offices.

TSC

Transmitter Start Code.

TURN-AROUND TIME

1. The time needed by a data modem to shift from a transmit to a receive mode (or vice-versa). 2. The time required for Echo Suppressors, within a voice transmission circuit, to reverse themselves and permit conversation in the opposite direction. 3. The time required for a communications device or system to respond to a transmission.

TWO-WIRE

The transmission facilities required to permit nonsimultaneous, two-way transmission of voice or data. The term is used as the equivalent of half-duplex.

TWX

Teletypewriter Exchange Service.

TYPING BLIND

To prepare a punched paper tape or transmit to a signal circuit by manual keyboard entry while the associated typing unit is simultaneously receiving a message thus preventing the operator seeing what is being transmitted or punched.

TYPING UNIT

A printer which types one character-per-cycle as opposed to a line printer. The equivalent of the somewhat less specific term "page printer."

UNATTENDED ANSWERING

The ability of a communications receiver to accept incoming traffic without human intervention.

UNIT CODE

A description of character length (typically a character generated by a teletypewriter) which is independent of operating speed. The START element is considered to be the basic unit. Each code pulse is an additional unit. The STOP interval, for synchronism reasons, may be of unit length, or more often, greater than unit length. The unit code is used to calculate bit rate. (Unit Code \times Char per Second = Bit Rate)

Example:

Conventional Teletypewriter (Baudot Code)

Pulse	Units
START	1.00
#1 thru #5	5.00
STOP	1.42
Unit Code =	<u>7.42</u>

Newer Teletypewriter (ASCII)

Pulse	Units
START	1.00
#0 thru #7	8.00
STOP	2.00
Unit Code =	<u>11.00</u>

USASI

United States of America Standards Institute.

VERTICAL PARITY

1. Character Parity. 2. The error detection method which summarizes the data bits, in each character, and expresses this summary as an additional bit position or level in that same character. The total number of 1 bits in a given character is made either even or odd (according to the system convention) by the addition of a 1 bit or 0 bit in the parity level. This character parity *bit* may or may not be again summarized in the horizontal parity check *character*.

WATS

See Wide Area Telephone Service.

WAY STATION

Western Union term denoting one of several points connected to a common communications facility. Each of several teletypewriters on the same circuit would be referred to as way stations.

WAY STATION SELECTOR

Western Union terminology for a Sequence Selector.

WIDE AREA TELEPHONE SERVICE (WATS)

A Bell System offering which provides unlimited access, via the switched telephone network, to all telephones within a defined area. The user selects the geographical area (measured across the country in "bands") and pays for either 24 hour/day or 15 hours/month service.

WILLFUL INTERCEPT

See Intercept.

WORD

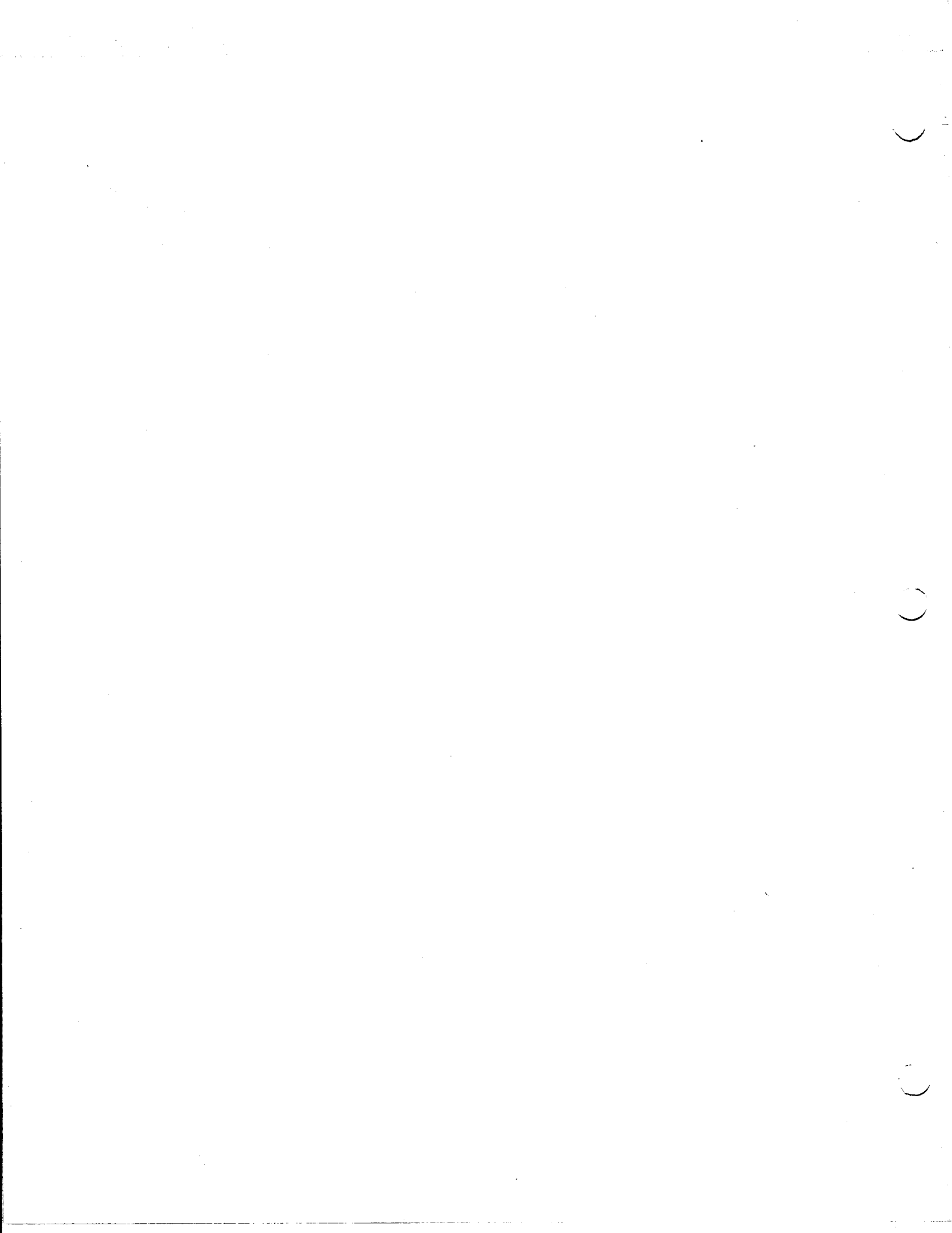
A layman's method of approximating teletypewriter speeds. In this case, the "word" is assumed to consist of five characters plus a SPACE. Thus, a teletypewriter which actually generates 368 characters-per-minute is said to operate at "60 words-per-minute."

WPM

Words-per-minute.

XD

Transmitter (transmitting) Distributor.



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