CONTROL DATA
CORPORATION

CONTROL DATA®
791 COMMUNICATIONS SUBSYSTEM CONTROLLER

FUNCTIONAL CHARACTERISTICS AND PROGRAMMING MANUAL

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PREFACE

Refer to the following Control Data publications for supplementary and complementary information.

Publication	Publication No.
Local Communications Controller Customer Engineering Manual	60321800
Buffer Controller Reference Manual	60275000
18-Bit Word, 200 Nanosecond Memory Assemblies	60309700
7077-1 Communications Station Reference Manual	60364600

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SYSTEM DESCRIPTION 1

791 COMMUNICATIONS SUBSYSTEM CONTROLLER

The CONTROL DATA® 791 Communications Subsystem Controller (CSC) is an internally programmed device which connects multiple communication lines of different types and speeds to a CONTROL DATA® 6000 Computer System (via the 7077-1 Communications Station). The 791 CSC performs most of the control functions necessary for servicing up to 48 full- or half-duplex communication lines and transmits data to the computer system in a standard format ready for processing. By performing these functions, the 791 CSC frees the central processing unit and central storage for more productive processing.

The basic 791-1 has 4096 (4K) 16-bit words of core storage with a cycle time of 200 nanoseconds. The storage can be increased to a maximum of 8192 (8K) words with the addition of a CONTROL DATA® 10274-1 Storage Module. To ensure communication accuracy, the 791-1 has a hardware cyclic encoder unit.

The 791-1 services up to 16 communication lines via the 792 Series Communication Adapters (CA) which are mounted inside the 791-1 cabinet. Line speeds may vary from 110 bits per second to 50,000 bits per second and the transmission mode is half- or full-duplex. The 791-1 also contains all of the control logic necessary to expand the system up to a maximum of 48 lines, a total which is dependent on the type and speed of the lines.

The full complement of communications lines is attained by adding 791-2, 791-3, 791-4, and 791-5 Communication Modules and the associated 792 Communication Adapters. (Refer to Table 1-1 for the CSC modular expansion capability).

The 791 Communications Subsystem Controller is controlled via an internal software program. The CSC software currently supports two line control procedures: mode 2 and mode 3. Mode 2 consists of two-way simultaneous transmission on a point-to-point, dedicated, full-duplex, non-switched communication channel. Mode 3 (teletypewriter - TTY) consists of interactive, two-way alternate transmission on a point-to-point, full-duplex, switched or non-switched communication channel.

NOTE

Unless otherwise stated, the descriptions in this manual apply to both mode 2 and mode 3.

7077—1 COMMUNICATIONS STATION

The 7077-1 Communications Station provides the physical link between a 6000-series input/output channel and the 791 Communication Subsystem Controller. It contains core storage used for data buffers and the software table interface between the 6000 Peripheral Processor Unit and the 791. The 7077-1 consists of:

1. A PL SAC coupler which interfaces a 6000-series input/output channel to the SAC.
2. A storage access controller which provides a data path between a central storage cabinet and a 6000-series input/output channel and between the 791 and the central storage cabinet.
3. A central storage cabinet which consists of 8K of 16-bit words with an access time of 1.1 microseconds. The 10262-1 (8K) Storage Module can be added to the basic configuration to provide additional storage capacity; the 10262-2 (8K) and 10262-3 (8K) Storage Modules can also be added to increase the storage capacity to a maximum of 32,768 (32K) 16-bit words.

792—1 COMMUNICATIONS ADAPTER

The 792-1 Communications Adapter:

- Interfaces a serial-bit, asynchronous (unclocked) American Telephone and Telegraph (AT&T) Model 103A, 202, . . . Data Set, conforming to Electronic Industries Association Standard RS232C (EIA) characteristics
- Assembles 8-bit characters
- Disassembles 8-bit characters
- Synchronizes input bits
- Controls the data set
- Is timed by a 75 to 1800 bits per second tunable clock located on the CA board
- Has a self-contained data set simulator for testing
- Connects directly to the normal input/output channels

792–2 COMMUNICATIONS ADAPTER

The 792-2 Communications Adapter:

- Interfaces a serial-bit, synchronous (clocked) AT&T Model 201A, 201B, 203, . . . Data Set, Conforming to Electronic Industries Association Standard RS232C
- Assembles 8-bit characters
- Disassembles 8-bit characters
- Synchronizes input characters
- Controls the data set
- Has a self-contained data set simulator for testing
- Connects directly to the normal input/output channels
- Attaches to voice-grade lines of 2000 to 9600 bits per second

792–3 COMMUNICATIONS ADAPTER

The 792-3 Communications Adapter:

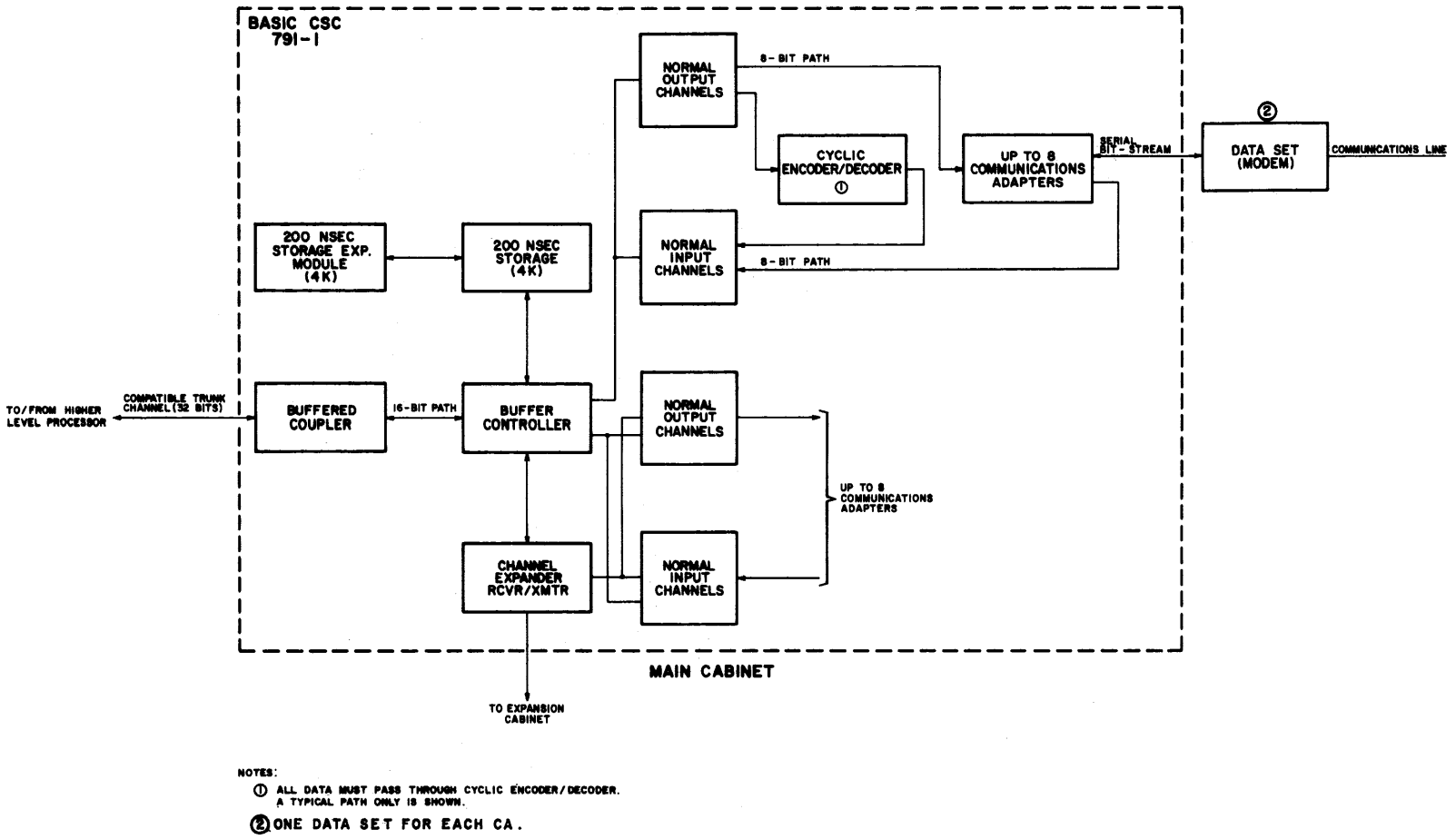
- Interfaces a serial-bit, synchronous (clocked) AT&T data set, conforming to AT&T Model 303 characteristics
- Assembles 8-bit characters
- Disassembles 8-bit characters
- Synchronizes input characters
- Controls the data set
- Connects directly to the normal input/output channels
- Attaches to broad band lines of 19,200 bits per second through 50,000 bits per second

TRANSFER OF DATA

The communications subsystem controller coordinates the transfer of data between a higher level processor and remote terminals. It employs a buffer controller as a programmable control element. The CSC is subordinate to the higher level processor and dominant over the communication line to the remote terminal. The CSC initiates all transmission on the communication line. It monitors the state of each transfer for transmission errors and executes the appropriate error recovery procedures.

BASIC AND EXPANDABLE STATION SUBSYSTEM

Figures 1-1 and 1-2 show a basic and expandable CSC station subsystem, respectively. The CSC is modular and can be configured to accommodate a variety of applications (refer to Table 1-1).

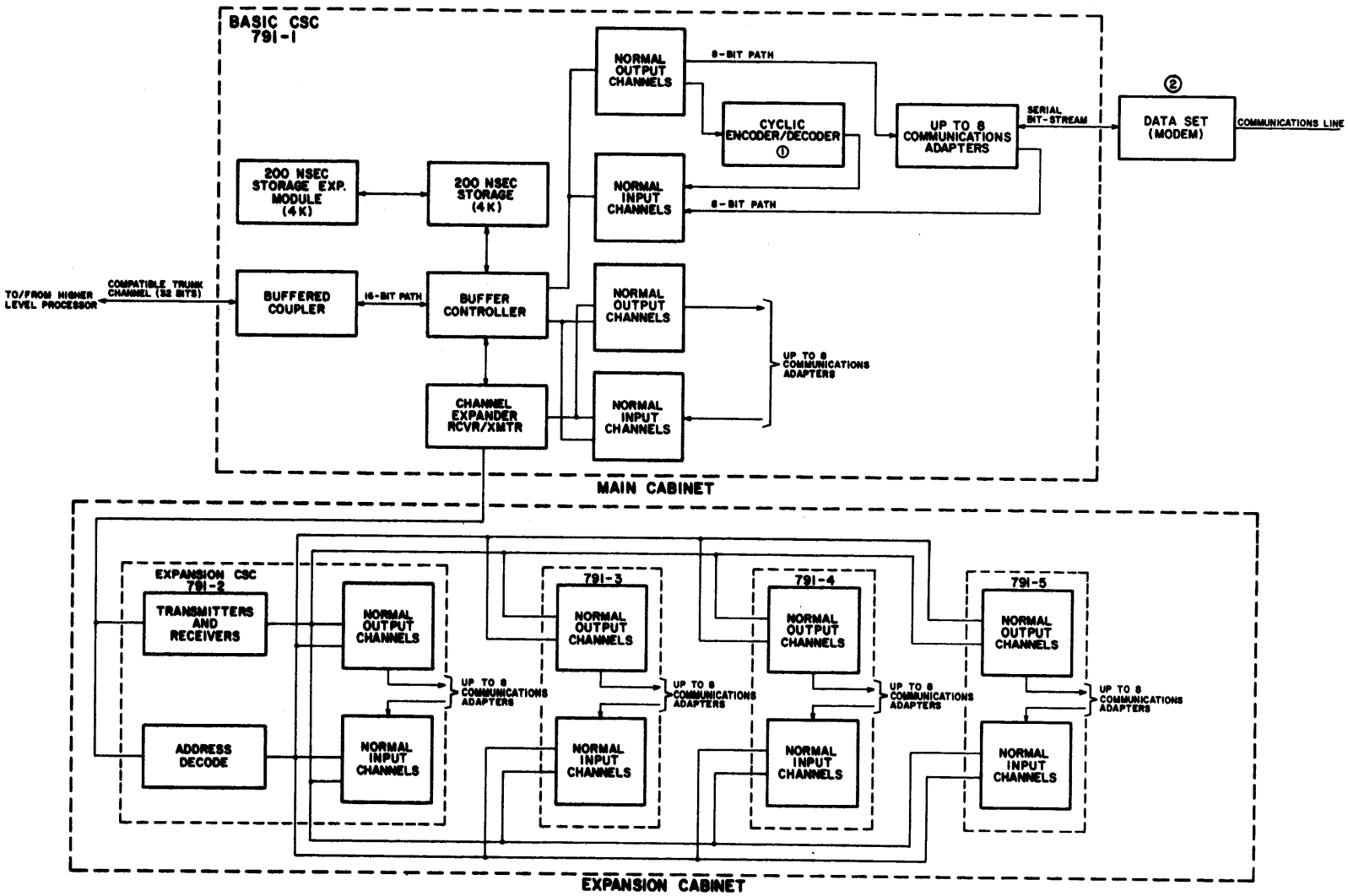


NOTES:

① ALL DATA MUST PASS THROUGH CYCLIC ENCODER/DECODER. A TYPICAL PATH ONLY IS SHOWN.

② ONE DATA SET FOR EACH CA.

Figure 1-1. Basic CSC Station Subsystem



NOTES:
① ALL DATA MUST PASS THROUGH CYCLIC ENCODER / DECODER A TYPICAL PATH ONLY IS SHOWN.
② ONE DATA SET FOR EACH CA.

Figure 1-2. Fully Expanded CSC Station Subsystem

TABLE 1-1. MODULAR EXPANSION CAPABILITY

Product Number	Product Description	Communications Adapters	Level
791-1	Main (SCU) Cabinet Power Supply Normal Output Half-Channels 0-F, Bits 00-15 Normal Input Channels 0-F, Bits 00-15 Buffered Coupler (32 Bits) Station Control Board Cyclic Encoder/Decoder Board Buffer Controller *4K, 200 nsec Storage Module Wired Back Panel Connector and Switch Panel Channel Expander Receivers and Transmitters Boards	1 to 16 (Basic CSC)	1
791-2	Expansion (62" Nu-line) Cabinet Power Supply Normal Output Half-Channels X00-X03, X08, and X09, Bits 00-15 Normal Input Channels X00-X03, X08, and X09, Bits 00-15 Transmitters and Receivers Boards Address Decode Boards Set/Clear Boards Wired Back Panel Connector and Switch Panel	17 to 24	2
791-3	Normal Output Half-Channels X04-X07, X10, X11, X18, and X19. Normal Input Channels X04-X07,	25 to 32	3
791-4	Normal Output Half-Channels X12, X13, X1A, X1B, and X14-X17. Normal Input Channels X10-X13, X18, X19, X1A, and X1B.	33 to 40	4
791-5	Normal Input Channels X14-X17.	41 to 48	5

* A fully expanded system has two 4K storage modules; one is optional.

THROUGHPUT RATE

The CSC services up to 48 mixed, synchronous and/or asynchronous communication lines. Lines of 110 bits per second to 50,000 bits per second are supported. These lines can be mixed for a single 791 Communications Subsystem, but the number of lines is limited by the number of ports (communication adapter positions) and the throughput limitations of the software contained in the 791. The maximum instantaneous throughput rate (total for all channels) is 400 kilobits per second; that is, a 200 kilobit input and a 200 kilobit output.

MODE 2

Synchronous medium and high speed, full-duplex lines of 2400 bits per second to 50,000 bits per second are driven point-to-point, two-way simultaneous and must be non-switched. Typical terminals such as the low speed and medium speed batch use voice-grade lines of 2400 bits per second to 4800 bits per second. The high speed batch uses broad band lines of up to 50,000 bits per second.

MODE 3

Asynchronous low speed lines of 110 bits per second to 300 bits per second are driven point-to-point, two-way alternate, and may be either switched or non-switched. Typical terminals using the low speed lines are Teletypewriter Models 33 and 35 (ASR and KSR) and the CONTROL DATA® Model 713.

STATION SOFTWARE

The CSC subsystem software, resident in the buffer controller, controls all station operations. Subsystem characteristics are thus highly software dependent.

Software support for the 791 Communication Subsystem Controller consists of resident programs within the 791, together with the operating system software for the 6000 Computer System.

791 RESIDENT SOFTWARE

The CSC is supported currently by the 6000 Computer System product line. Mode 2 and mode 3 interface with the 7077-1 Communications Station only.

LEVELS OF SOFTWARE

Generally, two levels of software are associated with a communications subsystem, the application software and the driver. It is the responsibility of the application software to interpret and process data associated with the terminals, while it is the responsibility of the driver software to maintain an orderly flow of data between the application software and the terminal network. Since the communications subsystem controller is a driver-level product, this manual concerns itself with the control and maintenance of an orderly flow of data between central site facilities and the terminal network.

The HLP and the 791 Communications Subsystem Controller each contain one of the two complementing levels of drivers. A communications driver usually consists of the functions listed. The general division of functions between the HLP driver and the 791 is as indicated:

791 - Line multiplexing (scanning for assembled data)
Line control (half-duplex or full-duplex considerations, speed, mode 2 or 3, and error recovery)

Network control (polling)

HLP - Device control (code conversion, code compression/decompression, device not ready/down recovery, and escape sequence processing)

In order that the two driver elements be coordinated in the communications process, a request/reply table interface is required. This interface is contained in the central storage cabinet of the HLP.

FACTORS AFFECTING PERFORMANCE

The two important factors affecting the performance of the CSC are the data throughput rate and the capacity of storage.

DATA THROUGHPUT RATE

The data throughput rate (the number of lines times the speed of the lines) which is serviced by the CSC is based upon the amount of time required to move 8 bits of data through the CSC. Factors affecting the data throughput are:

1. The buffer controller storage cycle time: 200 nanoseconds
2. The number of lines serviced. Forty-eight lines are serviced only if all

are relatively low speed (mode 3 only). Each increment of 8 lines adds approximately 1 microsecond to the minimum scanning time.

3. The rate at which the HLP can accept 64 bits of data. The minimum rate (worst case) at which the higher level processor can accept 32 bits of data is 4.4 microseconds. A slower rate may increase the throughput time for a byte so that fewer lines are supported.

The number of lines supported (in a two-way simultaneous mode) by the CSC, based on service rates is as follows:

1. Up to 4 lines at 50,000 bits per second
2. Up to 16 lines at 9600 bits per second
3. Up to 30 lines at 4800 bits per second
4. Up to 48 lines at 2400 bits per second

STORAGE CAPACITY

The second factor affecting the number of lines that is supported by the CSC is storage capacity. The amount of core storage required for the CSC software of a given configuration varies according to the number of line protocols (modes) supported. The software which supports a particular mode interacts with other line mode (s) software through a base set of software.

The amount of storage required for a given configuration is calculated by using the following formula.

X words of storage = 1700 + A + mode 2 + mode 3 + ... mode x

where 1700 is number of fixed 16-bit words of storage used as base software

A = additional program size for the data set adapter driver

4 lines = 0 words of storage
8 lines = 60 words of storage
24 lines = 180 words of storage
32 lines = 240 words of storage
40 lines = 300 words of storage
48 lines = 360 words of storage

Mode 2 through mode x are the storage equations which are unique to each mode.

Mode 2 words of storage = $1960 + 37L_2 + 16AL_2 + 16S_2$

1960 = fixed words of mode 2 software

L_2 = number of mode 2 lines

AL_2 = number of active (open) mode 2 lines

S_2 = the sum of active streams (that is, the sum of stream requests processed by the CSC at an average operation time)

Mode 3 words of storage = $1750 + 19L_3 + 24AL_3$

1750 = fixed words of mode 3 software

L_3 = number of mode 3 lines

AL_3 = number of active mode 3 lines

In general, the maximum number of streams serviced decreases as the number of lines attached increases. If the number of lines attached remains constant, and the number of active lines decreases, the number of streams serviced increases (refer to Tables 1-2 and 1-3 for examples of "worst cases" of support under a given configuration for 4096 word and 8192 word storage modules).

TABLE 1-2. 4096 WORD STORAGE MODULE SUPPORT

Lines Attached	Lines Active	Streams Serviced
3	3	9

TABLE 1-3. 8192 WORD STORAGE MODULE SUPPORT

Lines Attached	Lines Active	Streams Serviced
16	16	140
25	25	120
36	36	108

STATION HARDWARE

Figure 1-2 shows a fully expanded CSC station subsystem. The principal hardware elements are the following:

COMPATIBLE TRUNK CHANNEL

Files and data flow are controlled via a series of requests, commands, and responses exchanged on the compatible trunk channel. The 32-bit wide channel serves also as the data path between the CSC and the HLP.

BUFFER CONTROLLER

The buffer controller is a small scale, stored-program processor, used as a programmable control element in the communications subsystem controller.

STORAGE

A 4096 word (4K) 200 nanosecond storage module is used for the station operating programs and data. Storage is expanded from 4K to 8K by adding a 4K increment (10274-1 Communications Subsystem Storage Module) to the basic configuration.

NORMAL INPUT/OUTPUT CHANNELS

The normal input/output channels interface the exchange of data between the communications adapters (which in turn interface the data sets) and the buffer controller. The number of normal channels required depends on the number of data sets serviced. A total of 40 input and 40 output channels (40 pairs) are installed in a fully expanded CSC configuration. Forty pairs of channels interface 48 communications adapters. See section 2 of the Local Communications Controller Customer Engineering manual for the channel bit assignments.

BUFFERED COUPLER

The buffered coupler is an interface between the buffer controller block transfer channel and the 32-bit compatible trunk channel, providing a 32-bit buffer to the channel.

CHANNEL EXPANDER

A channel expander is required for configurations that include more than 16 normal input and 16 normal output channels (16 pairs). It allows the buffer controller to address up to 40 pairs of input/output channels (24 pairs of channels beyond the basic system).

EXPANSION CABINET

The expansion cabinet is required for configurations that include more than 16 normal input and 16 normal output channels (16 pairs). Eight pairs of channels are furnished with the expansion cabinet and 16 additional pairs can be added (in two distinct stages).

COMMUNICATIONS ADAPTERS

The communications adapters interface the data set (modem) and the normal channels. One CA is required for each communication line. During input operations, the CA assembles the serial bit-stream furnished by the data set into 8-bit characters. During output operations, the CA disassembles 8-bit characters into a serial bit stream for the data set. Three types of CA's are available to accommodate a variety of data sets. Each CA is a separate pluggable module. There are positions available for 48 CA's in a fully expanded CSC system.

DATA SETS (MODEMS)

Data sets or modulators/demodulators (modems) are not a physical part of the CSC system but each communication line serviced by the CSC must be terminated by a data set. The function of a data set is to convert a serial bit stream to a form suitable for transmission over a voice grade line or other communication line (modulation), or to perform the reverse operation (demodulation).

NOTE

Caution should be exercised when selecting modems which are sensitive to the "time-fill" pattern of hexadecimal 01 which is used between data transmissions. The CSC does not drop the request to send line to the modem.

LOW SPEED LINES

Modems must be chosen according to line-type and line-speed. For lines of 110 bits per second to 300 bits per second, a pair of asynchronous modems, each with an RS232 interface is required. One modem terminates the line at the local end and the other modem terminates the line at the terminal end. An example of this class of modem is the AT&T 103 Series which may be attached to either a switched or private line.

Modems at the local end which connect to switched lines may or may not be strapped for automatic answering. If automatic answering is present, the software in the 791 automatically initiates the processing on that line when a call-connection is detected. However, if automatic answering is not present manual intervention is necessary to place the modem in the data mode.

In either instance, the line is automatically disconnected at the conclusion of processing. The user must check with his common carrier facility to see if it is possible for the callee to disconnect the line at the conclusion of a call. If this is not possible, the line must be disconnected manually by lifting the handset, pressing the TALK button, and replacing the handset.

MEDIUM SPEED LINES

For lines of 2400 bits per second to 9600 bits per second, a pair of synchronous modems, each with an RS232 interface is required. An example of this class of modem is the AT&T 201B which provides a transmission rate of 2400 bits per second on a full-duplex, private line.

HIGH SPEED LINES

Lines of 19,200 bits per second to 50,000 bits per second require a pair of synchronous modems which conform to the AT&T wide-band interface. An example of this class of modem is the AT&T 300 Series which provides transmission rates of up to 50,000 bits per second on a full-duplex, private line. A second example is the CONTROL DATA® 358-4 Transceiver which provides an identical capability over a customer-provided, twisted-pair line.

CYCLIC ENCODER

MODE 2

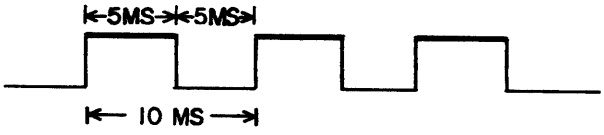
The cyclic encoder generates the cyclic redundancy code which detects transmission error(s) associated with each data block. It is a standard component in all mode 2 CSC configurations.

MODE 3

The cyclic encoder is not used with mode 3.

REAL-TIME CLOCK

The real-time clock is a multivibrator (oscillator) used by the CSC to detect line timeout conditions, thereby enabling the CSC to initiate line error recovery procedures. The clock has a fixed setting of 10 milliseconds.



ASSEMBLY/DISASSEMBLY

Data is transmitted in a serial bit stream on the communication line. The communications adapters perform serial-to-8-bit assembly on input operations and 8-bit-to-serial disassembly on output operations. In addition, the subsystem software performs 8-bit/32-bit assembly/disassembly for data exchanged with the higher level processor.

MULTIPLEXING

The subsystem software scans all communication lines periodically. Data is transmitted or received at the rate dictated by the line. High speed lines are serviced more often than low speed lines if CA's are placed in lower numbered slots.

MESSAGE FRAMING AND LINE CONTROL

MODE 2

The subsystem is responsible for activities such as:

- Inserting characters or stripping characters that define the beginning or end of transmission blocks and messages
- Adding/deleting characters that are required for transparent data blocks
- Adding/deleting status information transmitted between the remote terminals and the CSC
- Acknowledging transmissions
- Detecting and recovering errors - Each message block is protected via a cyclic redundancy check code.

MODE 3

Teletype transmissions consist of a stream of data and format characters (for example, carriage return). There are no communications control characters framing a TTY message. A stream is passed between the TTY and HLP without being examined by the 791 software except as noted in the mode 3 data dependencies description.

STATION CONTROL

MODE 2

The CSC transmits multiple data streams on a time-shared basis over a single communication line. (See multi-streams description in section 2.)

MODE 3

Mode 3 has two defined streams. There is a single input stream (from either paper tape or the keyboard) and a single output stream (to either paper tape or the printer).

SYSTEM INTERFACE

The CSC processes the HLP's requests and commands and sends responses to the HLP indicating the status of the request(s) and command(s).

OPERATING CHARACTERISTICS 2

MULTI-LINES

The station software scans all communication lines periodically and transmits or receives data at the rate dictated by the lines.

Communication lines connected to the CSC on lower numbered CA ports (communications adapter input/output slots within the CSC) are serviced more often than the higher numbered CA ports. Therefore, when a system is configured, the high speed lines must interface with the lower numbered CA ports. See the channel bit assignments in section 2 of the Local Communications Controller Customer Engineering Manual.

MULTI-STREAMS

DESCRIPTION

NOTE

Mode 3 has two streams only: 0 and 1; mode 2 supports multi-streams.

A stream is the simplex flow of data from one point to another (that is, from a source to a sink). Streams are differentiated from each other by numbers. For example, stream 1 has a different source/sink than stream 2. Even numbered streams refer to output simplex flow of data from a source in the HLP to a sink in the remote terminal, and odd numbered streams refer to input simplex flow of data from a source in the remote terminal to a sink (that is, a buffer) in the HLP. The CSC (mode 2) monitors the transmission of several streams (multi-streams) on a time-shared basis over a single communication line. Since the CSC system is point-to-point, there is only one remote terminal per communication line (Figure 2-1).

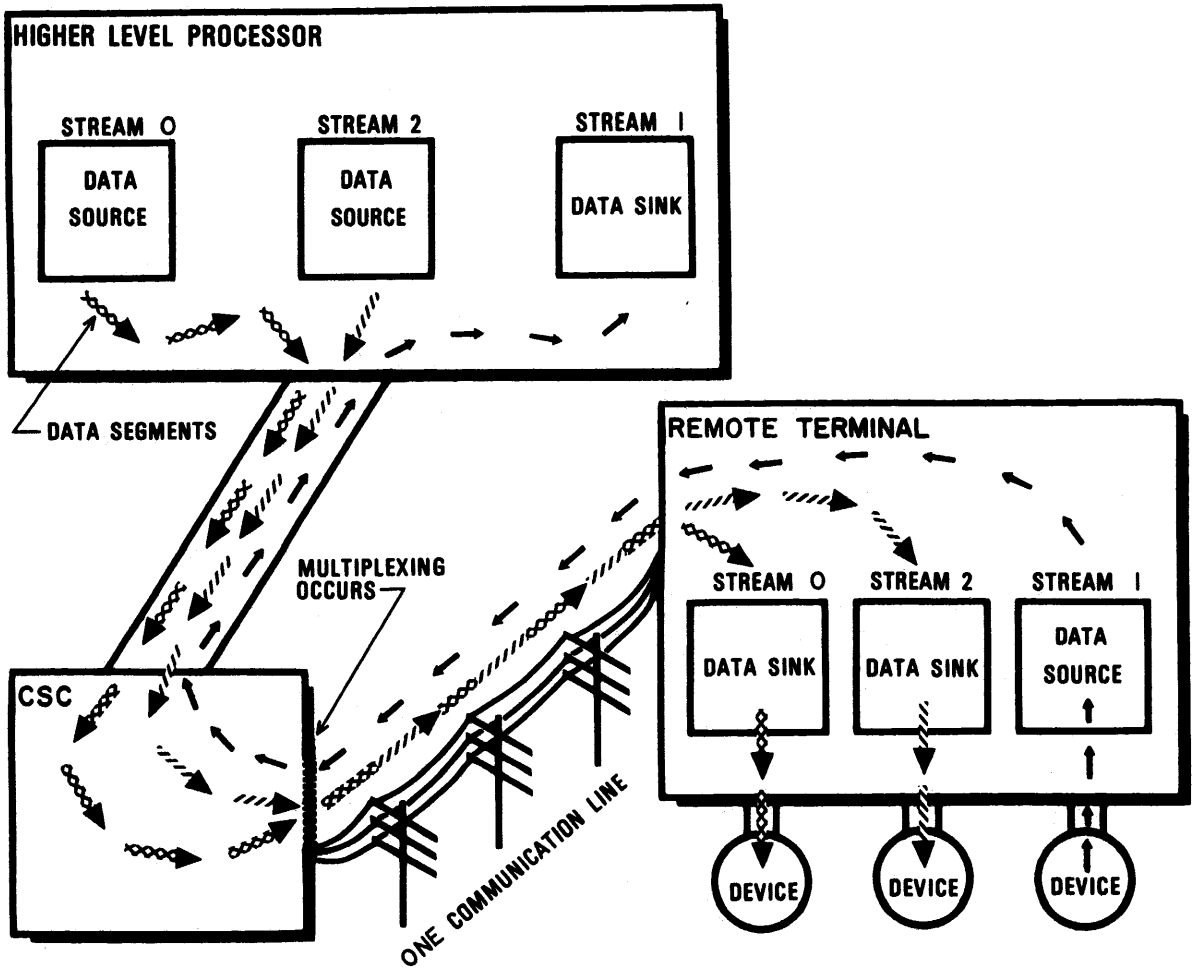


Figure 2-1. Multi-Stream Activity

MODE 2 EXAMPLE

An example of multi-stream activity is the following: An HLP has a data buffer for stream 4 and a data buffer for stream 8. Both data streams are to be sent to the same remote terminal. The remote terminal, like the HLP, provides internal buffer storage for streams to allow two-way simultaneous operations between the HLP and the remote terminal. The remote terminal defines stream 4 as the printer buffer and stream 8 as the card punch buffer. The CSC sends a block (a block $\leq$ the HLP buffer size) of data for stream 4. While the remote terminal is printing the buffer, the CSC sends a block of data for stream 8. Thus, the remote terminal has sufficient data to drive two devices simultaneously. Because the system is two-way simultaneous, similar multi-stream transmissions can be sent from the remote terminal to the CSC. Refer to Figures 3-9 to 3-28 for graphic representations of multi-stream activity.

MODE 3

A teletypewriter has two defined streams; a single input stream (from either paper tape or the keyboard) and a single output stream (to either paper tape or the printer). TTY streams are two-way alternate in nature; input and output operations cannot occur simultaneously.

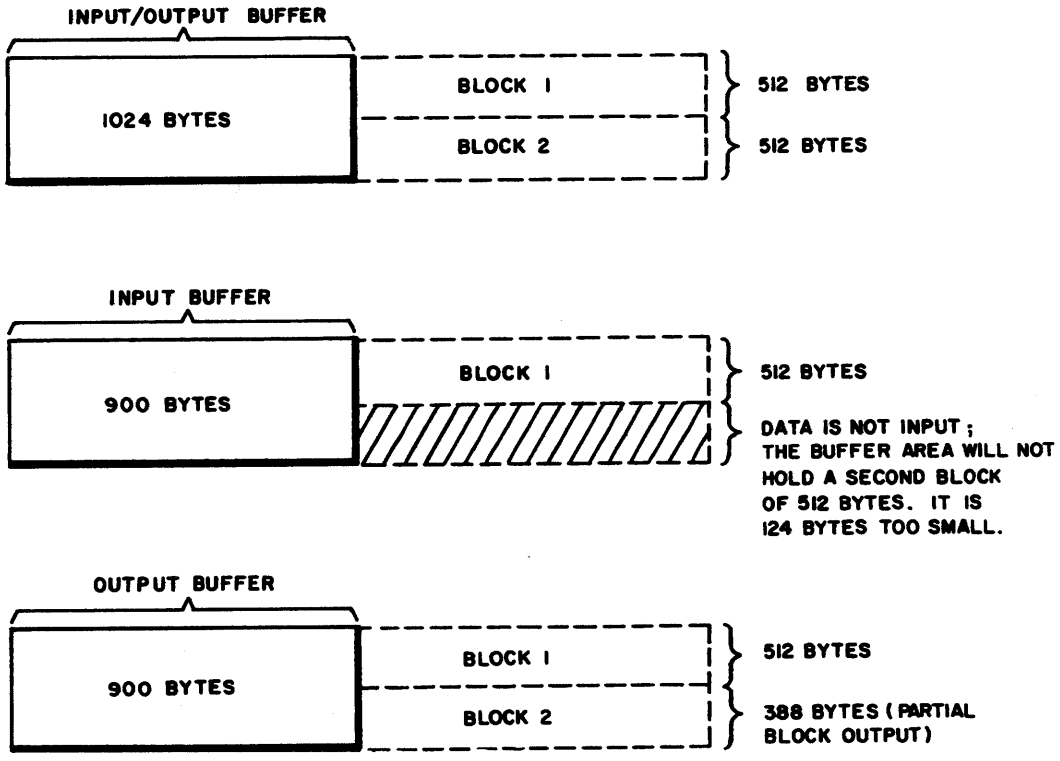
BLOCKING OF DATA

MODE 2

The HLP assigns the buffer area(s) within its storage and the total data byte count for each buffer. This data is to be output to a remote terminal (stream x and line y). The total byte count may be greater than that which the remote terminal is able to receive in a single burst so the CSC divides the transmission of this data into blocks of bytes (multiples of 4 bytes) which are acceptable to the remote terminal. Thus, the data is transmitted in one or more blocks. The CSC inputs data from stream z and line y in blocks. If the HLP buffer area is larger than the input block size, the CSC packs successive blocks from stream z into the HLP buffer area. However, if the HLP buffer area is smaller than the input block size, the CSC does not input the data for that particular block (Figure 2-2).

NOTE

It is very important that all blocks be multiples of 4 bytes in length, except for the last block of a message denoted by an end of transparent text character (ETX); because the interface between the CSC and the HLP is constrained by the hardware transmission width of 32 bits across the compatible trunk channel. If an intermediate block appears, containing a byte-count which is not a multiple of 4 bytes, extraneous data appears in the data buffer (filling into the next 32-bit boundary) between this block and the following block.



Note: In this example, the clock size is 512 bytes.

Figure 2-2. Blocked Buffers

MODE 3

The HLP assigns a buffer area(s) in storage and defines the total data byte count for each area. This data is destined for the teletypewriter on stream x, line y. The 791 reads the data from the HLP in blocks (each block is a multiple of four 8-bit bytes) and passes it character-by-character to a 792 Communications Adapter. The 792 appends start and stop bits to each character.

For input operations, the HLP also defines a buffer area and its size. The 791 collects a block of eight characters and passes the block to the buffer (four 8-bit bytes at a time). This process continues until a pre-defined character is encountered which defines end of message (EOM). Status is returned when a complete message is collected; however, should the buffer fill before the end of message character is encountered, error status is returned and the remaining characters of the message are lost.

CONTROL CHARACTERS ADDED/DELETED

MODE 2

The CSC is dominant during transmission and frames all data blocks with a set of control characters. These control characters consist of an opening delimiter sequence, station control information, a data (text) framing control character and ending delimiters.

The CSC receives data blocks from the subordinate remote terminal. These blocks are framed with control characters. The CSC interprets these control characters, ascertains if they are valid or invalid, and removes them from the data block before it records the data in the HLP data buffer.

MODE 3

The 792 Communications Adapter automatically adds start and stop bits to each character on output operations and removes start and stop bits from characters on input operations.

DATA DEPENDENCIES

MODE 2

Basically, the CSC is not data dependent. Data blocks must all be transparent. Transparency is invoked by control characters (the CSC does not expect bit-position eight of a character to reflect parity, and does not generate parity or check for parity), thus allowing any of the 256 possible bit combinations per byte.

MODE 3

In general, the 791 is not sensitive to the contents of the TTY data stream except as noted in Table 2-1.

During an input operation, the 791 packs successive characters into the HLP buffer which was previously defined by the HLP software.

The first character received is placed into the upper byte of the buffer word and the second character is placed into the lower byte. Each successive pair of characters is similarly packed into successive words of the buffer. Should the buffer be smaller than the incoming message (the buffer fills before the end of message character is detected) an error response is returned to the HLP and all subsequent characters of the message are lost.

Each input character is subject to a lost character check. Should this condition occur, an error response is returned. The parity bit is not stripped from the character before it is passed to the buffer.

The output operation is similar to the input operation, but in reverse.

In either input or output, the data is passed between the buffer in the 7077-1 and the TTY without conversion or change, except as noted. The data stream consists of a series of 8-bit characters from the ASCII code set.

Table 2-1 indicates the characters within the TTY input data stream recognized by the 791 software.

TABLE 2-1. INPUT DATA STREAM CHARACTER RECOGNITION

Character Detected in Input Stream	Operation Performed
LF (Line Feed)	When the CSC detects LF in the input stream, it sends a response to the HLP which indicates a termination with LF. This response is interpreted by the HLP (for example, the LF may be used by the processing application to denote that a segment of a larger message has been entered, but that the message is not yet complete). The LF is not placed into the HLP buffer. The CSC sends a CR to the TTY following a message that terminated with LF. The carriage is positioned and the operator of the TTY is informed that more data can be entered.
CR (Carriage Return)	When the CSC detects CR in the input stream, it sends a response to the HLP which indicates a termination with CR. This response is interpreted by the HLP (for example, the CR may be used to indicate that the final segment of a message has been entered). The CR is not placed into the HLP buffer. The CSC sends an LF to the TTY following a message that terminated with CR.
NUL or DEL	NUL characters are ignored by the CSC. They are not placed into the HLP buffer.
X-OFF or EOT	Keyboard Input Treated the same as for CR except that no LF is sent to the TTY. Also, no timeout is set up as for paper tape. Paper Tape Input 1. Used as message delimiters. X-OFF, which turns the paper tape reader off, and end of transmission (EOT) terminates a message if either is encountered after a series of data characters with no intermediate LF or CR. The CSC sends a solicited response to the HLP which indicates termination with CR. This response is interpreted by the HLP (for example, the X-OFF or EOT character is used to indicate that the final segment of a message has been received).

TABLE 2-1. INPUT DATA STREAM CHARACTER RECOGNITION (Cont'd)

Character Detected in Input Stream	Operation Performed
	The X-OFF or EOT character is not placed into the HLP buffer. In addition to the above processing, the CSC times out for 0.2 second at the time the X-OFF or EOT is encountered. If no input is received within 0.2 second, it is assumed that tape motion has stopped and an unsolicited response (which indicates X-OFF or EOT) is sent to the response list in the HLP storage. DEL/NUL characters received during the time-out interval reset the timeout. When tape motion has stopped, the CSC places the line in the idle state and is prepared to accept further input from the keyboard. A readTI command must be issued to restart the tape reader. 2. Used as single control characters. If X-OFF and EOT are not encountered after a series of data characters, they are assumed to be control characters. No response (indicating termination with CR) is sent to the HLP (that is, X-OFF and EOT are not put into the HLP buffer), but the remaining processing, including the timeout processing is the same as if X-OFF and EOT were message delimiters.
Any input during an output operation	Whenever an input is detected during an output operation, the CSC sends a response to the HLP which indicates that the remote operator has interrupted the output cycle. The interrupted output is terminated by the CSC. This feature is useful when a long file is transmitted in relatively short segments. The "interrupt" is interpreted by the HLP as a request to discontinue or delay the present output.

The CSC software does not inspect the TTY output data stream; therefore, the HLP software must insert as many carriage return and line feed characters as necessary for formatting.

LINE ERROR RECOVERY

MODE 2

If on receipt of an information block (β) or a data block (α) on a communication line, the CSC detects an error, it initiates line error recovery procedures for the block a maximum of N times (N is an assembly parameter). When recovery procedures are executed N times, the CSC exercises the communications adapter (via a pseudo diagnostic) to determine whether the condition is caused locally. The results of the exercise and the condition of a non-recoverable line error are reported to the HLP, the line is closed, and all HLP requests are terminated abnormally (refer to Table 2-2 for the conditions which stimulate the CSC into error recovery procedures).

MODE 3

Output error recovery is not possible with teletypewriters. If an input lost character condition occurs, the 791 immediately sends a repeat line message to the teletypewriter, preceded and followed by LF and CR.

TABLE 2-2. LINE ERROR RECOVERY PROCEDURES

Condition Causing Line Error	Line Error Recovery Procedure
Timed Out - A valid response block for an α (or β) transmission is not received within the allowed time-frame.	The last α (or β) block transmitted by the CSC to the remote terminal is retransmitted.
Incorrect Parity - A valid response block is received; however, the block has a control character parity or cyclic redundancy check error.	An α (or β) message which requests that the remote terminal's last α (or β) transmission be repeated is sent to the remote terminal from the CSC.
Negative Response - The remote terminal interpreted the last α (or β) transmission from the CSC: A control character parity error or cyclic redundancy check error exists.	The last α (or β) block transmitted by the CSC to the remote terminal is retransmitted.
Improper Sequence - The expected α (or β) numbered response (ASCII graphic characters 0, 1, p, or q) is not received; however, the control character parity and cyclic redundancy check are correct.	The last α (or β) block transmitted by the CSC is retransmitted.

If the CSC cannot read from or write into the HLP because of a coupler problem when processing requests, commands, and/or responses, the CSC attempts the read/write operation until it is successful. When a read/write is successful, the CSC continues its normal operation and notifies the HLP that an intermittent coupler problem occurred. If the read/write problem occurred when reading/writing data into the HLP which was being sent to or received from a remote terminal, the CSC does not re-initiate the read/write operation; instead, it initiates line error recovery procedures and notifies the HLP that an intermittent coupler problem occurred.

ERROR REPORTING

Error status is always reported to the HLP by the CSC, regardless of the success of the line error recovery procedures. Examples of error status are:

1. Number of times (N) line error recovery was initiated for the last block
2. Status of the communications adapter
3. Condition of the last data block
4. Condition of communications adapter carrier on/off signal(s)
5. Saturation of the CSC buffers.

BUFFER THRESHOLD

The CSC software uses a buffering system which allows it to dynamically rotate internal buffers so that a portion(s) of a currently unused buffer area can be used to support a saturated buffer area. When the buffer areas reach a saturation threshold, the CSC reports the fact to the HLP and aborts the request which was being processed when the condition was discovered. When the buffers are saturated, the CSC notifies the HLP that the line should be closed. The process is begun by doing the following. As each outstanding stream request is abnormally terminated, a response is written. When all stream requests are terminated abnormally and the HLP sends a close line request, a response is written that the line is closed.

CLOSING A LINE

The HLP can designate a communications line as inactive and the CSC discontinues servicing that line. No data is sent or received. When this action is taken, the CSC terminates all stream requests for this line. When all stream requests are terminated, the CSC notifies the HLP that the line is closed.

ACTIVATING A LINE

The HLP activates a line (opens a line) by first establishing a request list for each line to be activated. The location of each request list is entered in the appropriate slot in the line list. The channel flag is then set, notifying the CSC that new entries have been made in the line list. The CSC searches the line list for all new entires. As each new entry is found, the line is activated. The channel flag is cleared and a response is written indicating that the lines are activated when the line list has been searched completely.

IDLE LINE-POLL

MODE 2

The idle line-poll feature is for remote terminals that go off-line or for start-of-day conditions. If the HLP does not want to close a line completely, it may request the CSC to poll the remote terminal periodically to determine whether it is ready to receive or send data on the partially closed line. If the CSC does not get an immediate response to its poll (the poll is timed out), the CSC polls the remote terminal again at the next polling interval. When the CSC gets the required response to its poll (transmission blocks are received), it continues as though the line had not been idle; it initiates information trade with the remote terminal and scans the HLP lists for requests. The HLP can remove the CSC from an idle poll state by issuing an HLP request to close the line. The request must be accompanied by a channel flag because the CSC does not reference the HLP request list when a line is in the idle poll state. If the remote terminal does not reply to further CSC transmissions when communication is established (the CSC is out of idle poll), the CSC initiates normal error recovery procedures.

MODE 3

The mode 3 procedures consist of an implicit input/output exchange and preemptive output operations. The CSC is automatically prepared to accept data from a TTY line upon receipt of data set ready and carrier on signals from its associated modem. This occurs whether or not the HLP has issued a command which defines the receiving buffer in the central storage cabinet.

MODE 3 INPUT OPERATIONS

When the CSC is not actively transmitting/receiving data over a TTY line, that line is in an unsolicited input mode. This is the normal idle state of an open TTY line. Any input which occurs on a TTY line while it is idle is assumed to originate from the keyboard. When data

appears on a line, the line is no longer idle. If it has not already done so, the HLP is requested to issue a read command to define the buffer area in the central storage cabinet. The request is via a response in the response list. Lost data occurs if the CSC does not detect the read command when 9 bytes are input, or the beginning of the next message occurs, whichever is the shorter. The CSC immediately sends a repeat line message to the teletypewriter, preceded and followed by LF and CR.

MODE 3 OUTPUT COMMANDS

Commands for output operations are honored whenever the TTY line is idle. In this instance, the output preempts the idle state of the line. The line returns to the idle state when the output is complete.

A command for an output operation received while the line is not idle (an input operation is in progress) is held until the line once again becomes idle.

AUTOLOAD

INTRODUCTION

The HLP initiates the autoload operation across the compatible trunk channel by setting an external flag. Once the CSC is autoloaded, the remaining CSC programs are transferred across the trunk channel. The autoload operation is complete when all of the executable code is loaded into the CSC storage.

AUTOLOAD RECORD (Figure 2-3)

The HLP places the 64-word (16 bits per word) autoload record in the central storage cabinet, beginning at address 0000, prior to initiating the CSC autoload operation. The code being loaded is stored in the CSC's buffer controller storage beginning at address 0000.

AUTOLOAD CONTROL WORD

The autoload control word (word 2 of the autoload record) specifies the type of operation:

0002 = Autoload

ADDRESS OF AUTOLOAD TABLE

The 32-bit first word address of the autoload table (words 0 and 1 of the autoload record) points to the 16-word autoload table in the central storage cabinet. This table supports the autoload operation and communication via the software interface when the autoload operation is complete.

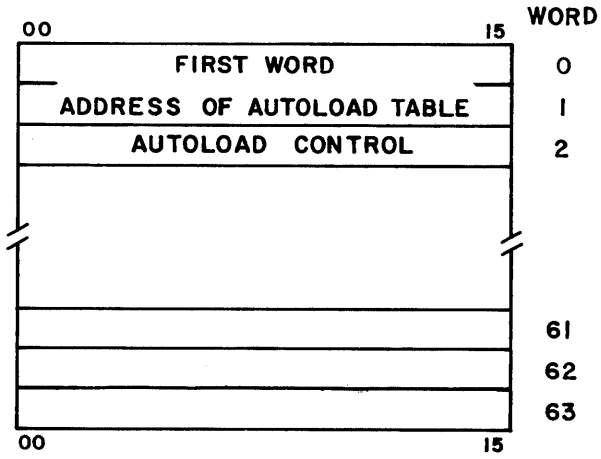


Figure 2-3. Autoload Record Format

AUTOLOAD TABLE (Figure 2-4)

The autoload table is located in the central storage cabinet and is not transferred to the CSC during an autoload operation.

AUTOLOAD RESPONSE (WORDS 0 AND 1)

The CSC writes one 32-bit response into words 0 and 1. The following codes are used:

0000	0001	Error switch: Used if a local autoload occurs when a function (other than a local autoload) was requested.
0000	0002	Ready to read (load) another record: Used in autoload operations.
0000	0004	Autoload operation complete: The last segment is loaded. Used at the completion of autoload operations.
0000	0008	Ready to dialogue via software interface: Used after internal initialization following completion of autoload operations.
0000	0016	Error response: CSC aborted current operation and requires autoload to restart.

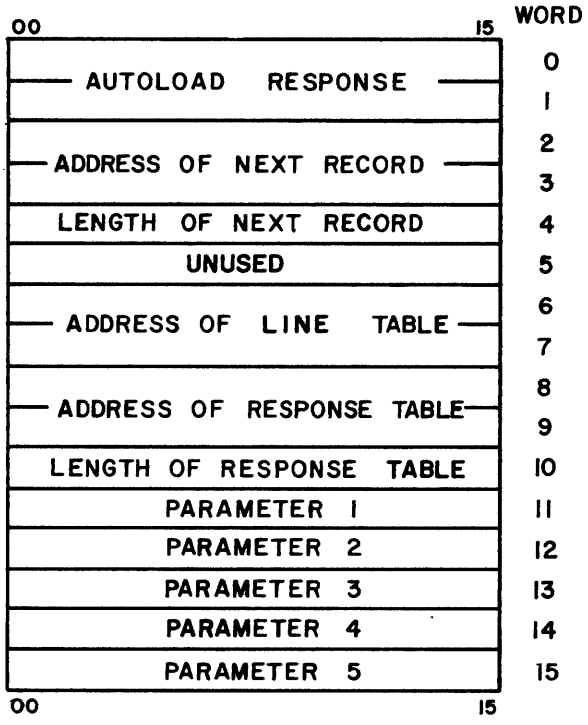


Figure 2-4. Autoload Table Format

ADDRESS OF NEXT RECORD (WORDS 2 AND 3)

This address indicates where the CSC must read or write the next record.

LENGTH OF NEXT RECORD (WORD 4)

This word indicates the even number of 16-bit words of the next record. A length of 0000 terminates the remote autoload operation.

WORD 5

Unused.

ADDRESS OF LINE TABLE (WORDS 6 AND 7)

This address "points" to the line list in the central storage cabinet used by the CSC.

ADDRESS OF RESPONSE TABLE (WORDS 8 AND 9)

This address specifies the location of the IN pointer in the response table.

LENGTH OF RESPONSE TABLE (WORD 10)

This word indicates the number of 32-bit words in the response table, which also includes the IN and OUT pointers.

PARAMETER 1 (WORD 11)

Reserved.

PARAMETER 2 (WORD 12)

This word indicates the number of lines attached to the CSC operating in mode 2. The CSC automatically allocates a portion of its storage for this configuration.

PARAMETER 3 (WORD 13)

This word indicates the number of lines attached to the CSC operating in mode 3.

PARAMETER 4 (WORD 14)

Reserved.

PARAMETER 5 (WORD 15)

Reserved.

AUTOLOAD PROGRAM FROM HLP

The HLP places the 64-word autoload program in the central storage cabinet starting at address 0000 and sends an external flag to initiate autoload.

All responses sent to the HLP from the CSC during autoload operations are accompanied by an interrupt. The absence of a response from the CSC during an autoload operation indicates a record was transmitted in error and the HLP must reinitiate the operation after a timeout of approximately 1 second.

Upon receipt of an external flag from the HLP, the CSC autoload hardware does the following to receive the autoload program.

1. Performs a master clear
2. Reads the 64-word autoload program from the central storage cabinet (bank 0), starting at address 0000.
3. Transfers the 64 words to the CSC storage, beginning at address 0000.
4. Begins execution of the loaded code, beginning at address 0001.

When the autoload program is loaded, the CSC interrupts the HLP and waits for a channel flag from the HLP. The interrupt is sent to acknowledge receipt of the 64-word program. Upon receipt of this initial interrupt from the CSC, the HLP interrogates the compatible trunk channel interface to ensure that no errors occurred during the 64-word transfer of the autoload program. If no errors occurred, the HLP sends a channel flag to the CSC. If errors did occur, the HLP must reinitialize and then send another external flag to recycle the autoload process.

Upon receipt of the channel flag from the HLP, the CSC interrogates the autoload control word. If an autoload or install/load operation is specified, the autoloading process is performed. If any other operation is specified, nothing is done.

AUTOLOAD PROCESS

An autoload response of 2 is sent back to the HLP to acknowledge receipt of a legal autoload control word. The CSC then waits for a channel flag from the HLP.

Upon receipt of the 2 response, the HLP places the next record address and the next record length in the autoload table and sends a channel flag. The CSC reads the autoload table upon receipt of the channel flag and interrogates the next record length entry.

A nonzero next record length entry informs the CSC of the presence of a code to be read from the central storage cabinet. When the read operation is completed, the CSC sends an autoload response of 2 back to the HLP. The process is repeated until the HLP has no more records to transmit to the CSC. The HLP then sets the next record length equal to 0 and sends a channel flag to the CSC. Upon receipt of the channel flag and the zero next record length, the CSC returns an autoload response of 4 for the autoload operation.

STANDARD DIALOGUE INTERFACE INITIALIZATION (JUST AFTER AUTOLOAD)

The CSC waits for a channel flag after sending a 4 response during the autoload operation. Upon receipt of a 4 response, the HLP inserts the request table address, the response table address, the response table length, and the control word (parameter words 2 and 3) into the autoload table. The HLP then sends a channel flag to the CSC. Upon receipt of the channel flag, the CSC unconditionally initializes its internal tables, buffers, line tables, and response table pointers which comprise the standard dialogue interface. The CSC initializes its internal system using the values of parameter words 1 through 5. The sum of the parameter words must equal the highest-numbered communications adapter port; if a communications adapter is in physical port 09, the sum of parameter words 1 through 5 must equal 9. An autoload response of 8 is sent upon the completion of initialization. The CSC exits from initialization and enters its monitor routine upon receipt of the next channel flag from the HLP.

MODE 3 OPERATOR'S INTERRUPT

If any input is received while the CSC is outputting data, it is assumed that the TTY operator wishes to send keyboard input. The present output operation is terminated and the CSC prepares to receive data.

EXTERNAL INTERFACES 3

INTERFACE WITH HIGHER LEVEL PROCESSOR

CHANNEL FLAG

The channel flag is set by the HLP to inform the CSC that it wants a line(s) to be activated or to pass a request which closes a line which is in an idle poll state. The CSC clears the channel flag and sends a response(s) to the HLP stating that it has activated the line(s). It also sends a second response to the HLP stating that the channel flag has been cleared.

LINE LIST (Figure 3-1)

The line list resides in the HLP. There is an entry slot for every line in the system. A line number is equated to a CA port; line 1 refers to port CA01, line 2 refers to port CA02, etc. When the channel flag is set by the HLP, the CSC reads entries from the line list for those lines that are currently inactive (closed). If the entry is negative, there is no new activity for the line; if the entry is positive, the line list contains a 32-bit base address of the request line for this line.

REQUEST LIST (Figure 3-1)

Once the base address of the request list is read into the CSC, it remains there until the line involved is closed. Periodic references to the request lists are made by the CSC to determine whether a new request has been entered. As each request is completed (normal or abnormal), a response is sent to the HLP.

The request list for each line has two types of entry slots. The first entry slot of each list is dedicated to requests for communication between the HLP and the CSC. The second and succeeding entry slots are dedicated to streams. The request list must have as many stream entries as the maximum number of streams allocated for that line. The maximum number of streams is 16.

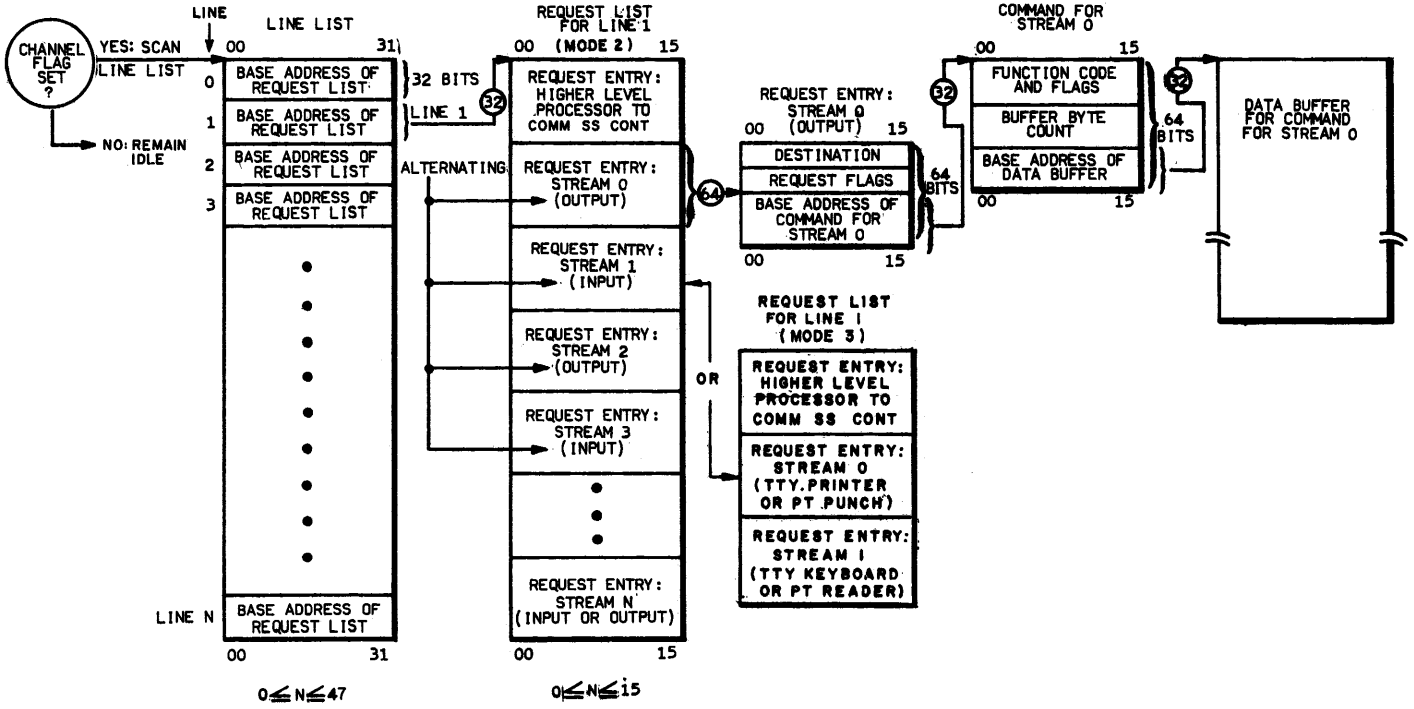


Figure 3-1. Interface Lists Resident in the Higher Level Processor

Streams are identified by number. For mode 2, an even numbered stream is dedicated to the CSC simplex output operation (the CSC transmits data to the remote terminal on even streams only). An odd numbered stream is dedicated to the CSC simplex input operation (the CSC receives data from the remote terminal on odd streams only).

NOTE

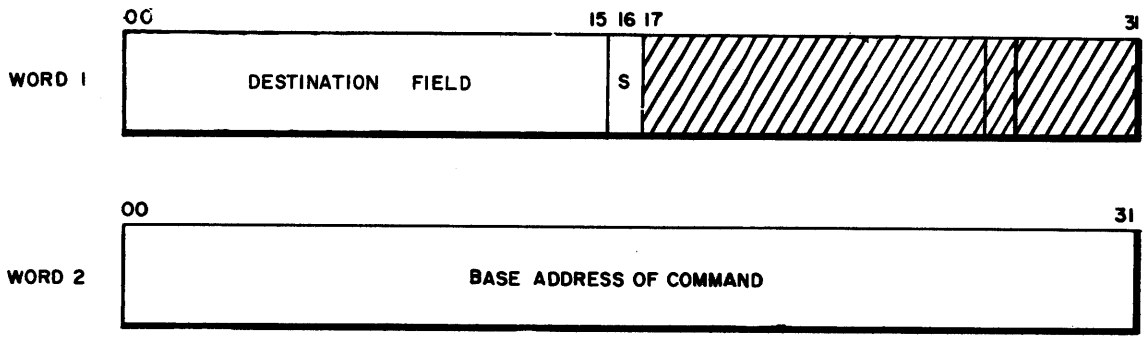
Stream entries within a request list must be consecutive.

Mode 3 has two defined streams, a single input stream (from either paper tape or the keyboard) and a single output stream (to either paper tape or the printer). Mode 3 streams are two-way alternate in nature; thus, input and output operations cannot occur simultaneously.

NOTE

There are two request entries associated with modes 2 and 3. Refer to Figure 3-1 and Tables 3-1 and 3-2.

REQUEST ENTRY FORMAT—HLP TO CSC



Bits 17-31 should be filled with zeros.

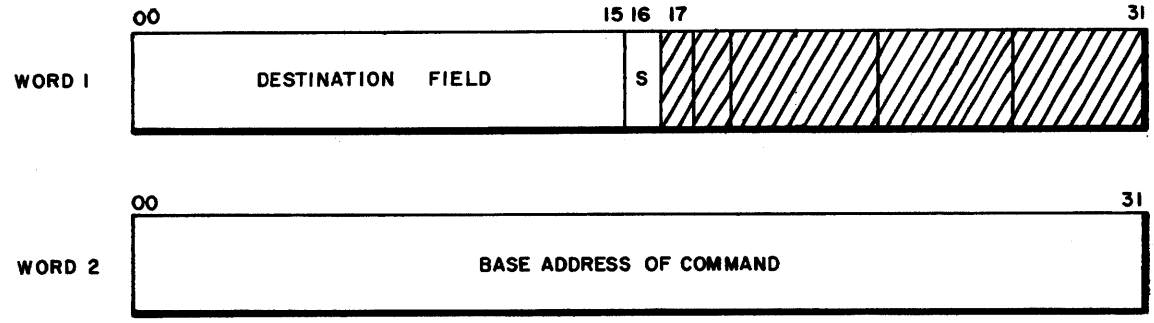
TABLE 3-1. REQUEST ENTRY - HLP TO CSC

Word	Bit(s)	Description
1	00-15	Destination Field: Supplied by the HLP and returned in the solicited response
	16	S Field: Status of this request slot 0 - This request is active or has been completed. The CSC clears this bit when it initiates this request.

TABLE 3-1. REQUEST ENTRY - HLP TO CSC (Cont'd)

Word	Bit(s)	Description
1	16	1 - This request is ready for initiation. The HLP sets the bit when it enters a new request.

REQUEST ENTRY FORMAT—STREAM



Bits 17-31 should be filled with zeros.

TABLE 3-2. REQUEST ENTRY - STREAM

Word	Bit(s)	Description
1	00-15	Destination Field: Required in all requests and is returned in the solicited response
	16	S Field: Status of this request slot
		0 - This request is active or has been completed. The CSC clears the bit when it initiates this request.
		1 - This request is ready for initiation. The HLP sets the bit when it enters a new request.

COMMANDS (Figure 3-1)

Commands are 64 bits in length and supply detailed information to the CSC from the HLP for proper execution of a request. There is one command for each request.

Commands for streams direct two types of executable functions: An input stream (odd numbered stream) reads data and an output stream (even numbered stream) writes data. For mode 2, input stream requests to read are rejected by the CSC if an unsolicited request to send (RTS) is not received from the remote terminal (refer to Tables 3-3 and 3-4).

For mode 2, it is recommended that buffers be a multiple of the transmission block size for a stream. Input streams: If the buffer does not hold multiples of the block size, and the last block is smaller than the block of bytes to be received from the remote terminal, the CSC terminates the request with the byte count reflecting the number of bytes received. Input and output transmission blocks must be a multiple of 4 bytes (32 bits) in length, except for the last block of a message (denoted by ETX) which may be less than or equal to the stated block size. It is recommended that the data buffers for output operations be multiples of the transmission block size if the request is terminated with an end of transmission block (ETB). Most remote terminals require that the maximum block be transmitted to them. If the request is terminated with an EOM (ETX), the defined data buffer can be smaller or larger than the transmission block size.

NOTE

When the write function on an output stream reflects an end of message, or a received block on an input stream contains an ETX, the request is terminated as "correctly completed with ETX." Also, on input streams, if a buffer is filled and an ETB is received, the request is terminated and the HLP receives a response from the CSC with an implied unsolicited response which states that the remote terminal has additional data for this file.

COMMAND FORMAT—HLP TO CSC

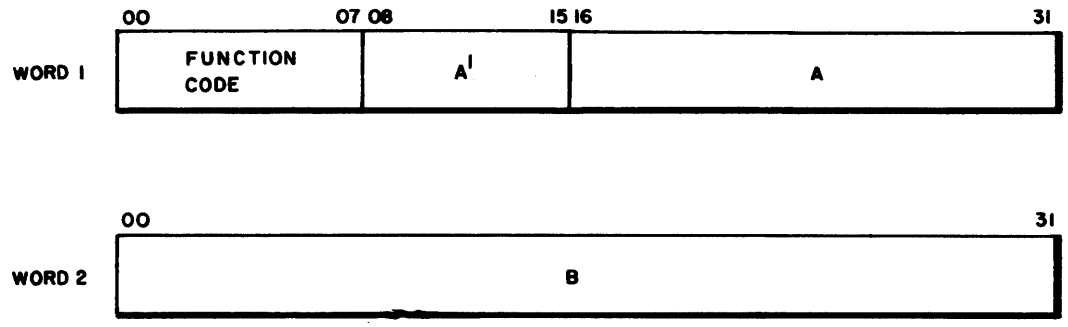


TABLE 3-3. COMMANDS - HLP TO CSC

Word	Bit(s)	Function Code (HEX)	Mode(s)	Description
1	00-07	F1	2 and 3	Close Line: Terminate all outstanding stream requests to this line. Responses reflect an abnormal termination since this is a requested action. The CSC scans each entry in the line request queue before writing the completion response to this request. New requests are terminated abnormally. All references to this line are eliminated and the line is considered inactive when all entries are scanned.
		F2	2 and 3	Terminate the Active Request on Stream x defined in Field A. Field A is the input or output stream number. The line returns to an idle state. A normal response is given for successful completion of this request. The CSC is in one of three states with the defined stream when a "terminate the active request on stream x" command is issued. 1. The CSC has processed and is executing a stream request for the defined stream. The CSC terminates that request. An abnormal termination response is sent to the HLP. The byte count in the response reflects the number of bytes successfully received/transmitted. 2. The CSC does not have a stream request in storage for the defined stream. However, internal flags infer that implied RTS or CTS blocks have been traded with the remote terminal. The CSC clears all internal flags. An abnormal termination response is sent to the HLP.

TABLE 3-3. COMMANDS - HLP TO CSC (Cont'd)

Word	Bit(s)	Function Code (HEX)	Mode(s)	Description
				3. The CSC does not have a stream request in its storage area nor does it have internal flags for the defined stream. An abnormal termination response is sent to the HLP. The CSC transmits an abort stream SID to the remote terminal for all three states described above.
		F5	2 and 3	Configuration Definition for Line x - mode 2. This request should be issued at open-line time only. If it is issued at other times, the result cannot be determined. This request defines the timeout type (bits 13-15 of field B) and the maximum number of streams for this line (bits 27-31). The timeout type is an index similar to that defined for field B (block type) in a stream request. The index must point to the entry in the table describing the terminal supported on this line. The entries in the table are constant: Index 0 = high speed line (210 millisecond timeout) 1 = low and medium speed line (1 second timeout) Indexes 2 through 7 are not defined. Open Line Request - mode 3. This must be the first request received for a newly opened line. It does not contain parameters for mode 3.

COMMAND FORMAT—STREAM

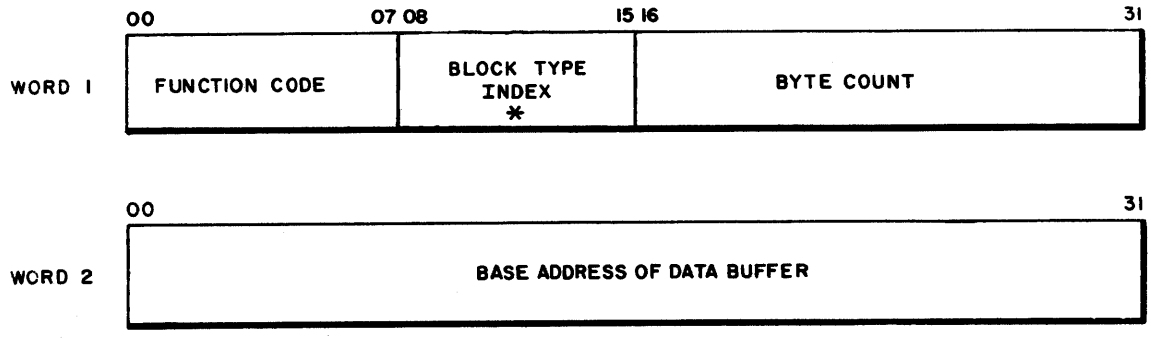


TABLE 3-4. COMMANDS FOR STREAMS

Word	Bit(s)	Function Code (Hex)	Description
1	00-07	00	Read The CSC stores the data it receives from the line and stream (defined in the request) into the data buffer.
		80	Write transparent text with ETB
		81	Write transparent text with EOM
	08-15		*Block Type Index An index (ranging from 0-7) for a table containing block byte counts. The index points to the entry in the table depicting the block size for a particular stream. The entries in the table are constant.
	16-31		Byte Count This field specifies the number of 8-bit data bytes to be processed (read or write) from the data buffer. Used by all function codes.
2	00-31		Base Address of Data Buffer Used by all function codes

* Mode 2 only

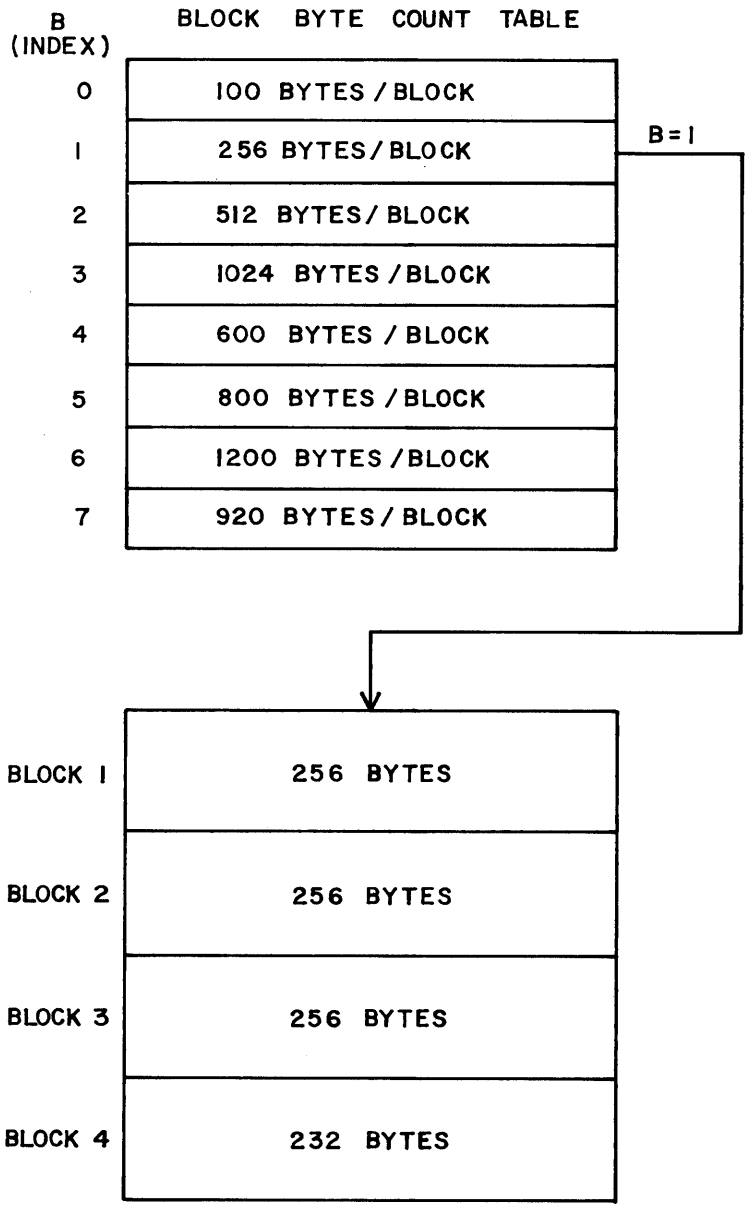


Figure 3-2. B Field Block Byte Count

MODE 3 INPUT COMMANDS

There are two forms of input commands: those associated with keyboard input operations and those associated with paper tape input operations. It is tacitly assumed by the CSC that the HLP is aware of which TTY device is sending data and is directing the CSC accordingly (refer to Table 3-5).

NOTE

All DEL and NUL characters which appear in the TTY input stream are discarded by the CSC.

NOTE

There are two descriptions of the read command (function code 00). The first description describes the input operation from paper tape and the second description describes the input operation from the keyboard.

TABLE 3-5. MODE 3 INPUT COMMANDS

Word	Bit(s)	Function Code (Hex)	Description
1	00-07	00	Read (Paper Tape) This command is issued for all subsequent inputs from paper tape after readTI. Read, unlike readTI, does not send X-ON (which turns the paper tape reader on) prior to a data input. The primary function of read is to define the central storage cabinet buffer in which input data from the associated TTY line is to be placed. The read command may be issued either before or after the input flow begins. The input flow is defined as the first character encountered. Should the TTY input begin before the central storage cabinet buffer is defined, a response is sent to the HLP which demands read be issued promptly. The buffer defined by read is terminated normally when the CSC encounters any of the following conditions: 1. Line feed 2. Carriage return

TABLE 3-5. MODE 3 INPUT COMMANDS (Cont'd)

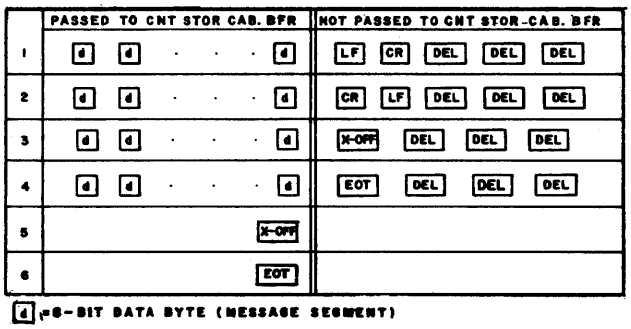
Word	Bit(s)	Function Code (Hex)	Description
1	00-07	00	3. X-OFF (if immediately preceded by data) 4. EOT (if immediately preceded by data) LF or CR is the first terminating character encountered in a message segment. This determines the response which is sent. The terminating character is not placed into the central storage cabinet buffer. Succeeding DEL characters are ignored as is the LF or CR which occurs after the initial LF or CR. The characters X-OFF and EOT are used as message delimiters as well as control functions. X-OFF and EOT terminate a message if either is encountered after a series of data characters with no intermediate LF or CR. The message response indicates "termination with CR" when X-OFF and EOT terminate the message. Message segments from paper tape may appear in any order on the tape insofar as the CSC is concerned. 

TABLE 3-5. MODE 3 INPUT COMMANDS (Cont'd)

Word	Bit(s)	Function Code (Hex)	Description
1	00-07	00	It is recommended that not fewer than three DEL/NUL characters be sent to the CSC to provide adequate time delays in HLP to CSC communications. The characters X-OFF and EOT are processed in a unique way by the CSC. When either is encountered in the input stream, a timeout of 0.2 second occurs. If no input is received within 0.2 second, it is assumed that tape motion has stopped and a response, which indicates X-OFF or EOT, is sent to the response list. DEL/NUL characters received during the timeout interval reset the timeout period. When it is determined that tape motion has stopped, the CSC places the line in the idle state and is prepared to accept further input from the keyboard. ReadTI must be issued to restart the tape reader. If, however, an input does occur before the expiration of the timeout, the response is cancelled and the input is accepted. It is assumed that this data originates from the paper tape reader. Read (Keyboard) This command is issued for all keyboard input operations. Read may be issued either before or after the input flow has begun. The input flow is defined as the first character encountered in a message. Should the input flow begin prior to the issuance of read, a response is sent to the HLP demanding that a read command be given to define the central storage cabinet input buffer. The read command is terminated whenever one of the following characters is encountered: 1. Line feed 2. Carriage return 3. EOT 4. X-OFF Treated as CR but timeouts are not set as with tape. LF is not returned as for CR. The ending character determines which response is sent.

TABLE 3-5. MODE 3 INPUT COMMANDS (Cont'd)

Word	Bit(s)	Function Code (Hex)	Description
1	00-07	00	If the message terminates with LF, the CSC automatically sends a CR to the TTY prior to expecting a subsequent message. Conversely, if the message terminates with CR, the CSC sends the TTY an LF.
		01	ReadTI This command is issued prior to the initial input from paper tape. This command differs from the read from paper tape command (function code 00) in that X-ON is sent to the TTY prior to a data input. NOTE The HLP is aware of a forthcoming paper tape input via either prior entry at the keyboard or another stimulus. A tape input may occur before the CSC recognizes the readTI command. In this instance, the input is assumed to originate from the keyboard, X-ON is not sent, and any data received up to the time readTI is detected is treated as though it originated from the keyboard. Should an entire tape message be received before readTI is detected, that message is treated as though it originated from the keyboard.

MODE 3 OUTPUT COMMANDS

Output commands are honored when a line is open and idle. The CSC does not inspect the output stream for special characters as it does during an input operation. It is assumed that proper format codes are contained in the message and that the carriage is positioned for the subsequent input/output operation (refer to Table 3-6).

TABLE 3-6. MODE 3 OUTPUT COMMANDS

Word	Bit(s)	Function Code (Hex)	Description
1	00-07	80 and 81	Write These commands output data to the TTY and operate with either the printer or paper tape. There is an output to paper tape only if paper tape punch is manually turned on. When the CSC outputs data to the TTY, it does not inspect the output stream for special characters as it does during an input operation; therefore, the HLP must insert as many carriage control characters into the output stream as necessary for formatting. It must also ensure the positioning of the carriage for the following input/output operation. The CSC initiates this operation when a message is not presently being received. If an input operation is in process when the HLP issues a write, the CSC allows the input to continue to completion. The termination of write occurs when a given number of bytes is transmitted. The CSC does not distinguish between write, function code 80 and write, function code 81; the difference centers entirely around the response sent to the HLP. The HLP may find the distinct responses useful for its own control.
	16-31	80 and 81	Byte Count This field specifies the number of 8-bit bytes to be read from the data buffer.

RESPONSE LIST (Figure 3-3)

The CSC informs the HLP of current requests, commands, and the status of the system by updating the response list. There are two types of responses: solicited and unsolicited. Solicited responses are the result of an HLP request. Unsolicited responses are the result of unexpected stream or system condition(s). Examples of unsolicited responses are:

1. The remote terminal input stream requests to send data to the CSC.
2. The CSC storage threshold is exceeded.

3. Unique stream status bits are received.

4. The CA exerciser and its status are in this response.

RESPONSE LIST FORMATS

Responses are 128 bits in length. They provide the higher level processor either with information about a previous request or information which the HLP must act upon. There are four response entry formats. The response code reflects the format (refer to Figures 3-4 through 3-7 and Tables 3-7 through 3-10).

Fields Defined for Format 3

Retransmit Count - Number of error recovery attempts on the last block.
Byte Count - Number of 8-bit bytes received/stored in data buffer.

Fields Defined for Format 4

There are two format 4 responses: response code 44 (line errored out) and response code 45 (intermittent SAC problem). Response code 44 uses fields B, C, and D and response code 45 uses field A.

Response Code 44 - Field B: Line Status = 8 bits (B, S, C, NE, N, NA, SAC, or TO)

B = illegal data SID
S = out-of-sequence block
C = CRC or character parity error
NE = no ending delimiter
N = NEG was received
NA = not assigned
SAC = intermittent SAC problem
TO = line timeout

} Mode 2 only

Response Code 44 - Field C: Results of CA Exercise (Data Set Loop Results)

= 0 - successful communications adapter loop exercise
≠ 0 - number of unsuccessful attempts to loop character

} Mode 2 only

Response Code 44 - Field D: Carrier On/Off Status

00 - Carrier is on and data set is ready
01 - Carrier is on but data set is not ready
02 - Carrier is not on and data set is ready
03 - Carrier is not on and data set is not ready

} Mode 2 only

Response Code 45 - Field A: Number of Intermittent SAC Rejects in this Pass

No meaningful destination field.

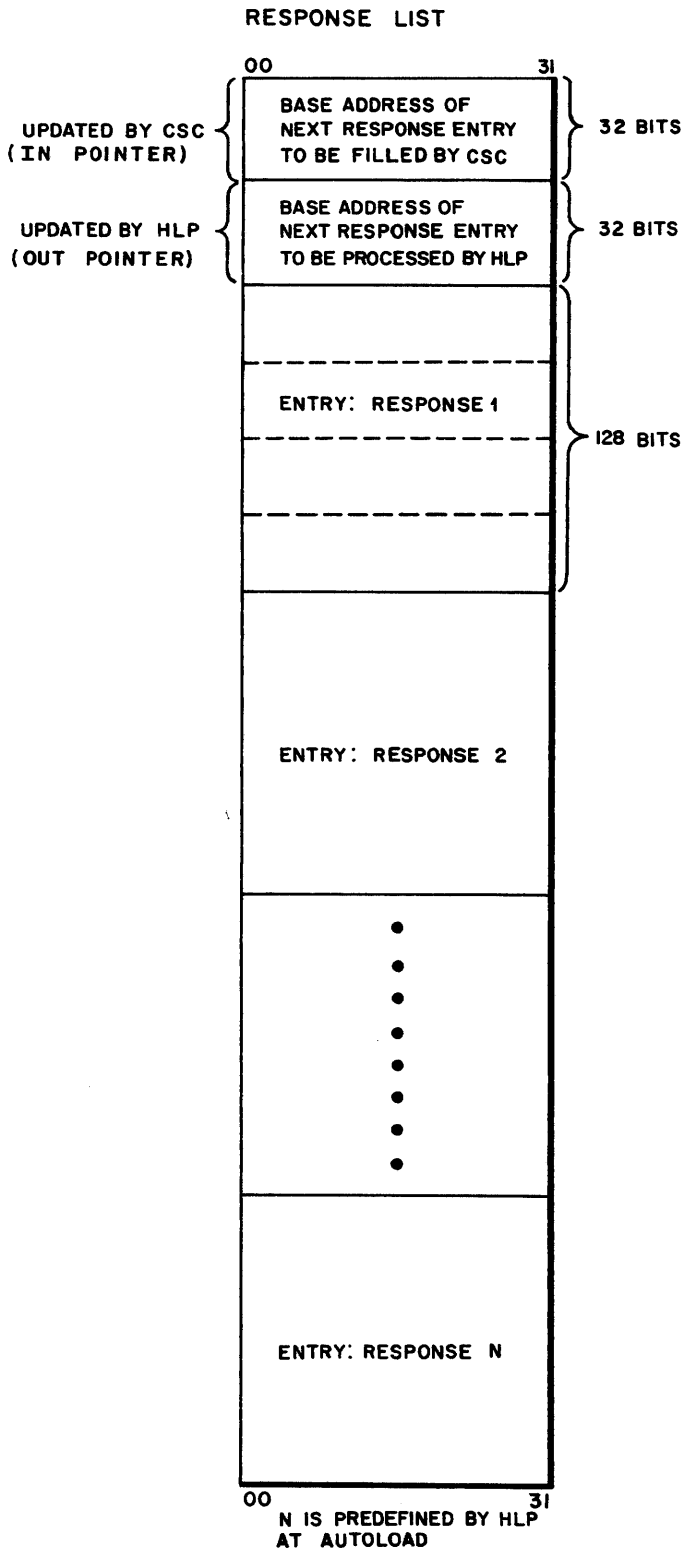


Figure 3-3. Response List

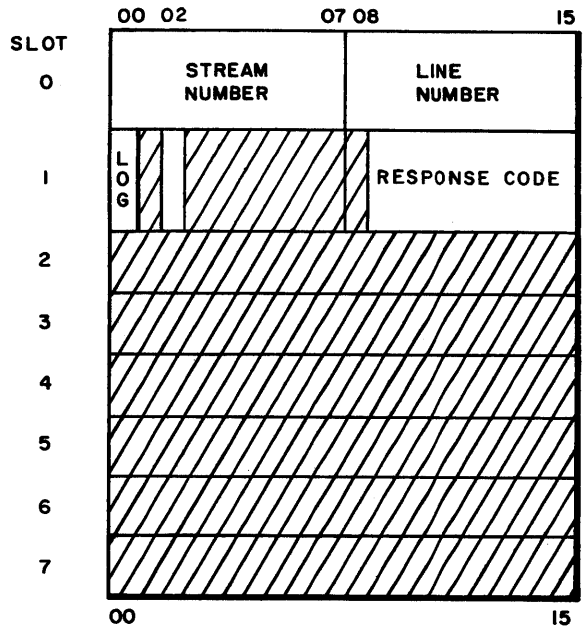


Figure 3-4. Normal Unsolicited Response - Format 1

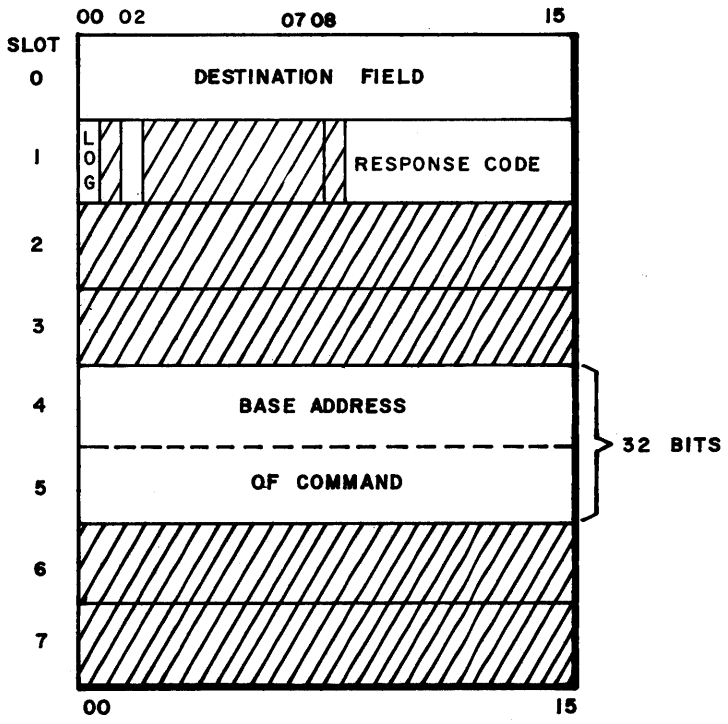


Figure 3-5. Normal Solicited Response to HLP/CSC Request and to Illegally Formatted Requests - Format 2

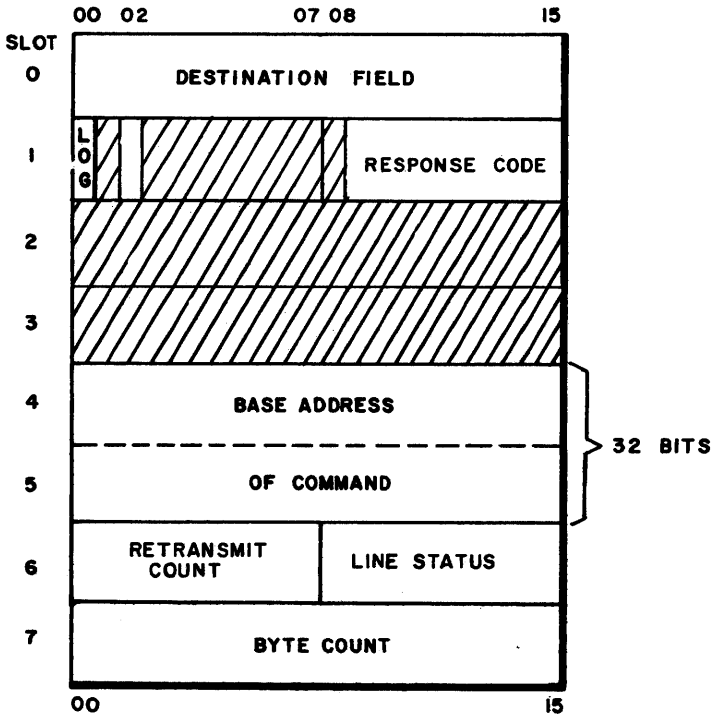


Figure 3-6. Normal Solicited Response to a Stream Request - Format 3

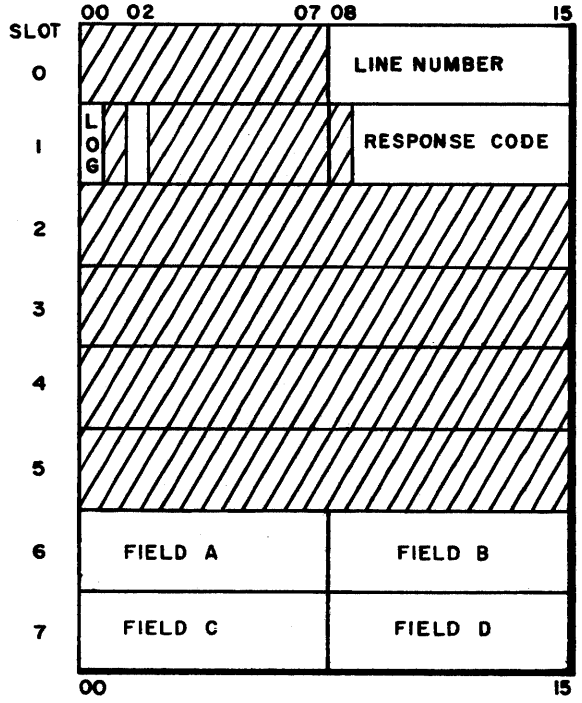


Figure 3-7. Abnormal Unsolicited Response - Format 4

TABLE 3-7. MODE 2 SOLICITED RESPONSE CODES AND DEFINITIONS

Code	Format	Associated Command	Definition
0-20			Not assigned.
21	3	80	Write stream x request (function code = 80) terminated normally with an ETB. Another buffer of data is required.
22	3	00, 81	Read/write stream x request terminated normally with an ETX. This file is complete.
23	2	F5	HLP request to configure line x is complete.
24	2	F2	HLP request to terminate stream x is initiated. Response code 28 will be given for this stream.
25			Not assigned.
26			Not assigned.
27			Not assigned.
28	3	0, 80, 81	Stream x request terminated abnormally.
29	2	All	Request rejected - illegal parameter.
2A	3	0, 80, 81	On threshold of buffer saturation. This request is rejected.
2B			Not assigned.
2C			Not assigned, line not opened successfully. The first request read for line was not open line request.
2D	2	All	Line not opened successfully. The first request read for line was not open line request.
2E			Not assigned.
2F			Not assigned.
61*	3		Read stream x request terminated normally with unsoliciated RTS.

*Solicited and unsolicited response.

TABLE 3-8. MODE 2 UNSOLICITED RESPONSE CODES AND DEFINITIONS

Code	Format	Definition
40	1	Response from line x - stream x has RTS. Read command required.
41	1	Response from line x - stream x idle.
42	1	Response from line x - stream x not available.
43	1	Response from line x - stream x has busy status.
44*	1	Line x errored out and is closing. All outstanding requests are terminated abnormally. HLP must issue a close line request.
45*	1	System had intermittent SAC rejects. Field A of response contains the current count.
46*	1	Buffer saturation. Line x is closing. HLP must issue a close line request.
47	1	Illegal stream identifier (SID) in status block. HLP must issue a close line request.
48*	1	CA malfunction. Line x is closing. HLP must issue a close line request.
49	1	Channel flag cleared.
4A		Not assigned.
4B		Not assigned.
4C	1	Remote terminal has initiated restart (it is rewinding its files). Line x is closing.
4D		Not assigned.
4E	1	Line x is closed.
4F		Not assigned.
50	1	Terminal has established communication with CSC. This line is no longer in idle poll state.
51-60		Not assigned.
61**	3	Read stream x request terminated normally with unsolicited RTS.

*Logged

**Solicited and unsolicited response

TABLE 3-9. MODE 3 SOLICITED RESPONSE CODES AND DEFINITIONS

Code	Format	Associated Command	Definition
0-20			Not assigned.
21	3	Write (function code 80)	The output is complete.
22	3	Write (function code 81)	The associated read or write command has terminated.
		ReadTI (function code 01)	This response has no inherent meaning to the CSC for subsequent input/output operations.
		Read (function code 00)	In the case of output operations, the response implies the entire buffer has been transmitted; in the case of input operations, the response implies the message terminated with carriage return.
23	2		Line open. This response is sent to HLP upon receiving configure command.
24			Not assigned.
25			Not assigned.
26			Not assigned.
27			Not assigned.

TABLE 3-9. MODE 3 SOLICITED RESPONSE CODES AND DEFINITIONS (Cont'd)

Code	Format	Associated Command	Definition
28	3	Close	This response indicates that a stream is abnormally terminated. This results from a close command or from a forced closing of a line by the CSC.
29	3	All	This command is unrecognizable and/or the command contained illegal values.
2A	3	All	The initial buffer pool in the CSC has reached a threshold level. This request is rejected.
2B			Not assigned.
2C			Not assigned.
2D	2	All	Line failed to open. The first request for this line was not an open line request.
2E			Not assigned.
2F-3F			Not assigned.
61*	3	Read (function code 00) and READTI (function code 01)	The TTY input stream terminated normally with LF as the last character.

* Solicited and unsolicited response

TABLE 3-10. MODE 3 UNSOLICITED RESPONSE CODES AND DEFINITIONS

Code	Format	Associated Command	Definition
40-43			Not assigned.
44*			Line x errored out and is closing because of lost data condition. Repeated efforts to input the line failed. Any outstanding request is abnormally terminated.
45*	4		The CSC experienced intermittent SAC rejects.
46*	4		System buffers are saturated. Line x is closing. HLP must issue a close line request.
47			Not assigned.
48*			The communications adapter connected to this line is malfunctioning. Line x is closing. When closed, response code 4E is sent to the HLP. Response code 28 is also sent to the HLP if a stream command is terminated. HLP must issue a close line request.
49	1		The channel flag is cleared. This occurs when the scan of the line list is complete during the open procedure or when the suspend command is cancelled.
4A-4D			Not assigned.
4E	1		Line x is closed. This response is returned following either a close command or forced line closing caused by an abnormal condition. If stream commands are active when line x is closing, they are terminated. Response code 28 is returned for each stream so terminated.
4F			Not assigned.
50	1		The CSC has answered a call on TTY line x. This response is sent when the data set ready lead from the modem is on and occurs with either a switched or a dedicated line. The line is prepared for an unsolicited keyboard input operation.

*Logged

TABLE 3-10. MODE 3 UNSOLICITED RESPONSE CODES AND DEFINITIONS (Cont'd)

Code	Format	Associated Command	Definition
51	1		X-OFF is received from the paper tape reader and there is an input for 0.2 second. It is assumed that tape motion has stopped. If a read command is active and the X-OFF did not occur with data, the read command is not terminated and is used for subsequent keyboard inputs.
52	1		EOT is detected; otherwise, it is assumed that tape motion has stopped (refer to X-OFF).
53-57			Not assigned.
58	1		The receive carrier lead from the modem indicates that a carrier signal is not being received. Line x is closing. When line x is closed, response code 4E is sent to the HLP. Response code 28 is also sent to the HLP if a stream command is terminated.
59	1		The data set ready lead from the modem is off. The call has been disconnected and line x is closing. When line x is closed, response code 4E is sent to the HLP. Response code 28 is also sent to the HLP if a stream command is terminated.
5A	1		One or more characters of the TTY message are lost because: 1. HLP did not supply an input buffer in time. 2. Internal CDC timing conflicts - the LOG flag is set in the response word. This is an informative response. No special recovery actions are required by the HLP because the CSC initiated retransmission of the message.
5B	1		An input is arriving on the indicated TTY line. The HLP must promptly issue a read command to define the receiving buffer.

TABLE 3-10. MODE 3 UNSOLICITED RESPONSE CODES AND DEFINITIONS (Cont'd)

Code	Format	Associated Command	Definition
5C	1	Write (function codes 80 and 81)	Interrupt received during output operation. The current output operation is terminated and the CSC prepares to receive data. Response code 28 is sent to the HLP for the terminated output command.
5D	1		The TTY input buffer filled before a CR or LF was encountered. The CSC spaces to the end of the message segment, discarding the remaining characters of the segment. Response code 28 is sent to the HLP if an input stream command is present.
5E-60			Not assigned.
61*	3	Read (function code 00) and ReadTI (function code 01)	The TTY input stream terminated normally with LF as the last character.

*Solicited and unsolicited response

RESPONSE CODE WORD BIT ASSIGNMENTS

The response code word is 16 bits in length. Bit 00 and bits 09, 10, and 12 of the 8-bit block allocated to the response code are dedicated to flagging the response and its operations. Bits 08-15 specify the unique solicited or unsolicited response code for mode 2 or mode 3.

NOTE

The shaded areas for Figure 3-8 are unused bits and should be filled with zeros.

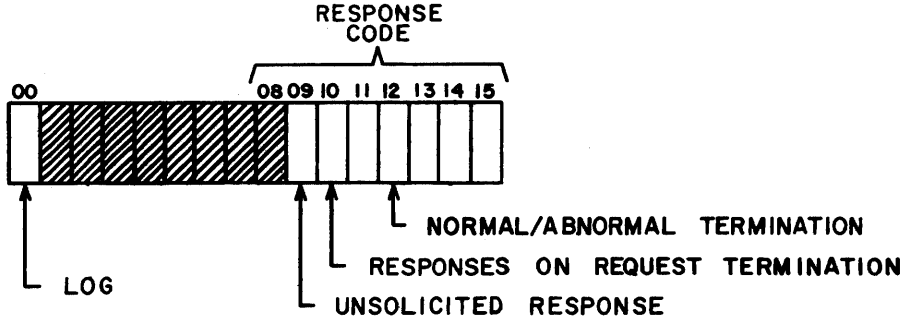


Figure 3-8. Response Code Word Bit Assignments

Bit 00 (Log) - A flag which indicates that specific conditions should be logged on an error file.

Bit 09 (Unsolicited Response) - This bit is set via an unsolicited response (one that cannot be directly associated with a request).

Bit 10 (Responses on Request Termination) - This flag is set via a response that is associated with a specific request.

Bit 12 (Normal/Abnormal Termination) - If this flag is set, an abnormal condition is indicated.

Bits 08-15 - The solicited/unsolicited response code specifying the status of the operation.

INTERFACE WITH REMOTE TERMINALS (MODE 2)

INFORMATION FLOW

The CSC and the remote terminal interface by trading blocks of information. The CSC is dominant; all trades are initiated by the CSC. There are three types of information trades: control block, alpha (α), and beta (β). The CSC (with type α and type β information trades merged) maintains two-way simultaneous, non-continuous information flow (refer to Figure 3-9 for a graphic description). The CSC always maintains this sequence of trades. Following every α transmission, the CSC transmits a β block, then an α block, then a β block, etc.

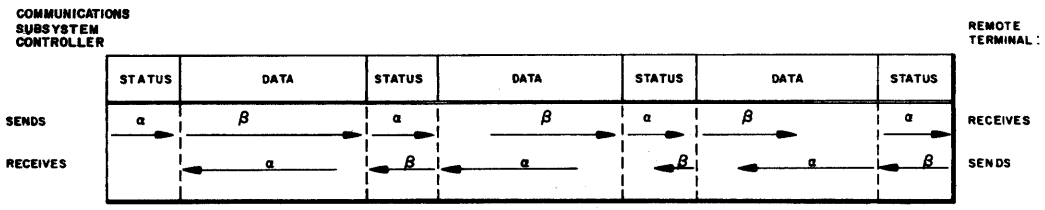


Figure 3-9. Two-Way Simultaneous, Non-Continuous Information Flow

CONTROL BLOCK INFORMATION TRADE

Control blocks are unique line-trades which are two-way alternate. Control blocks are outside the alpha/beta information trade; the trade of control blocks must occur before an alpha/beta communications trade is initiated, or after the trade is terminated. Control blocks carry different function codes or meanings.

Restart Function

Upon receipt of a restart control block by the remote terminal or the CSC, the alpha/beta numbers are reset to an even state, and any outstanding trades of information are negated. If the CSC is reautoloaded by the HLP when information is traded between the CSC and the remote terminal, the restart control block informs the remote terminal that the last data block was not accepted. Once the remote terminal acknowledges receipt of the restart control block, the CSC considers communications to be established and the trade of alpha/beta transmission blocks is initiated. The remote terminal must always acknowledge receipt of a restart control block by transmitting a restart control block back to the CSC.

Refer to Figures 3-10 through 3-12 for graphic descriptions of control block trades. An arrow denotes a block of information and its direction. Read the graphs from left to right.

ALPHA INFORMATION TRADE

Type α information trade consists of two information blocks. The CSC initiates the trade by transmitting a status block. After the complete block is received by the remote terminal, the remote terminal responds with a data block. An α status block contains stream control information which is used by the remote terminal to direct its activities. An α data block contains specific data (or text) which is associated with an input (odd number) stream destined for the HLP.

Refer to Figure 3-13 for a graphic description of an α trade. An arrow denotes a block of information and its direction. Read the graph from left to right.

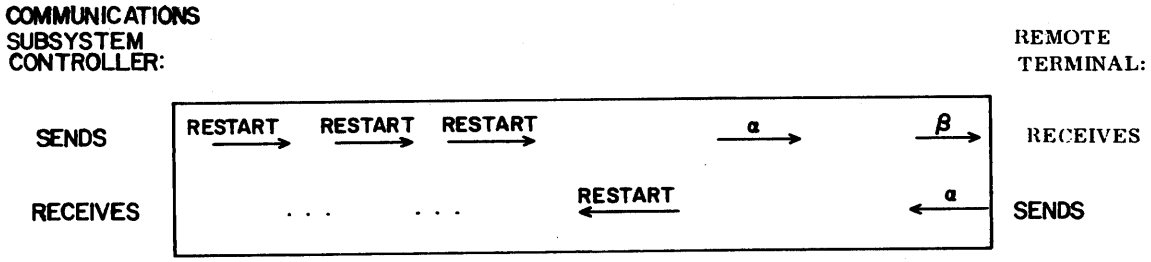


Figure 3-10. Idle Poll - CSC Initiates Restart in Dormant System

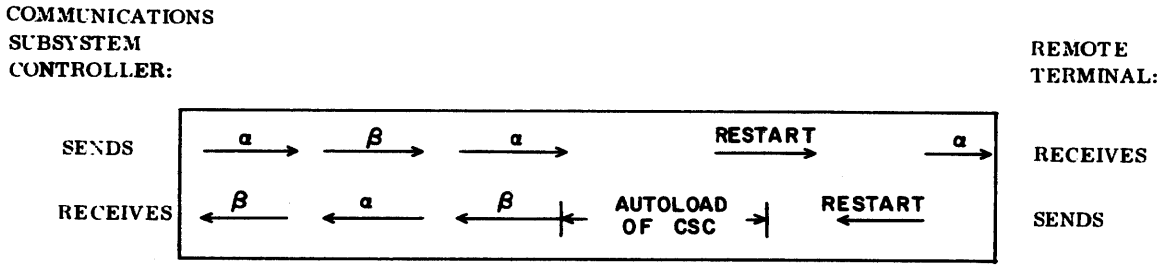


Figure 3-11. CSC Initiates Restart During α/β Information Trade

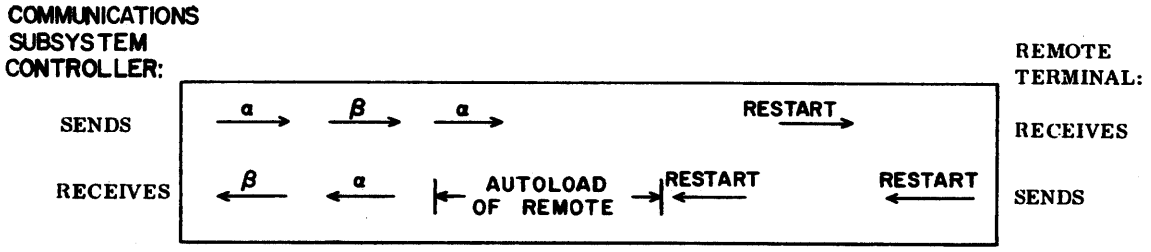


Figure 3-12. Remote Terminal Initiates Restart During α/β Information Trade

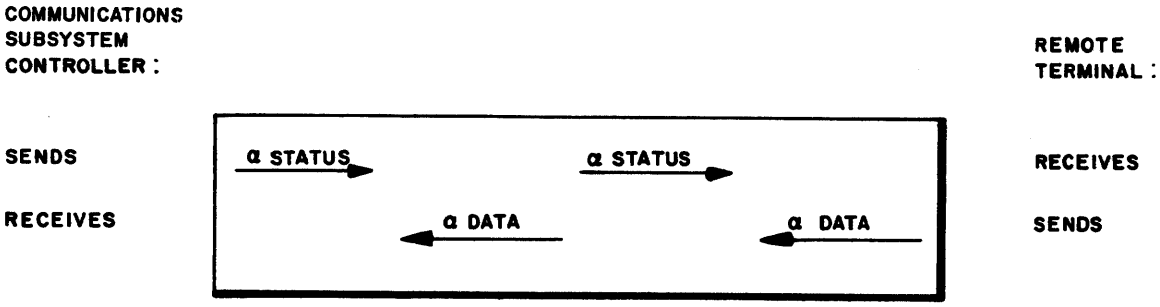


Figure 3-13. Alpha Block Trade

BETA INFORMATION TRADE

Type β information trade also consists of two information blocks. The CSC initiates the trade by transmitting a data block. After the complete data block is received by the remote terminal, the remote terminal responds with a status block. A β data block contains data (or text) which is associated with an output (even numbered) stream destined for the remote terminal. A β status block contains the status of streams in the remote terminal (that is, they are busy, they can accept data, etc).

Refer to Figure 3-14 for a graphic description of a β trade. An arrow denotes a block of information and its direction of flow. Read the graph from left to right.

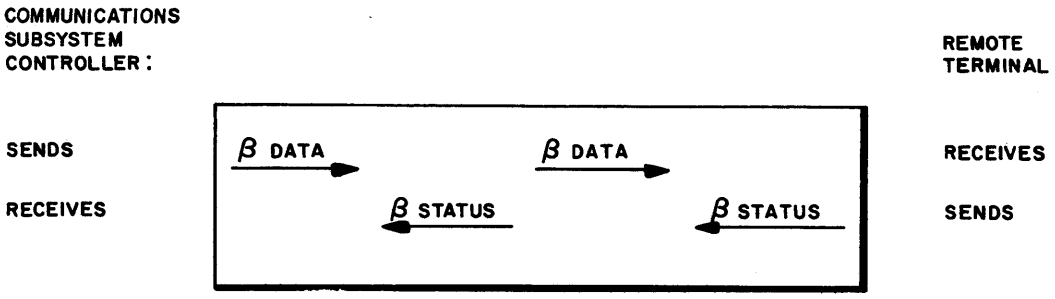


Figure 3-14. Beta Block Trade

If there is no information to trade but communication is to be maintained, the CSC and remote terminal send an idle block (a block with no data or status) in lieu of the data or status block (refer to Figure 3-15).

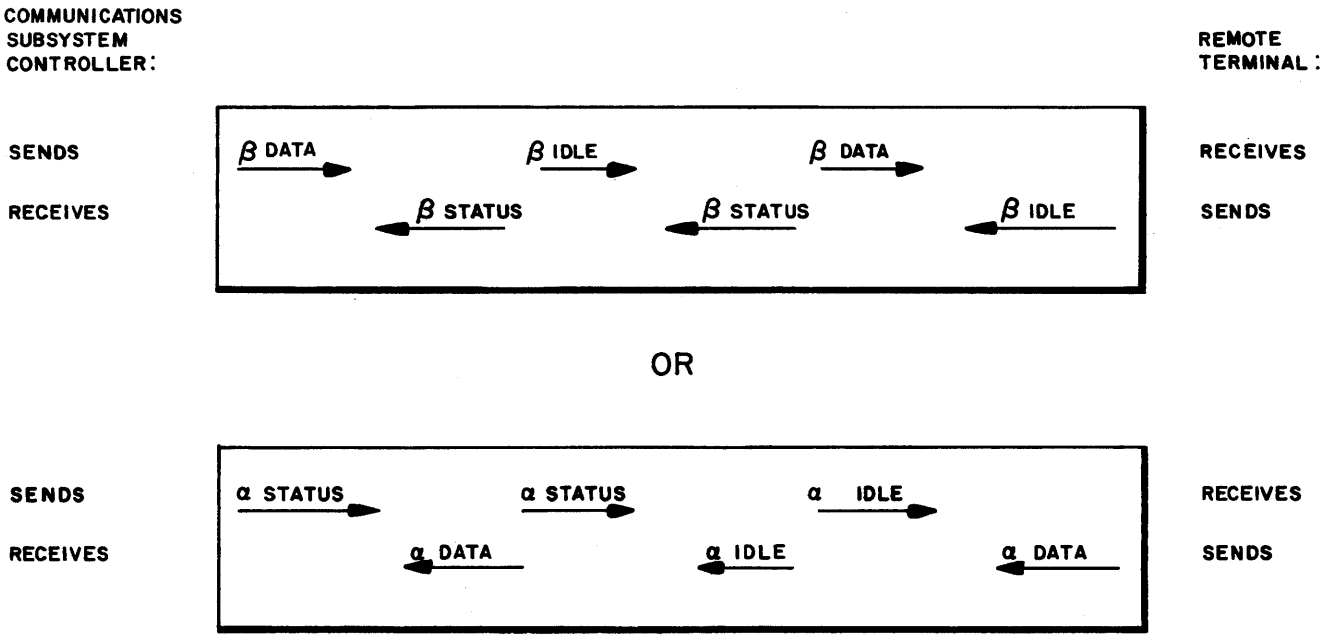


Figure 3-15. Idle Block Trade

SEQUENCE NUMBERS

Blocks are differentiated from each other by sequential numbers. Each transmitted block contains an even or odd sequence number. The even/odd numbers transmitted by the CSC for α type information blocks are the ASCII graphic characters p and q, and for β type information blocks are the ASCII graphic characters 0 and 1. The even/odd numbers anticipated by the CSC in the responding blocks sent by the remote terminal for α type information blocks are the ASCII characters 0 and 1, and for β type information blocks are the ASCII characters p and q (refer to Figure 3-16 for a graphic description). If the responding block number is not correct, the CSC initiates line error recovery procedures.

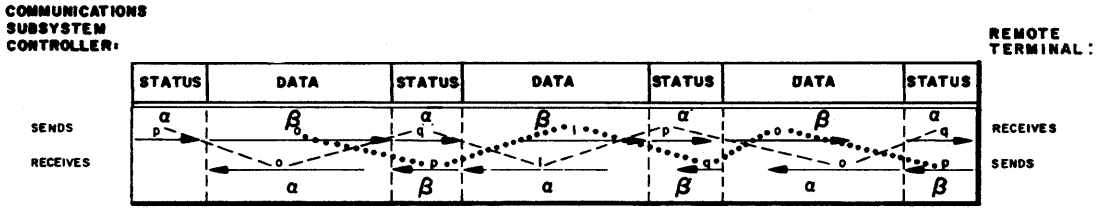


Figure 3-16. ASCII Even/Odd Character Sequence

TYPES OF TRANSMISSION BLOCKS

There are two types of transmission blocks: information blocks and error information blocks. There are two types of information blocks: data information blocks and status information blocks. Data information blocks contain data which is associated with streams destined for the HLP or remote terminal. Status information blocks contain stream information only. These blocks are the conversation media used by the CSC and the remote terminal to coordinate their activities.

There are also two types of error information blocks: repeat blocks (REP: x/y) and negative response blocks (N). The repeat blocks are sent by the CSC to the remote terminal to inform the remote terminal it must retransmit a block. The negative response block is sent by the remote terminal to the CSC to inform the CSC that the remote terminal could not accept the last information block sent by the CSC (refer to Figures 3-17 and 3-18 for a graphic representation of the N/REP blocks).

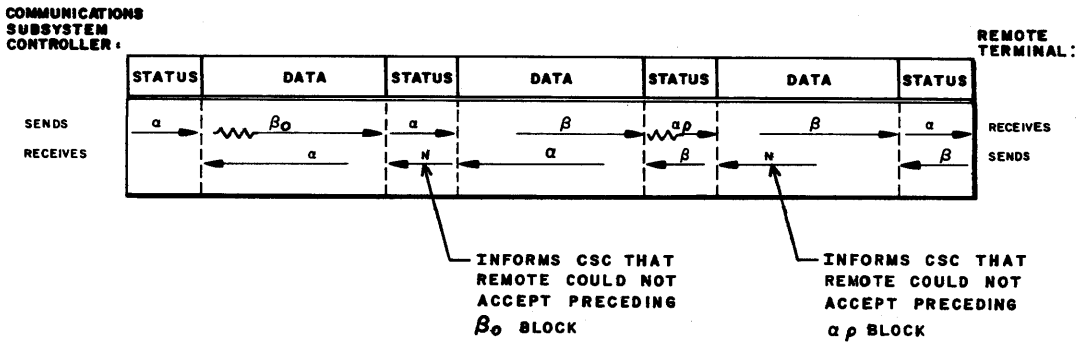


Figure 3-17. N Response Sequence

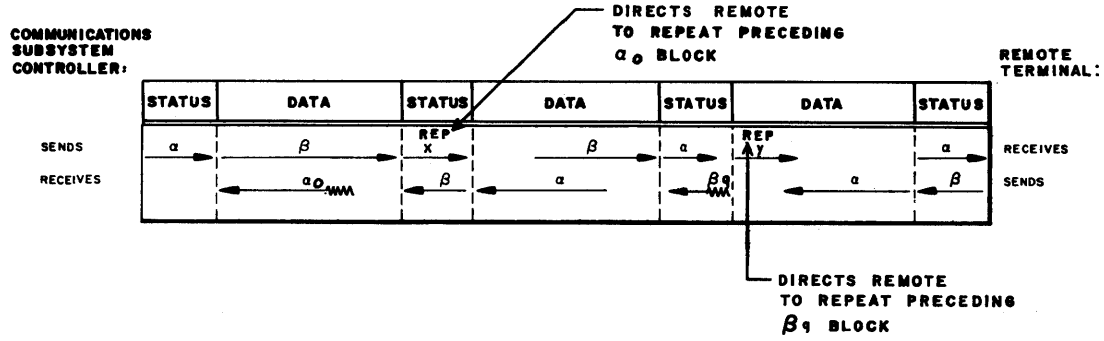


Figure 3-18. REP Response Sequence

FORMAT OF BLOCKS

Information blocks/error information blocks are comprised of a combination of the following fields: opening delimiters, control information, data framing control character sequence, data characters, closing delimiters, cyclic redundancy check, and/or control block code.

- Opening delimiters. All blocks must have opening delimiters. This sequence of ASCII characters defines the beginning of a transmission block.
- Control information. All information blocks and control blocks contain control information. Control information is comprised of stream identifiers or a control block code.
- Data framing control character sequence. All data information blocks have data text or routing information) framed with an ASCII control character sequence.

- Data characters. 8-bit bytes of data.
- Closing delimiters. All blocks must have closing delimiters. This sequence of ASCII characters defines the end of a transmission block.
- Cyclic redundancy check. All blocks must contain this field. It consists of two 8-bit bytes.
- Control block code. Restart function 01.

INFORMATION / ERROR INFORMATION BLOCKS

Each variation of block type has a unique combination of the above specified fields (refer to Figures 3-19, 3-20, and 3-21 for examples of these combinations in an information flow).

Information Blocks

Data Blocks:

Opening delimiter - DLE, α XSN or DLE, β XSN
Control information - One SID only with YY status: data
Data framing control character sequence - TSTX (DLE, STX)
Data characters - 8-bit data characters
Closing delimiter - TETB (DLE, ETB) or TETX (DLE, ETX)
Cyclic redundancy check characters

Status Blocks:

Opening delimiter - DLE, α XSN or DLE, β XSN
Control information - A variable number of SID's

Example:	S	S	S	S	S	S	S
	I	I	I	I	I	I	I
	D	D	D	D	D	D	D
	0	1	3	4	5	8	N
	RTS	CTS	CTS	RTS	IDLE	RTS	-

Closing delimiter - ETB
Cyclic redundancy check characters

Idle Blocks:

Opening delimiter - DLE, α XSN or DLE, β XSN
Closing delimiter - ETB
Cyclic redundancy check characters

Control Blocks (Restart):

Opening delimiter - DLE, Z
Control block code - 01
Closing delimiter - ETB
Cyclic redundancy check characters

Error Information Blocks

Repeat Blocks:

Opening delimiter - DLE, α REP (x) or DLE, β REP (y)
Closing delimiter - ETB
Cyclic redundancy check characters

Negative Response Blocks:

Opening delimiter - DLE, N
Closing delimiter - ETB
Cyclic redundancy check characters

OPENING DELIMITERS

There are two types of opening delimiters for transmission blocks: A type for information blocks and a type for error information blocks.

Information Block Opening Delimiters - DLE, XSN (α/β) and DLE, CBCODE (Z)

DLE - ASCII communication control character (referred to as data link escape)

α XSN - Odd/even sequencing number for α type information trades. The CSC transmits the ASCII graphic characters p and q. The remote terminal responds with the ASCII graphic characters 0 and 1 (refer to Figure 3-16).

β XSN - Odd/even sequencing number for β type information trades. The CSC transmits the ASCII graphic characters 0 and 1. The remote terminal responds with the ASCII graphic characters p and q (refer to Figure 3-16).

CBCODE - ASCII communication control character Z.

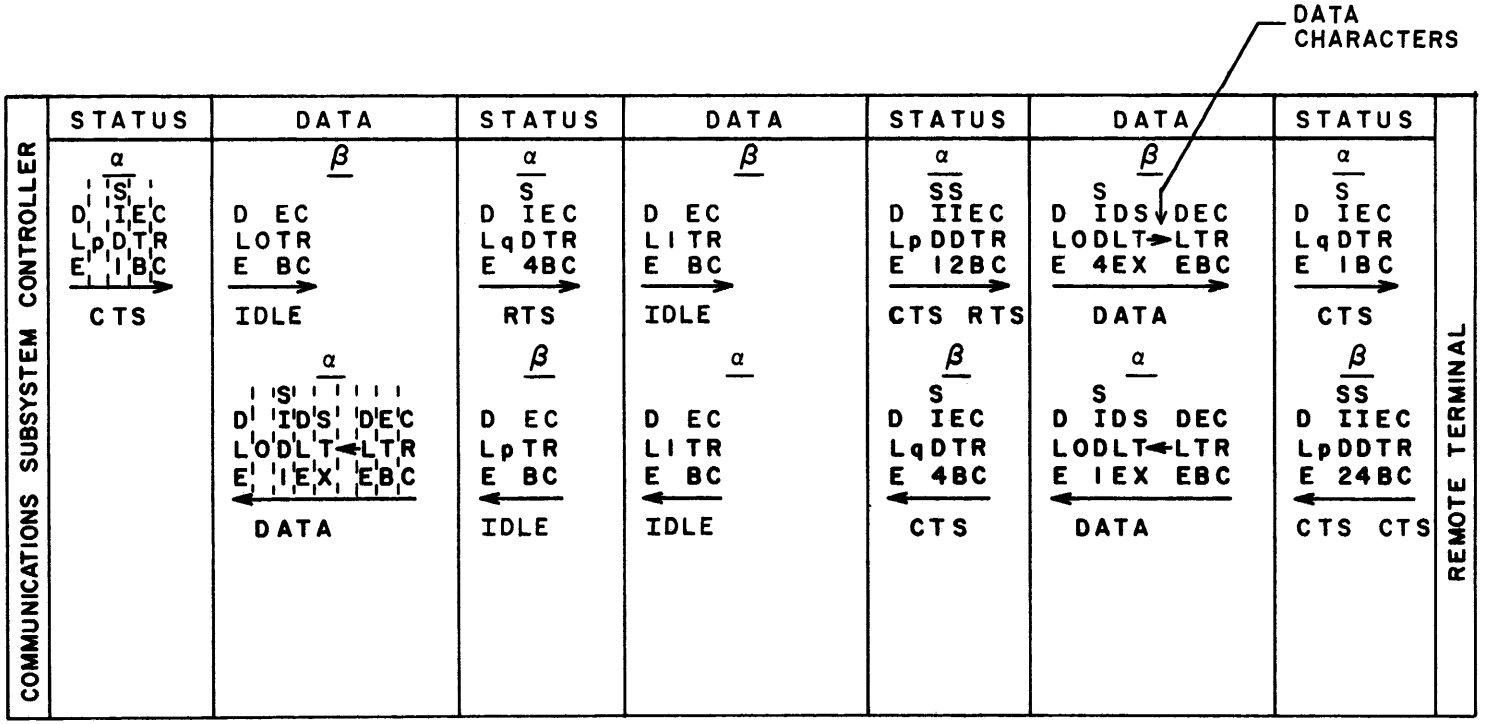


Figure 3-19. Data, Status, and Idle Blocks

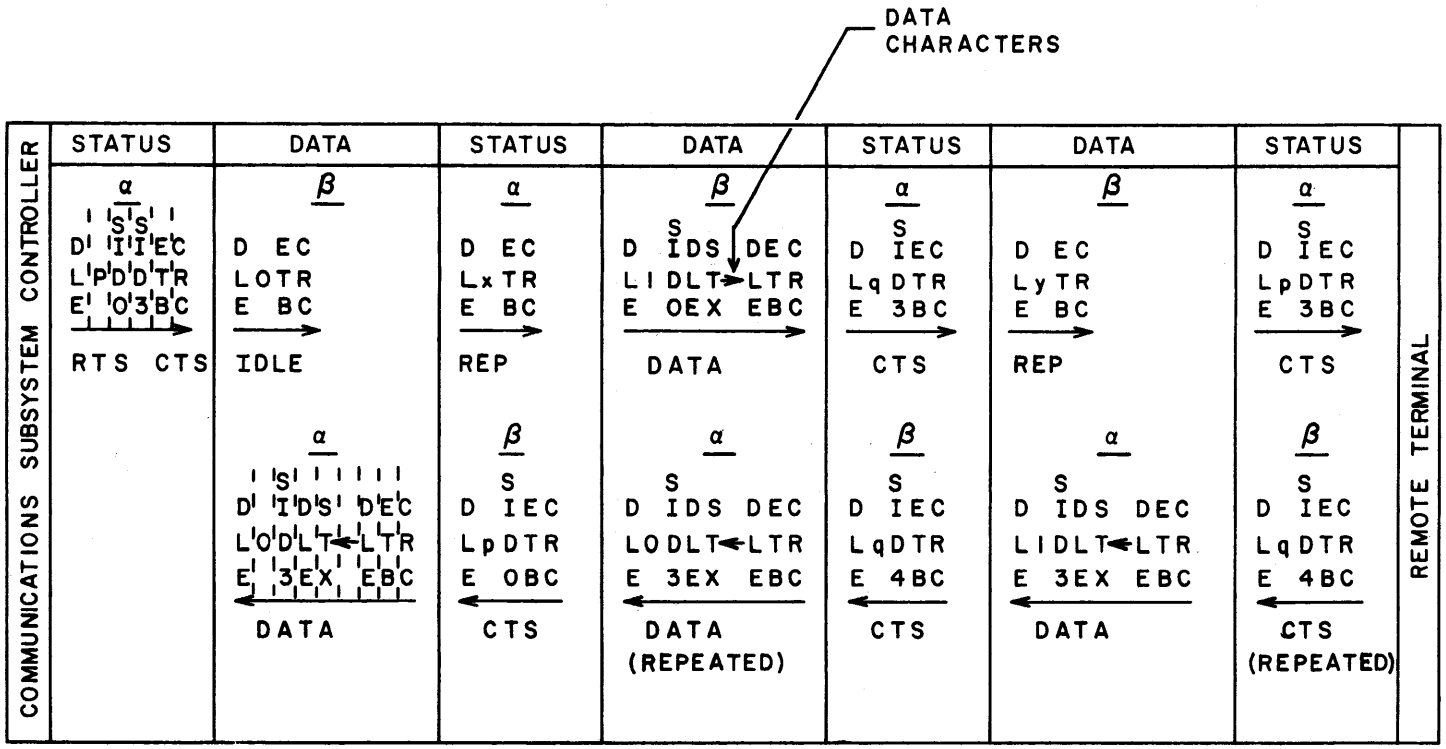


Figure 3-20. Data, Status, Idle, and REP Blocks

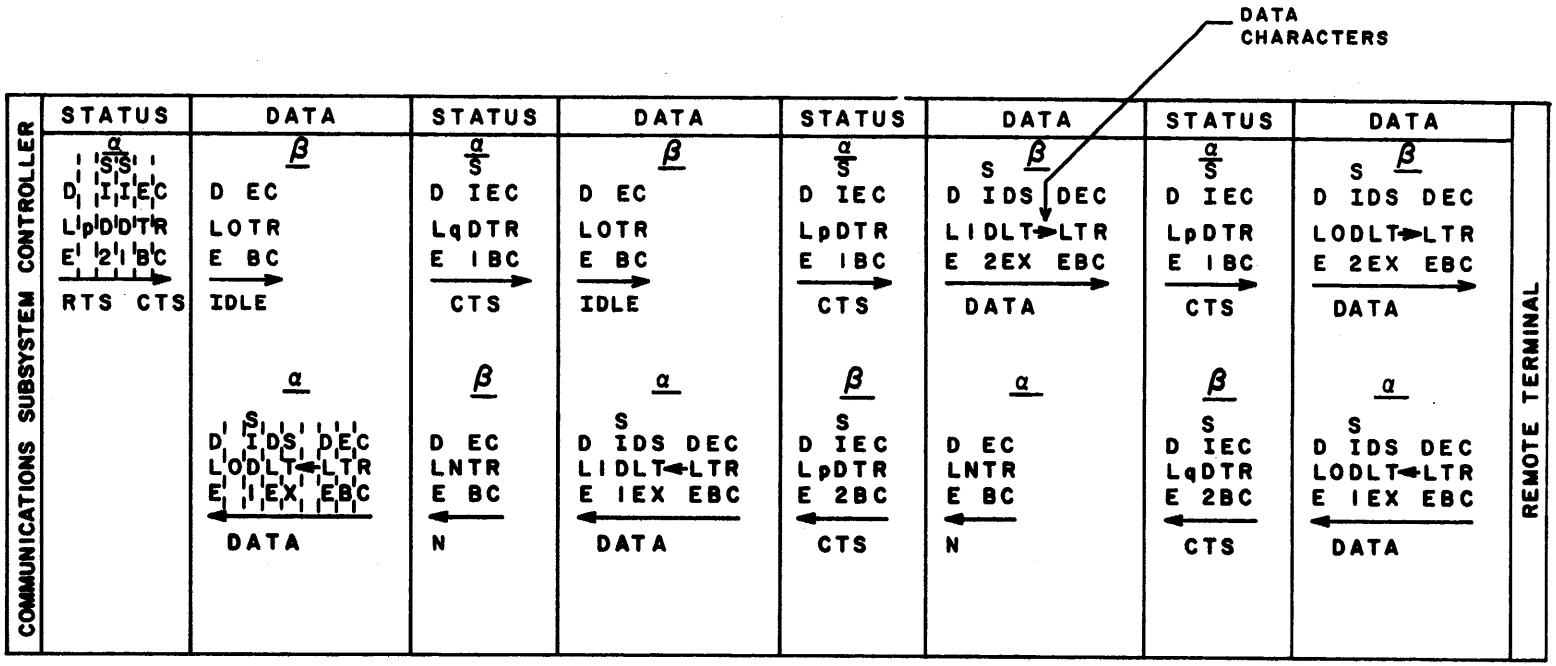


Figure 3-21. Data, Status, Idle, and N Blocks

Error Information Block Opening Delimiters

Two types of error information block opening delimiters are DLE, REP (α x/β y) and DLE, N.

DLE - ASCII communication control character referred to as data link escape.

REP - ASCII graphic character x in α type information trades and y in β type information trades. This opening delimiter indicates that this block is a REPeat block (refer to line error recovery description).

N - ASCII graphic character N. This opening delimiter indicates that the last message was not received correctly. See line error recovery description.

CONTROL INFORMATION

Station Control Information

Station control information is comprised of 8-bit bytes referred to as Stream IDentifiers (SID). Each SID contains the current status of a stream, along with its identifier. A SID has the following 8-bit format: P1XXXXYY.

P - Parity of the SID

1 - A flag which indicates that this is a SID (or noncommunication control character)

XXXX - Stream number of a source/sink path. Even numbered streams refer to output simplex paths from a source (buffer) in the HLP to a sink (buffer) in the remote terminal. Odd numbered streams refer to input simplex paths from a source (buffer) in the remote terminal to a sink (buffer) in the HLP. The maximum stream number is 15_{10} and the minimum stream number is 0 (that is, $0 \leq XXXX \leq 15$).

YY - Current status of this stream (Tables 3-11 and 3-12)

Control Block Information

Control block information is comprised of 8-bit bytes referred to as CBCODE. A CBCODE (ASCII graphic character Z) has the following 8-bit format: P1XXXXXX.

P - Parity of the code

1 - A flag which indicates that this is a CBCODE (or noncommunication control character)

XXXXXX - Actual code. The only defined code is 000001 (restart).

TABLE 3-11. YY BIT ASSIGNMENTS WHEN CSC IS TRANSMITTING

Input Stream (Odd Number)	YY	Output Stream (Even Number)
Clear to Send (CTS)	00	Request to Send (RTS)
-	01	Data
-	10	-
Abort Stream (AS)	11	Abort Stream

TABLE 3-12. YY BIT ASSIGNMENTS WHEN CSC IS RECEIVING

Input Stream (Odd Number)	YY	Output Stream (Even Number)
Request to Send	00	Clear to Send
Data	01	Busy
Source Idle	10	Sink Idle
Not Available (NA)	11	Stream Aborted (SA)

CTS - Clear to send. The stream sink is conditioned and ready to receive data from the source.

RTS - Request to send. The stream source wants to send data to the sink.

Data - The stream source is delivering the data (which follows) to the sink.

Busy - The stream sink is unable to receive data because it is currently occupied with previous data.

Idle - The source/sink is idle. There is no activity; however, it is not yet prepared to send/receive data.

NA - Not available. The source/sink is not available for any activity. Example: Remote terminal sink (such as a printer) is down.

AS - Abort stream. The CSC is terminating the current operations of this stream. Example: The HLP is down, or the HLP has terminated the stream.

SA - Stream aborted. The terminal completed abortion of output stream.

DATA FRAMING CONTROL CHARACTER SEQUENCE

Data information blocks alone contain the ASCII transparent data framing control character sequence. This character sequence precedes the data. It identifies the following data as transparent (refer to Figure 3-22 for a graph of block formats). The data framing control character sequence is the following:

TSTX (DLE, STX) - Start of transparent text. This character sequence denotes the end of station control information. It also delimits the start of transparent text (data) in a block. The data characters which follow are 8-bit bytes with no parity.

CLOSING DELIMITERS

All blocks must have a closing delimiter. The closing delimiters are the following ASCII control characters.

ETB - End of this transmission block. This character is used only on status, idle, or control blocks.

TETB (DLE, ETB) - End of transparent text for this transmission block. This sequence is used only on data blocks. Additional transparent text for this stream is pending.

TETX (DLE, ETX) - End of transparent text for this transmission block and for this message or file. This sequence is used only on data blocks.

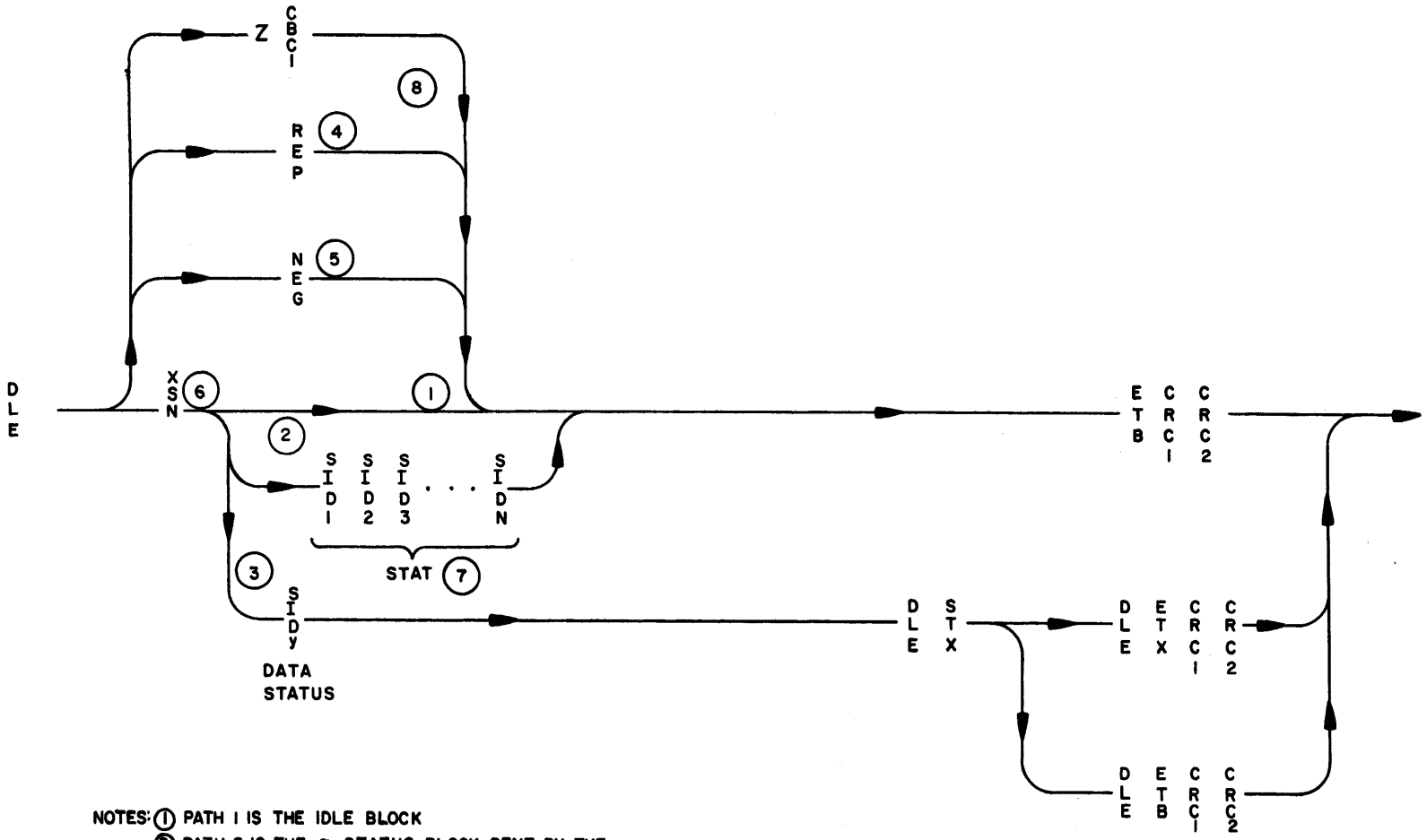
CYCLIC REDUNDANCY CHECK CHARACTERS

Two CRC bytes are accumulated at both the sending and receiving terminals during the transmission of a message to facilitate error detection. They are transmitted following the closing delimiters of blocks. The accumulation begins immediately after the first opening delimiter character (DLE) of a block is detected. All characters except SYN and TSYN transmitted after the accumulation begins are included in the accumulation, through and including the end-of-block or end-of-text (TETB or TETX) delimiter. The CRC bytes (CRC1 and CRC2) are transmitted following the end-of-block or end-of-text delimiter. The accumulation is reset and restarted with the detection of the opening delimiter of the following transmission block.

Characters which are excluded from the accumulation are as follows:

1. SYN* characters (synchronization characters detected after the opening delimiter and before the TSTX)
2. TSYN characters (DLE, SYN) detected after the opening delimiter.
3. One DLE character from the DLE sequences detected in the transparent text. All ASCII control characters use bit 8 for character parity. Transparent text uses bit 8 for data, thus providing 256 bit combinations in each byte. The data link escape character introduces the transparent text transmission and subsequently distinguishes the control character bit configurations which are present in the data

* 8-bit sync character (00010110) used by CSC for sequencing data bytes.



NOTES: ① PATH 1 IS THE IDLE BLOCK

② PATH 2 IS THE α STATUS BLOCK SENT BY THE CSC TO THE REMOTE, OR IT IS THE β STATUS BLOCK RESPONSE SENT BY THE REMOTE TO THE CSC.

③ PATH 3 IS THE β DATA BLOCK SENT BY THE CSC TO THE REMOTE, OR IT IS THE α DATA BLOCK RESPONSE SENT BY THE REMOTE TO THE CSC.

④ PATH 4 IS THE REPEAT BLOCK SENT BY THE CSC TO THE REMOTE (ASCII CHARACTER x OR y)

⑤ PATH 5 IS THE NEGATIVE RESPONSE BLOCK SENT BY THE REMOTE TO THE CSC.

⑥ XSN= TRANSMISSION SEQUENCE NUMBER (α OR β)

⑦ STAT = STREAM STATUSyy

⑧ PATH 8 IS THE CONTROL BLOCK SENT BY EITHER THE REMOTE OR THE CSC (TWO-WAY ALTERNATE). Z IS THE CHARACTER WHICH DENOTES THIS BLOCK AS A CONTROL BLOCK AND CBCI IS THE RESTART FUNCTION.

Figure 3-22. Block Format Train-Graph

stream. Once within the text (subsequent to a DLE, STX), control characters are recognized as such only when immediately preceded by a DLE character.

To preclude data simulation of this sequence, the procedure is as follows: The transmitting terminal monitors the data stream. When the bits within a byte-position duplicate the DLE bit configuration, an additional DLE character is inserted into the stream and follows it with the data DLE character. The receiving terminal interprets the DLE, DLE character sequences as representative of a single data byte with a bit configuration identical to that of the DLE character. To summarize, transmitting terminals add DLE's and receiving terminals delete DLE's to preserve the integrity of legitimate control character sequences.

The transmitting station and the receiving station both have hardware cyclic encoders, storage areas, and input/output channels for developing portions of the cyclic redundancy check character which monitors transmitted blocks for errors. The transmitting station develops two 8-bit bytes (CRC1 and CRC2) for the receiving station to use during its final two encodings to produce the code which indicates an errorless transmission or one that needs to be retransmitted because of error. The receiving station always indicates the error and notifies the transmitting station to retransmit the block in error.

See sections 2, 4, and 5 of the Local Communications Controller Customer Engineering Manual for a detailed description of the cyclic encoder which develops the cyclic redundancy check characters for transmitted blocks.

LINE ERROR RECOVERY RESPONSES

The CSC initiates a timeout feature of X milliseconds after a transmission block (the value is set by the CSC at system initialization via a configuration definition request). If the value X is reached before a valid response is received from the remote terminal, the CSC initiates a line error recovery procedure.

The remote terminal receives transmission blocks from the CSC in one of three conditions.

1. Valid and correct. A valid and correct transmission block is one that has no character parity error or CRC error.
2. Valid and incorrect. A valid and incorrect transmission block is one that has a character parity error or a CRC error.
3. Invalid. An invalid transmission block is one whose opening delimiter (DLE, α XSN/β XSN) and closing delimiter (ETB/ETX) are not recognized as being in a proper format.

A response to a transmission block depends on the condition and content of the block, as shown in Table 3-13. Figures 3-23 through 3-28 show error recovery information flow.

TABLE 3-13. RESPONSES TO TRANSMISSION BLOCKS

Remote Terminal Receives	Remote Terminal Responds With
1. Valid and correct block with:	
a. Data or status block in proper sequence	1. A new data or status block with an updated sequence number. The responding block number is the expected block number.
b. Data or status block in improper sequence	A repetition of the last correct data or status block, if the corresponding block number is not correct.
c. Repeat request block (REP)	A repetition of the last correct data or status block
2. Valid and incorrect block	2. A negative response block (DLE, N, ETB, CRC)
3. Invalid block	3. No response
CSC Receives	**CSC Responds With**
1. Valid and correct block with:	
a. Data or status block in proper sequence	1. A new data or status block with an updated sequence number
b. Data or status block in improper sequence	A transmission of the last correct data or status block
c. Negative response (N)	A transmission of the last correct data or status block
2. Valid and incorrect block	2. A repeat block (DLE, REP, ETB, CRC)
3. Invalid block or no response	3. A timeout and the last correct data or status block

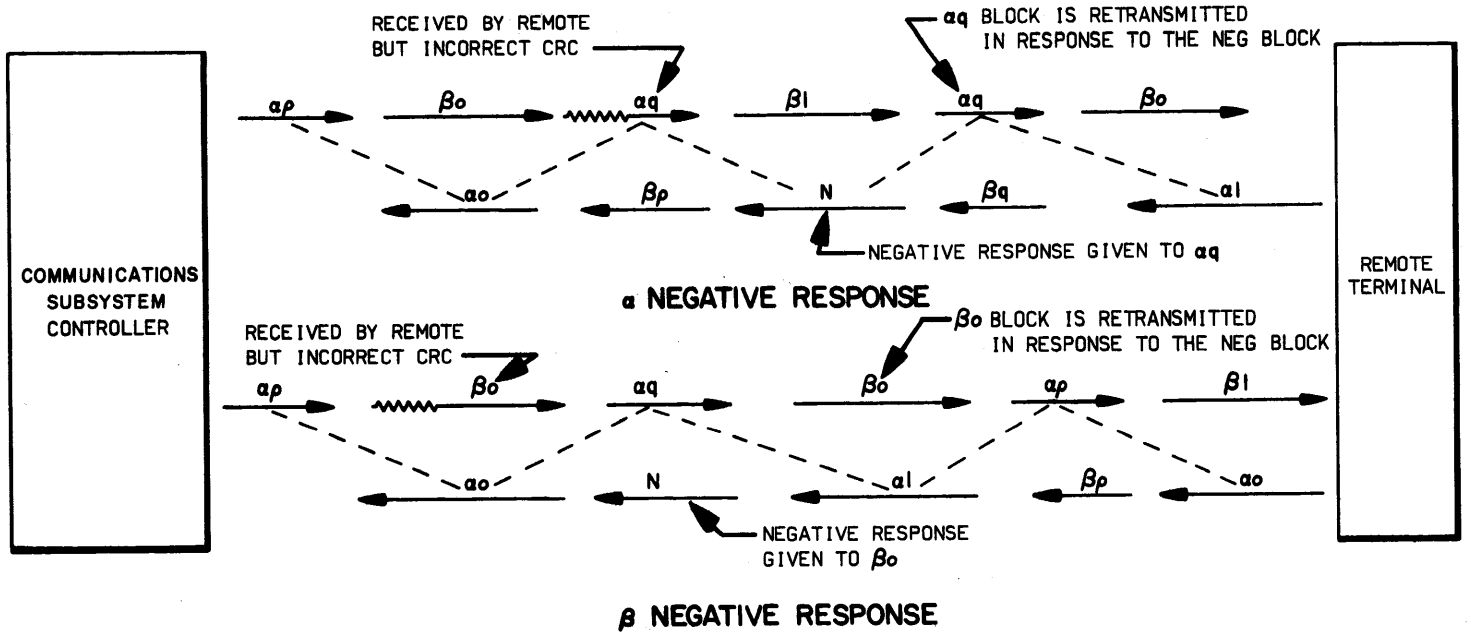


Figure 3-23. Error Recovery Information Flow

α/β Valid and Incorrect Blocks with Negative Response

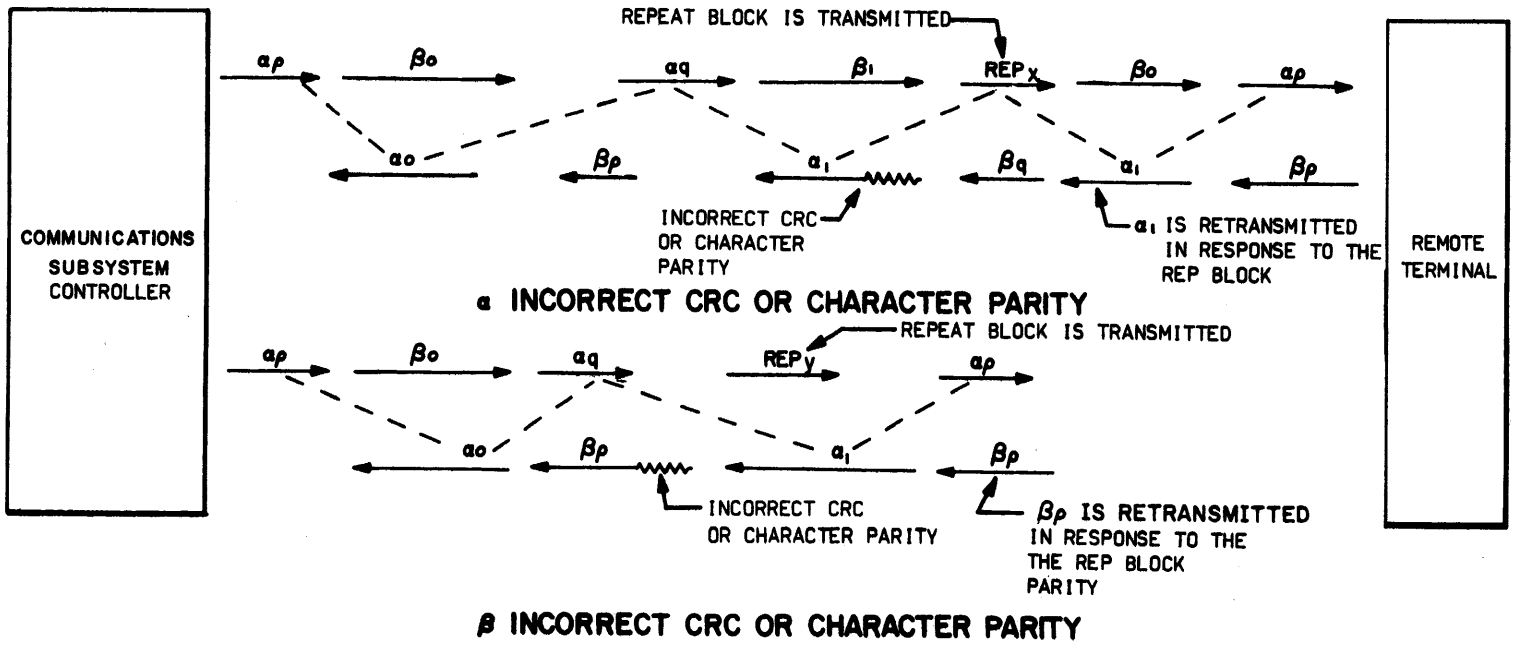


Figure 3-24. Error Recovery Information Flow

α / β Valid and Incorrect Blocks with Repeat Response

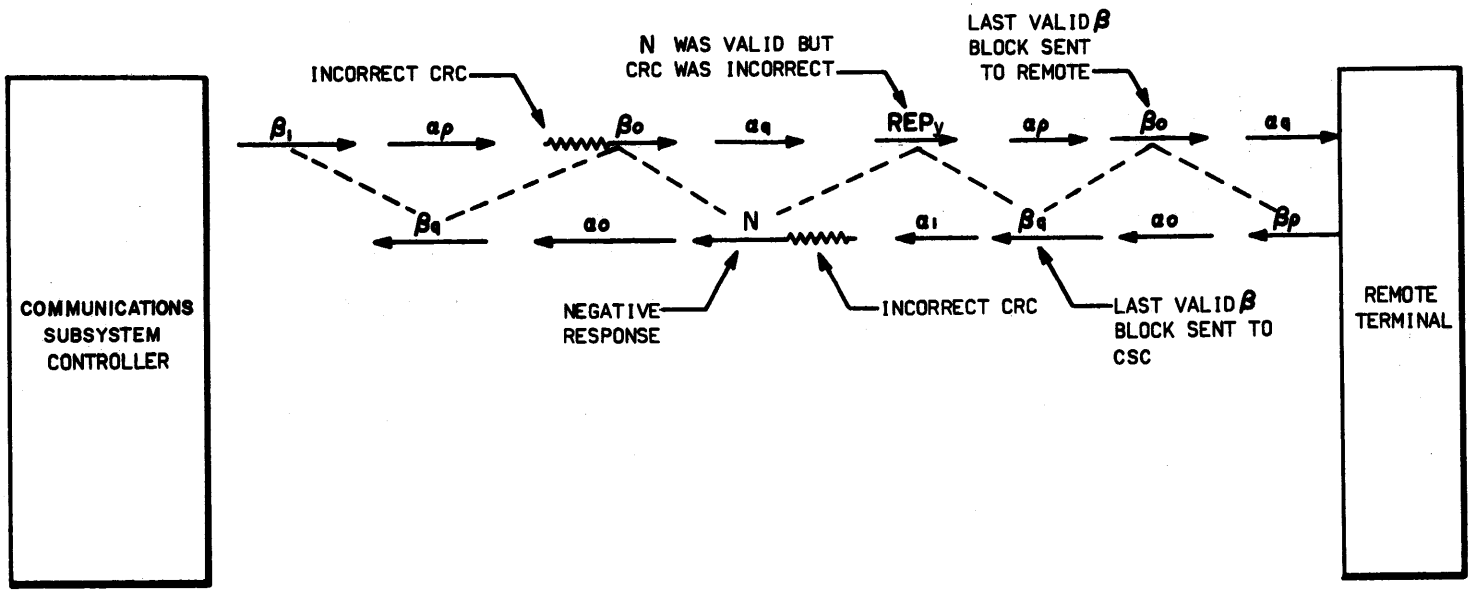


Figure 3-25. Error Recovery Information Flow

Valid and Incorrect Blocks
with Negative and Repeat Responses

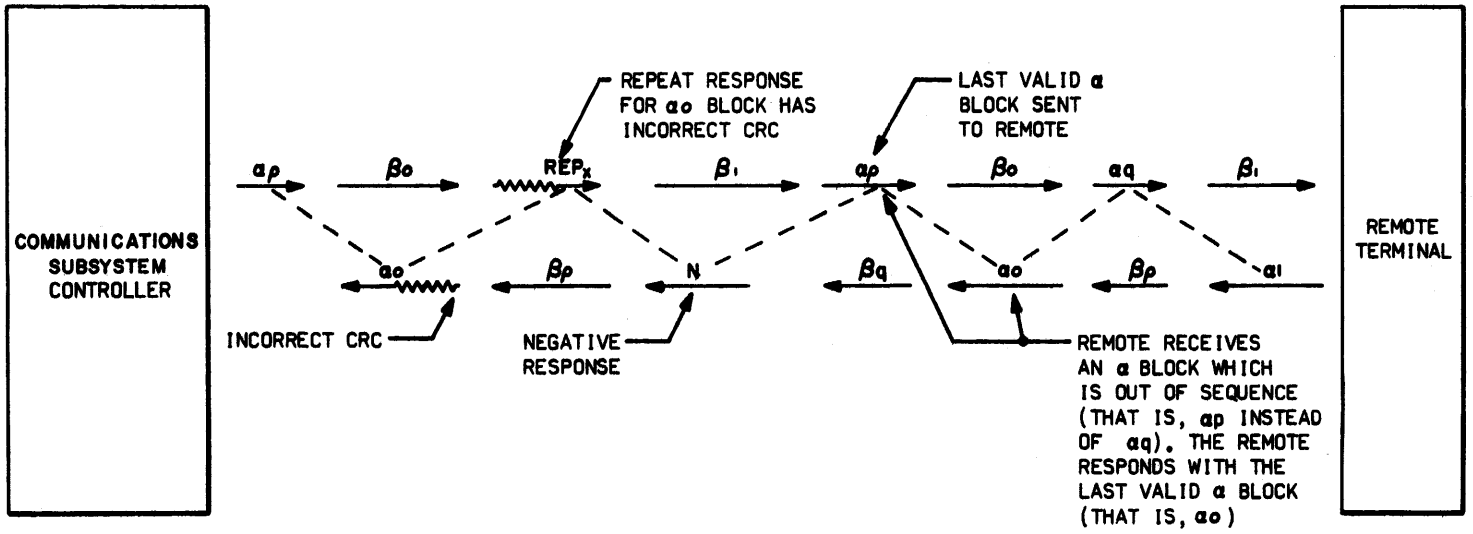


Figure 3-26. Error Recovery Information Flow
Valid and Incorrect Block
with Negative Response and Out of Sequence

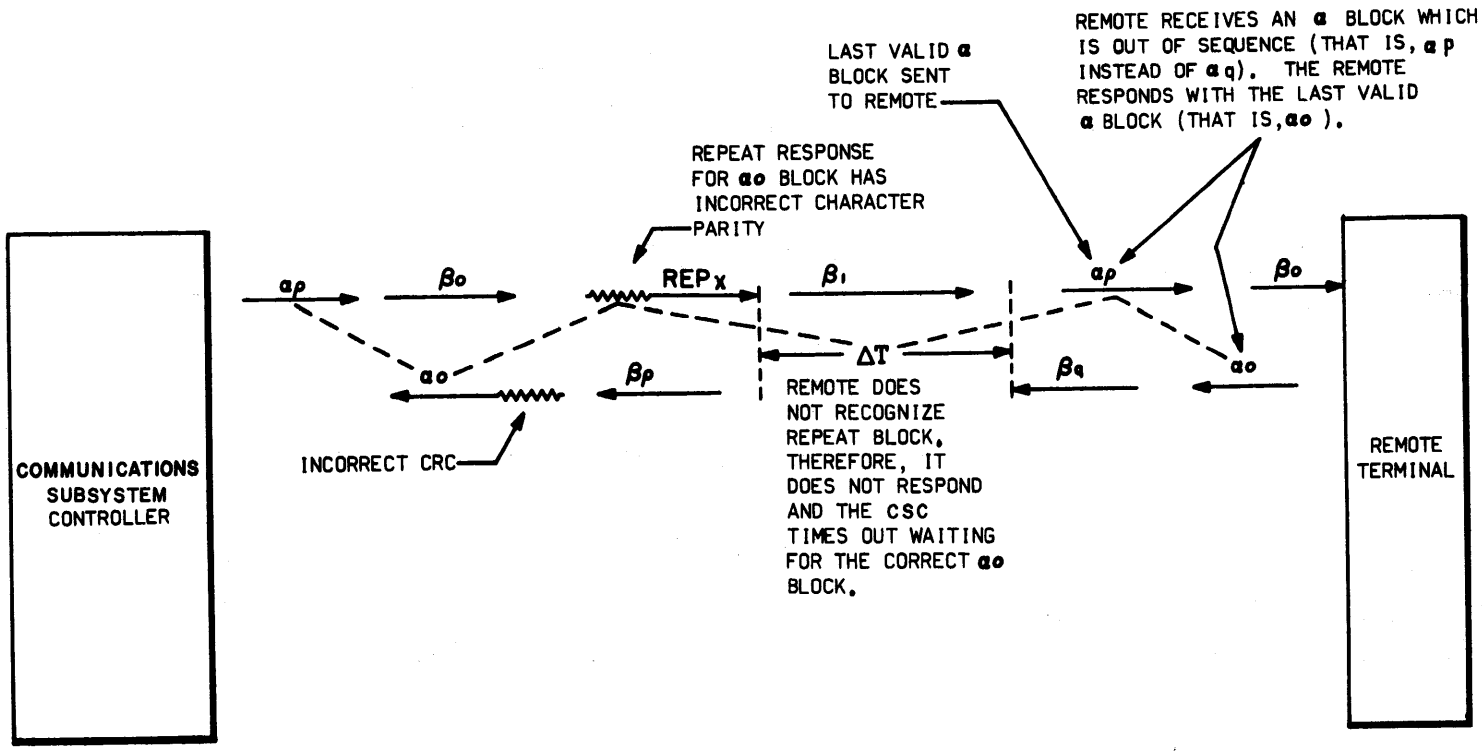
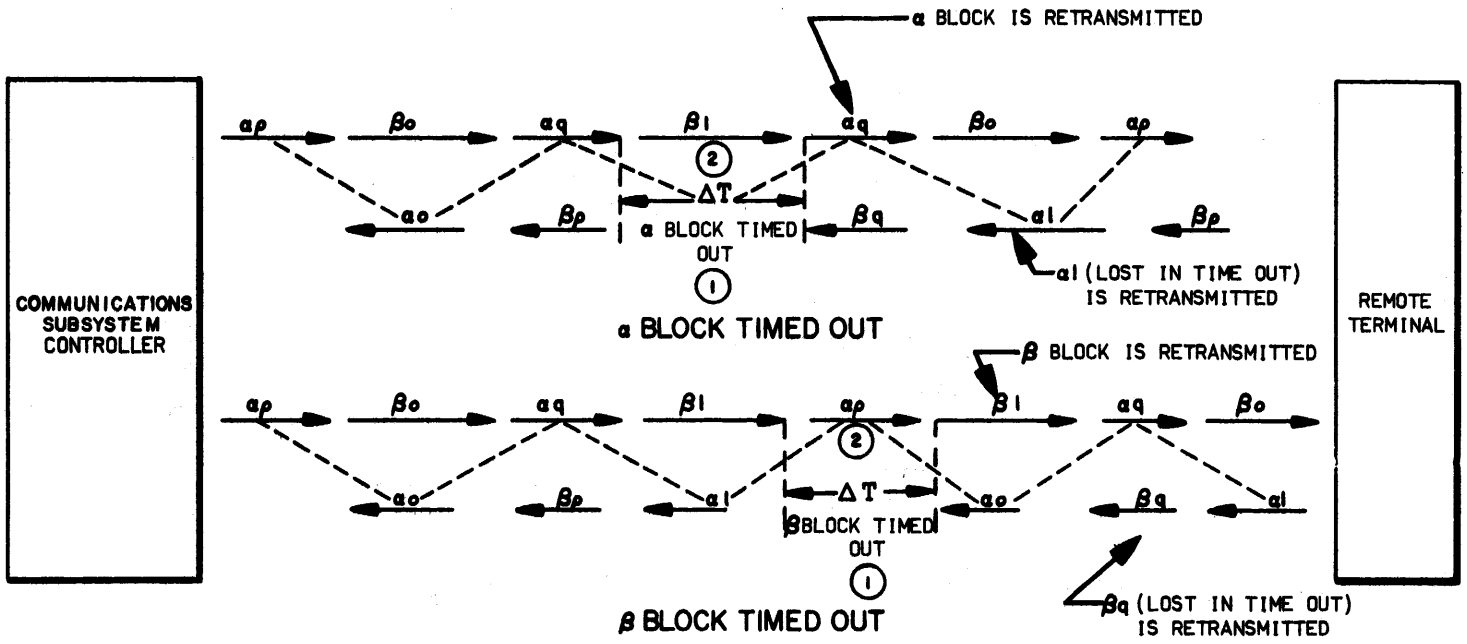


Figure 3-27. Error Recovery Information Flow

Valid and Incorrect Block with Repeat Response and Invalid or No Response Block with Time Out



NOTES: (1) "TIMED OUT" MEANS THAT THE TIME ALLOTTED TRANSMIT AN α/β BLOCK HAS ELAPSED AND A VALID TRANSMISSION HAS NOT OCCURRED.
(2) THE VALUE OF ΔT IS ESTABLISHED AT ASSEMBLY TIME.

Figure 3-28. Error Recovery Information Flow

α/β Invalid or No Response Blocks with Time Out

INTERFACE WITH REMOTE TERMINALS (MODE 3)

The operation of the teletypewriter (TTY) is very basic when compared to the mode 2 operation. There is a keyboard input and a graphic output. An optional form of input and output is paper tape. The TTY does not provide buffering or control over the transmission of characters. The operator provides the necessary control when interacting with the higher level processor.

INITIALIZATION

Prior to initiating operations, the CSC must be autoloaded. A 64-word autoload bootstrap program is sent across the compatible trunk channel from the HLP storage to the CSC storage. The bootstrap program then loads an initializer program from the HLP storage. The initializer program in turn loads the standard software program and constructs the necessary operation tables in the CSC. At this point, the CSC begins normal operations and awaits a channel flag from the HLP. Communication has not begun: The CSC is in a ready state.

KEYBOARD OPERATION

At some point in time after the autoload operation is complete, the HLP allows communications with a TTY terminal by opening a line. To open a dial-up line, a request list is constructed and its pointer is entered into the line list. When the channel flag is set, the CSC searches the line list and determines the location of the request list. The data terminal ready signal is sent to the modem, enabling the modem to automatically answer any incoming call. The CSC waits for a carrier on signal from the modem to indicate that a call is answered. The HLP is notified by a response of the change of conditions. The user can now use the resources of the TTY system. The HLP indicates this to the user by outputting a message which positions the carriage at the beginning of a new line.

As an example, assume that a user wishes to send a data file to the HLP which is greater than a predetermined buffer length. For example, if using 80 characters, the user would type in the first 79 characters of the data file and a line feed character. The CSC would respond with a carriage return to reposition the carriage to the beginning of the next line. The user then inputs the next 79 characters and a line feed. Again the carriage is positioned at the beginning of a new line. The user repeats this process until the last line of the data file, which he terminates with a carriage return so the CSC knows this is the end of the data file. The CSC responds to the TTY with a line feed to position the carriage at the beginning of the next line.

If a user types an incorrect character, he should immediately type a shift 0 character and follow it with the correct character. The HLP ignores the character preceding the shift 0. If several characters are in error, successive shift 0's (one for each character in error) should be typed.

NOTE

Characters on a previous line cannot be deleted by this method.

If a user wants to delete a large number of characters on a line, he should type in X^C (control X). All characters from the beginning of the line up to the X^C character are ignored by the HLP. The comments regarding shift 0 and X^C also apply when creating a paper tape.

ERROR CONDITIONS

During TTY operations, two possible error conditions may exist: lost data or buffer exceeded.

LOST DATA

There are three lost data conditions:

1. Internal buffer conflict during an input/output operation
2. Character lost on line during an input operation
3. Central storage cabinet data buffer address not received on time during an input operation

The CSC immediately outputs repeat line if any one of the above conditions occurs during a keyboard operation. If a paper tape operation is in progress and one of the preceding conditions occurs, the CSC waits until the paper tape motion stops and then outputs repeat line.

BUFFER EXCEEDED

When a buffer area is exceeded (buffer length + 1), the CSC notifies the HLP and spaces to the end of the record. It then accepts data again. The preceding is true for both keyboard and paper tape operations.

PAPER TAPE OPERATION

Assume that the TTY has paper tape capability. As an example, a user submits a program to the HLP via the keyboard. He then requests the HLP to compile it and punch it out on paper tape so it can be entered more easily at a later time. The user should turn on paper tape punch before CSC sends the program out to be punched. When the user wishes to resubmit the program via paper tape to the HLP, he types a message into the HLP indicating paper tape mode. The HLP issues a read TI command. The CSC outputs an X-ON to turn the paper tape reader on. Paper tape reading may then begin. When the CSC detects an X-OFF or EOT character, it times out for 0.2 second. If data does not arrive during this time, the CSC assumes that paper tape motion has stopped. Unless notified otherwise, all input after this timeout period is assumed to be from the keyboard. If data does arrive during the 0.2 second timeout interval, the HLP assumes that a new data file has begun. The user can terminate the paper tape input by turning the paper tape reader off. The CSC informs the HLP of this termination through an unsolicited response.

If the user is receiving output data on the TTY keyboard from the HLP, he may terminate this output by pressing any key on the keyboard.

NOTE

To avoid a possible line disconnection, the user should press a non-printing character to terminate an output operation.

Paper tape can be used in another way. The user can create a paper tape off-line and later submit it to the HLP when a line is open. In this case, shift 0 and X^C have the same meaning as for on-line keyboard input operations. Also, the message segments, excluding all control characters (LF, CR, X-OFF, and EOT) and DEL/NUL characters should not exceed 80 characters.

LF, CR, X-OFF, EOT, and DEL/NUL characters are not sent to HLP during both keyboard and paper tape inputs.

CLOSING A LINE

A line can be closed by either the user or the HLP.

USER

If a dial-up line is used, the user presses the TALK button, picks up the hand set, and replaces it on the telephone. The CSC detects that the line is disconnected and informs the HLP by an unsolicited response.

HLP

The HLP can send a command to the CSC to close a line on its own initiative or in response to a typed-in message from the user. In either case, all input operations are immediately cut off and the open line is closed and disconnected (if possible).

GLOSSARY

The definitions of terms in this glossary are general and are oriented toward their application to the communications subsystem controller: They should not be construed as absolute or applicable to all Control Data products.

ACTIVE LINE - A communications line which has an area in the higher level processor's storage dedicated to requests.

ACTIVE STREAM - A stream which has a valid request in a request list.

ALPHA DATA TRADE - See Contents for specific section of manual.

ASYNCHRONOUS - Having no fixed time base within or between signaling elements.

BETA DATA TRADE - See Contents for specific section of manual.

BLOCK - A transmission block is a group of bits, characters, or bytes that are transmitted on a line as an entity via line control.

BLOCK TRANSFER CHANNEL - A channel in the buffer controller which interfaces the buffered coupler, which in turn interfaces the 32-bit compatible trunk channel which is connected to the storage access controller input/output channels within the higher level processor system. The block transfer channel processes 16-bit, high-speed transfers of data between the buffer controller and the higher level processor.

BUFFER CONTROLLER - A 16-bit, parallel digital processor with a 200-nanosecond storage cycle time.

BYTE - 8 bits

CHANNEL FLAG - Communication between the higher level processor and the communications subsystem controller is initiated when the higher level processor sends a signal to the CSC via the trunk channel and a channel flag control code on the control lines. The channel flag indicates that the higher level processor requests that a line(s) be activated.

CHARACTER - An 8-bit byte. A member of a coded character set, the binary representation of such a member, and its graphic symbol or control function.

CLOSING DELIMITER - A character sequence which defines the end of a transmission block.

COMMAND - A command supplies detailed information to a station for proper execution of a request.

COMMUNICATIONS ADAPTER - A hardware module that interfaces a data set (or modem) with the normal channels. During input operations, the communications adapter assembles the serial bit stream furnished by the data set into 8-bit characters. During output operations, the communications adapter disassembles an 8-bit character for serial bit stream transmission.

COMPATIBLE TRUNK CHANNEL - A 32-bit major communications artery carrying messages simultaneously by means of time or frequency interface techniques. The trunk interfaces the buffered coupler (on the communications subsystem controller side) with the storage access controller (on the higher level processor side).

CORRECT TRANSMISSION - A transmission whose opening delimiter and closing delimiter are recognizable (that is, valid) and whose cycle redundancy check is errorless.

DATA - Those characters which comprise a message.

DATA FRAMING CHARACTER - A USASCII control character which delimits the data and indicates its transmitted mode (TSTX).

DATA LINK ESCAPE - A USASCII communications control character which introduces the transparent text transmission and distinguishes control character bit configurations which are present in the data stream.

DATA SET - A hardware modem which modulates/demodulates the data signals on a communications line.

DATA/STATUS BLOCK - A transmission block which contains stream identifiers only and their respective status.

DEMODULATER - A signal converter which accepts analog signals and converts them to digital signals.

DOMINANT - Stations on a line which initiate all activity. The subordinate must always reply to the dominant; the converse is not always true. The communications subsystem controller is dominant over the remote terminal (referred to as subordinate) but is subordinate to the higher level processor (referred to as dominant).

ENTRY SLOT - A dedicated area within a list where information is stored and used. For example, the first entry slot of each request list (bits 00-31) is dedicated to requests for communication between the higher level processor and the communications subsystem controller; the remaining entry slots are dedicated to streams.

EXERCISER - A pseudo-diagnostic which causes the communications adapter to loop as part of an error recovery procedure to determine whether an error condition is caused locally.

FRAMING CHARACTERS - Characters which bind a data block on both ends and define characteristics about the block.

FULL-DUPLEX - A hardware capability of transmitting and receiving simultaneously on a communications line.

FULL-DUPLEX CHANNELS - A pair of channels, one operating in each direction, allowing simultaneous information transmission in both directions.

INPUT STREAM - Input streams are the simplex flow of data which is received by the communications subsystem controller; that is, the communications subsystem controller inputs the block of data.

INTERPRETABLE RESPONSE - A response which has valid opening and closing delimiters; that is, ones which can be translated.

LINE - A data communication's channel and its control logic which is connected directly to a station.

MESSAGE - A logically related group of characters or bits which must be switched or processed as an entity by the data communications subsystem. A message consisting of a group of non-coded bits (binary) is a transparent message.

MESSAGE TRANSMIT TIME - The time required for transmitting a message from its point of origin to its point of destination in a system.

MODEM - A contraction of modulator/demodulator. A unit containing both a modulator and a demodulator.

MODULATOR - A device which changes the frequency of electrical waves by imposing upon them others of another, usually a lower, frequency. A signal converter which accepts digital signals and converts them to analog signals by modulating a carrier signal. The modulated analog signal must be suitable for transmission on a given circuit.

NON-CONTINUOUS - Every block which is transmitted (in one direction) must have a response before another block is transmitted in the same direction. The response temporarily discontinues the transmission.

NON-SWITCHED LINE - A communications line which has both ends connected point-to-point (the line does not go through a telephone switching network).

OFF-LINE - A remote terminal is off-line when it does not service a communications line but performs some external function.

OPENING DELIMITER - A sequence of characters which defines the beginning of a transmission block.

OUTPUT STREAM - Output streams are those simplex flow of data which are transmitted by the communications subsystem controller to the remote terminal; that is, the communications subsystem controller outputs a block of data.

POLL - A poll is a signal from the communications subsystem controller to the remote terminal which quizzes the remote terminal for activity.

POINT-TO-POINT - Two data sets only are connected on a communications line.

PREEMPTIVE PRIORITY - A request which is processed prior to all others, regardless of the time it enters a system.

REMOTE TERMINAL STATION - A subsystem that provides a user's interface to a system for the purpose of entering and obtaining information. It contains data and control logic, communication control elements, local storage, and input/output remote terminals.

REQUEST - A request is the leading part of a message sent to a station. The request contains a command which specifies the detailed information to be carried out by the station.

RESPONSE - A response is a message sent from a station to the operating system (higher level processor), usually in answer to a request. It provides information about a previous request to the higher level processor, or it notifies the higher level processor that an area needs attention.

ROTATE INTERNAL BUFFERS - Buffers are dynamically assigned from a "pool" of buffers; that is, a group of buffers sharing or allocated to a common interest.

SERIAL-BIT TRANSFER - A system of data transmission in which characters are sent bit-by-bit, in sequential order, over a single path.

SIMPLEX - Simple or uncompounded. Unidirectional, as in a communications line in which data flows in only one direction, irreversibly.

SINK - The receiver of data.

SOURCE - The sender of data.

STATION CONTROL INFORMATION - Information about the status or activity of a stream.

STREAM - A simplex flow of data.

STRIPPING - Framing characters are removed or stripped off of the data block before the data block is recorded in the higher level processor data buffer.

SUBORDINATE - A station on a line which responds to communications but does not initiate communications.

SYNCHRONIZE - To get in step with another unit or a bit, element, character, or word.

SYNCHRONOUS - Operating in isochronous harmony with connected devices; that is, an event recurring at regular intervals of equal time.

TEXT - That portion of a message which contains user data.

TRANSMISSION BLOCK KEY - A code (0-7) which indicates the size of the data block requested. The transmission block key is bits 08-15 of the command format stream. The size of the block, corresponding to the code, is an assembly parameter.

TRANSPARENT DATA OR TEXT - Data which uses all 8 bits of a byte. There is no character parity.

TWO-WAY SIMULTANEOUS - A mode of operation supporting both an outgoing transmission and an incoming transmission simultaneously. A full-duplex channel is required for two-way simultaneous operations.

USASCII - United States of America Standard Code for Information Interchange.

VALID TRANSMISSION - A transmission whose opening delimiter and closing delimiter are recognizable.

VOICE GRADE - A grade of communication line which has the same bandwidth as normal voice circuits and which is a part of the common carrier switched telephone network.

WORD - 16 bits of data or two 8-bit bytes.

COMMENT SHEET

MANUAL TITLE CONTROL DATA 791 Communications Subsystem Controller

Functional Characteristics and Programming Manual

PUBLICATION NO. 60325100 REVISION B

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