SOFTWARE

SPECIFICATION

Document Type: External Reference Specification

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Product Number: I039*1, 2 & 3

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I039*1 a2.v3

LOCAL COMMUNICATIONS CONTROLLER

PL10

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Local Communications Controller (LCC)

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CONTROL DATA CORPORATION
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1.0   INTRODUCTION

This ERS reflects how the LCC subsystem interacts with a higher
level processor {HLP} and how the LCC interacts with communica-
tion lines.

The LCC subsystem interacts with the HLP via a defined protocol
which is specified in the Software Interface for PL Compatible
Trunk Specification. This specification is the guide to all
subsystems which interact within a network of CDC CYBER central
processors, stations and subsystems. Thus, the LCC subsystem
can be a part of this network.

Since there is an array of types of remote terminals, line/
terminal protocols have been established for interaction with
the array of terminal types. These protocols are referred to
as ▽Modes▽. Each mode is numbered, thus, for each line/terminal
protocol there is a MODE X which is associated with that defined
protocol.

This ERS is organized so that information associated with a
particular mode is in a section dealing with that mode.

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2.0 APPLICABLE DOCUMENTS

2.1 General Documents

Buffer Controller Engineering Specification No. 52410600

Buffer Controller Normal Channels No. 52410700

Buffer Controller Block Transfer Coupler No. 52410800

CDC Compatible Truck Interface Specification No. 52418100

LCC11 Engineering Specification {Hardware} No. 52420800

Software Interface for PL Compatible Trunk No. 52426200

ERS for MSBT Software {1042×1}

ERS for HSBT Software {I041×1}

Software Interface Procedures PL10/ICL Compatible Trunk, No. 52426200, dated 7/70.

Preliminary 711 CRT Display Terminal Hardware Programming Manual, No. 62022700, dated 6/71.

200 User Terminal Hardware Reference Manual No. 82128000, Revision B-0-1.

Graphics Display Subsystem interfacing with Data-Phone

Data Set 201A or 201B, Engineering Spec. No. 14046000, Feb. 1970, Revision D

Remote Multi-Station Display Subsystem with USASCII

216-4 Controller Engineering Spec. No. 14048700, October, 1969; Revision A.

2.2 Documents Pertaining to Link Control Procedures

Memorandum to: Members of USASCII X3.3.4: Proposed Interactive

Procedures. {Submitted by R. F. Meyer, February 20, 1970.}

Communication Network Product Family Plan {Submitted by

R. F. Meyer, December 23, 1969.

6000 INTERCOM 4 ERS {Section Pertaining to TTY} No. E043*4.0 - E013*3.4.

2.3 External Documents

USA Standard Code for Information Interchange USA X3.4 - 1968.

Bell System Data Communications Technical Reference Manual

Data Set 201A and 201B Interface Specification - Spet. 1962

Data Set 203-Type, May 1969

Wideband 303-Type, 1966

Data Set 103A Interface Specification, February 1967.

Teletype Corp. Technical Manual Model 35 Automatic Send/Receive Teletypewriter Set.

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3.0 GENERAL DESCRIPTION

3.1 General Characteristics

There are generally two levels of software associated with a communications subsystem - the application and the driver.

It is the responsibility of the application to interpret and process data associated with the terminals while it is the responsibility of the driver to maintain an orderly flow of data between the application and the terminal network.

The LCC is a driver level product which is concerned with the control and maintenance of an orderly flow of data between central site facilities and the terminal network. There is; however, one fundamental difference between this and previous communications drivers. This difference centers around the concept of distributive computing made possible by the presence of the programmable LCC Subsystem.

In general a communications driver consists of the functions listed below. The general division of functions between the HLP and the LCC is as indicated:

Performed   • line multiplexing {scanning for assembled data}
by LCC
                  • line control {HDX/FDX considerations, speed, etc}

                  • Link control {link error recovery, interaction
                    with remote station}

                  • network control {polling}

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Performed   •   device control {code compression, device
by HLP
                 not ready/down recovery, escape sequence

                 processing}

The LCC is subordinate to the Higher Level Processor and dominant

over the link. In order that the two elements be properly

coordinated in the communications process, a series of pre-

defined interactions are exchanged via HLP Memory over the CDC

compatible trunk. This trunk, which is 32 bits wide, is also

the data path between the LCC and the HLP. In a logical sense,

the HLP memory module is the common element between the HLP and

the LCC subsystem.

Figure 3.1-2 shows a basic LCC subsystem. The subsystem is

modular and can be configured to accomodate a variety of

applications within the design constraints.

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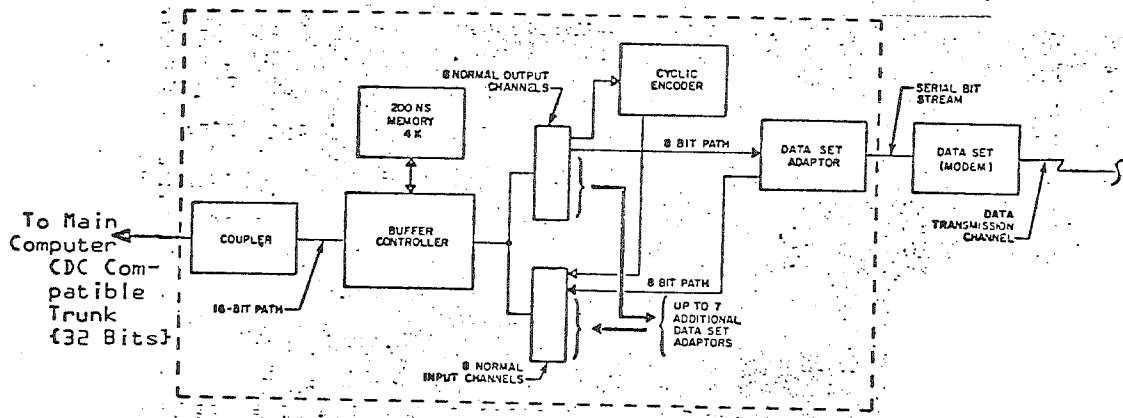
Figure 3.1-2   Basic LCC Configuration

The LCC services up to 48 mixed, synchronous and asynchronous

transmission channels.   Data can be transmitted in both

directions on each channel with transmission rates

ranging from 75 to 50,000 bits per second {bps}, depending

on the capability of the individual channels.   Maximum instan-

taneous throughput rate {total for all channels} is 400,000 bps;

for example, 200,000 bps input and 200,000 bps output or

300,000 bps input and 100,000 bps output, etc.

3.1.1 Functional Description

The major functions of the LCC are:

•   Assembly/Disassembly - Data is transmitted as a serial bit

    stream on the transmission channels.   The data set adapters

perform serial to 8-bit assembly on input and 8-bit to
serial disassembly on output. In addition, subsystem
software performs 8-bit/32-bit assembly/disassembly for
data exchanged with the higher level computer.

. Multiplexing - The subsystem software scans all channels
periodically to transmit or receive data at the rate
dictated by the channels. High speed lines are serviced
more often than low-speed lines.

. System Interface - The LCC processes the HLP's Requests and
commands and builds Responses indicating the status of the
Request and Command.

In previous communications sytems some of these functions
were handled by the central computer. The LCC reduces the
input/output overhead of the main computer by performing
many of the control and housekeeping functions associated
with data communications.

3.1.2 Hardware Configuration

Figure 3.1-3 shows a fully expanded LCC subsystem. The prin-
ciple hardware elements are:

. Buffer Controller - A small scale stored-program computer
used as a programmable control element in the communications
controller.

. Memory - A 4K, or 8K 200 nanosecond, 16-bit memory used for
storage of program and data. The 8K memory is achieved by
expanding the basic 4K in a 4K increment.

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- Normal Channels - Act as interfaces for the exchange of data between the data sets and the buffer controller. The number of normal channels required depends on the number of data sets to be serviced.

- Coupler - An interface between the buffer controller block transfer channel and a standard 32-bit CDC compatible trunk.

- Expansion Cabinet - Required in configurations that include more than 16 communication lines. It allows the buffer controller to address up to 48 communication channels.

- Data Set Adaptor - Acts as an interface between a data set {modem} and normal channels. One DSA is required for each transmission channel. During input operations, the DSA assembles the serial bit stream furnished by the data set, into 8-bit characters. During output operations the reverse disassembly operation occurs. Three types of DSA's are available to accommodate a variety of data sets. Each DSA is a separate pluggable module. There are positions available for 48 DSA's in a fully expanded LCC.

- Data Set - Data sets or modulator - demondulators {modem} are not part of the LCC but each transmission channel serviced by the LCC 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 transmission channel. It also performs the reverse operation, demodulation. A variety of data sets, furnishing

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a wide range of transmission rates, are available. Care
should be taken in selecting modems that are not data
sensitive.

The LCC with two-way simultaneous modes does not drop the
write line on full duplex synchronous models between trans-
missions; thus, an 01_{16} is used as time fill.

- Cyclic Encoder - This element is an error detection device
  that generates the cyclic redundancy code based on the
  polynomial $X^{16} + X^{15} + X^2 + 1$.

- Automatic Calling Adapter - This unit together with an
  Automatic Calling Unit {ACU} allows the LCC to call any
  telephone number in a switched network. ACU's, like data
  sets, are not part of the LCC. Each switched transmission
  channel requiring automatic calling capabilities must have
  an automatic calling adapter {ACA} as well as a data set
  adapter. ACA's plug into DSA positions within the LCC and
  thus reduce the maximum number of DSA's that can be in-
  stalled. This unit is used if the software is available.
  Check the sections in this ERS which deal with modes to
  see if this unit is supported.

- Real-Time Clock - The Real-Time Clock or oscillator is used
  to detect link time-out conditions. It has a fixed setting
  of 10 milliseconds. It may require an adjustment on site.

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EXAMPLE:

```
 ◁——————————— 10 msec. ———————————▷
 |                                              |
 |                          ┌———————————————————|
 ◁——— 5 msec. ———▷◁——— 5 msec. ———▷
 |_____|                              |
 |                                              |
 |                                              |
 ◁——————————— Real Time —————————————▷
              Clock Period
```

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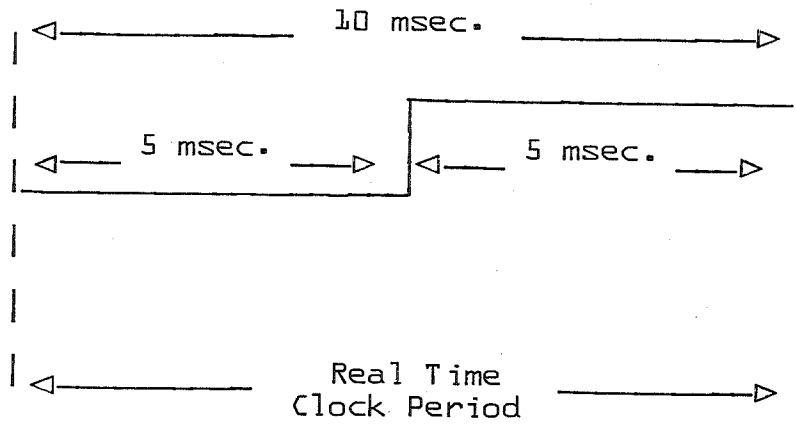
DOCUMENT CLASS____ERS_____ PAGE NO._____3-7____
PRODUCT NAME_____LCC_____
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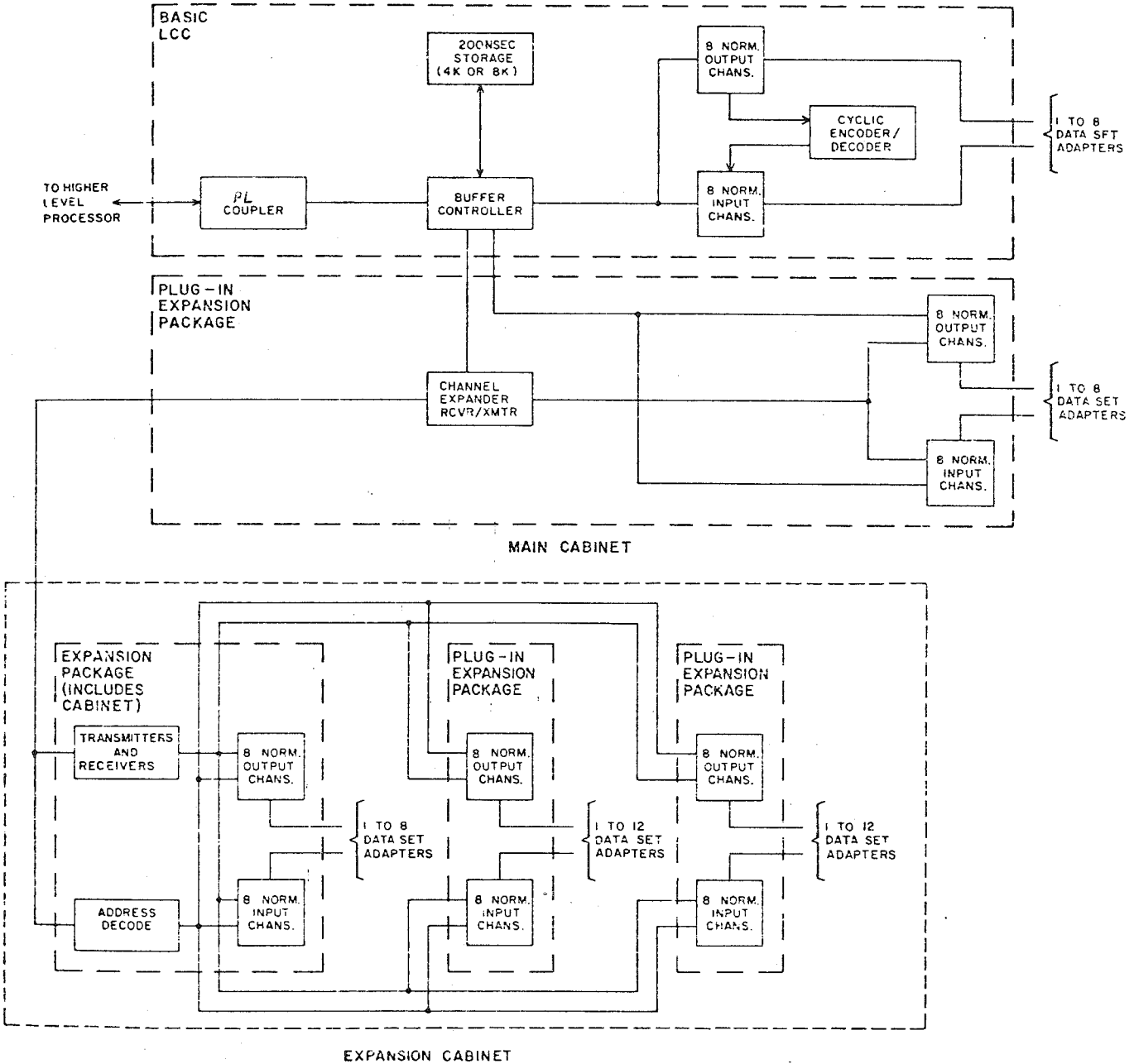
Figure 3.1-3. Fully Expanded LCC Subsystem

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3.1.3 Subsystem Software

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

3.1.3.1 Subsystem Software Organization

The software is basically divided into two general categories. One category is the interface with the higher level processor {HLP}, see Section 3.1.4 for details. The other category is line protocol.

Line protocol infers a defined mode of interaction with a remote terminal. Since there are several types of remote terminals, there are several different line protocols {modes}. The LCC subsystem software can have several modes {i.e., line protocols} of software interacting with the one set of software which interfaces with the HLP. Thus, an LCC can support one or more modes of communication lines. There need not be a mode per line.

An LCC could support 48 lines all interacting with one mode, or it could support 48 lines with groups of lines interacting with individual modes.

3.1.3.2 LCC Performance

There are two important factors affecting LCC performance. They are core restraints and data throughput.

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Core Restraints

The amount of core required for the LCC software of a required
configuration varies according to the number of different
line protocols {modes} to be supported. The software which
supports a line protocol {mode} interacts with other line
protocol {mode} software through a base set of software.

The amount of core for a given configuration may be calculated
by using the following formula:

X words of core = 2000+A+MODE2+MODE3+...+MODEX

2000 = fixed words {16 bit word} of core used as base
       software

A = additional program size for the DSA driver

   4 lines = 0 words of core

   8 lines = 60 words of core

  24 lines = 180 words of core

  32 lines = 240 words of core

  40 lines = 300 words of core

  48 lines = 360 words of core

MODE2 through MODEX are the core equations which are unique
to each mode. Reference the proper section of this ERS
which deals with the modes to be configured; place their
equations into the above equation.

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Data Throughput

The data throughput {the number of lines the LCC can service}
depends on the largest cumulative line rate which can be
driven by the LCC without data loss. Throughput is based on
the following factors:

1. The maximum LCC throughput is determined by the largest
    line service time. The service time is the time required
    by the LCC software to input or output a byte on a line.
    The service time may vary from protocol to protocol and
    increases as a function of increasing number of lines.

    The computed services times require that the buffer controller
    memory rate is 200 nsec cycle time and the rate that the
    HLP accepts 64 bits of data does not exceed 4.4 usec/32 bits.
    If these rates are slower, the service time per line in-
    creases. The larger the service time, the less the maximum
    supported throughput.

2. When two or more protocols are mixed in a configuration,
    the protocol with the largest service time determines the
    maximum supported throughput of the mix.

3. When a value for throughput is determined for a given number
    of lines and protocol mix, any combination of supported
    line speeds may be configured such that:

$$\sum \text{line speeds} \leq \text{throughput}$$

Each half duplex synchronous line and each full duplex

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asynchronous line is considered as a single line

operating at the rated one way bit per second rate while

each full duplex synchronous line is considered as a

single line operating at twice the rated one way bit per

second rate.

4. The maximum supported throughput of the LCC is determined

according to the following formula:

$$T = \frac{8}{S_{max}}$$

T = maximum supported throughput in bps

S_{max} = maximum line service time in seconds

5. Maximum line service times are as follows:

Mode 2 = $\{20+n+p\} \times 10^{-6}$ sec.

Mode 3 = $\{30+n+p\} \times 10^{-6}$ sec.

Mode 4 = $\{20+n+p\} \times 10^{-6}$ sec.

n = Additional service increment based
on number of lines:

    1-4   lines   n=0
    5-8   lines   n=3
    9-16   lines   n=6
    17-24 lines   n=9
    25-32 lines   n=12
    33-40 lines   n=15
    41-48 lines   n=18

p = Additional service increment based on
HLP memory access priority

    highest priority   p=0
    2nd   priority   p=1.1
    3rd   priority

NOTE: Access priority means that at highest priority

the HLP accepts data at a guaranteed rate of

4.4 usec per 32 bit transfer.

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Second priority implies the HLP accepts data
at a guaranteed rate of 5.5 usec per 32 bit
transfer.   Third priority implies that there is
no guaranteed transfer rate.   Thus if three
LCC's were coupled to one HLP {such as the
CDC 7077} the third LCC must be configured to
support exceedingly slow lines {300 bps and less}
or a �lost data⌄ condition may arise.

Since the sum of the line speeds is less than or equal to
the throughput, a configuration of lines can be calculated.
Following are some computed configurations attained by the
above calculations:

In a two-way simultaneous mode {such as Mode 2}:

        up to 4 lines at 50K bps
        up to 16 lines at 9600 bps
        up to 30 lines at 4800 bps
        up to 48 lines at 2400 bps

In a two way alternate mode {such as Mode 3 and Mode 4}:

        up to 30 lines at 9600 bps
        up to 48 lines at 4800 bps or less

For configurations where mixed line speeds are supported,
no simple formula exists to calculate the maximum configur-
ation for a given mix of line speeds.   A reasonably close
approximation may be obtained by replacing one or more
lines of a given speed {bps} from a known configuration
{a configuration generated by using the maximum throughput
computed for the protocol with the largest service time}

with slower lines. The sum of the bit rate of the lines

being added must not exceed the {sum of the} bit rate

of the line{s} being replaced. A margin of error must be

allowed {usually by omitting one of the lower speed lines}.

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3.1.4   Interface with High Level Processor {HLP}

The following paragraphs describe the mechanism by which the
HLP and the LCC communicate. The general structure is described
here leaving the detailed codes to be described in later sec-
tions. Figure 3.1-4 and 3.1-5 graphically depict the inter-
face lists.

3.1.4.1   Channel Flag

The Channel Flag is a hardware control line provided by the CDC
compatible trunk from the HLP to the LCC. The primary function
of the Channel Flag is to serve as a software interrupt in the
LCC.

The Channel Flag is used by the HLP to notify the LCC that
a line or lines are to be activated. Any further use of the
channel flags are unique in that the various versions of the
software and the respective sections should be consulted.

3.1.4.2   Line List

The Line List provides the basic linkage mechanism allowing the
HLP to communicate with the LCC. The Line List as well as the
Request lists, commands and responses reside in HLP memory.
When a line is opened, an entry in the Line List directs the
LCC to a Request List which allows the HLP and LCC coordinate
the flow of data to/from the terminals.

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The Line List is ordered according to line number; thus, the
first entry in the list is associated with line 1 which is
connected to DSA port 01 etc. There must be as many entries
in the list as the highest numbered line attached to the LCC.
That is, if the LCC is configured with lines 1 and 5 {lines
2, 3, and 4 are not present} then the Line List must be five
entries long. When the Channel Flag is set, the LCC reads
entries from the Line List for those lines that are currently
inactive {i.e., closed}.

If the entry = -1 {i.e. is negative} there is no new
                        activity for the line.

             ≠ -1 {i.e. is not negative} it contains a
                     32 bit base address of the Request
                     List for this line.

3.1.4.3 Request List

Once established, the Request List is the basic vehicle by
which the HLP and LCC coordinate the flow of data over the
associated line. The Request Lists provide the basic routing
functions as well as the controlling of the actual flow of data.

Once the base address of the Request List is read into the LCC,
{i.e. the line is opened} it remains there until the line
involved is closed. Periodic references to the Request Lists
are made by the LCC to determine if a new request has been
entered. As each request in the request list is completed
{normal or abnormal} a response is sent to the HLP.

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The Request List per line has two basic types of entry slots. The first entry slot of each list is dedicated for communications between the HLP and the LCC. The other entry slots are for control of data flow {streams}.

The Request List must have as many stream entries as defined for the mode servicing the Request List. See the appropriate section of this ERS for further definition.

Streams are identified by number. An even number stream is dedicated to the LCC simplex output operation {i.e., the LCC transmits data to the remote terminal on even streams only}. An odd number stream is dedicated to the LCC simplex Input operation {i.e., the LCC receives data from the remote terminal on odd streams only}.

3.1.4.4 Command

Commands are 64 bits in length and supply detailed information to the LCC for proper execution of a request. There is one command per request.

Commands for streams have only two allowed functions to be executed. An input stream {odd numbered stream} can read data and an output stream {even numbered stream} can write data. The byte count and the buffer address is passed to the LCC.

Commands for HLP to LCC requests are of a utility nature and cause specific functions to be performed, but do not involve data transfers with terminals.

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3.1.4.5 Response List

The Response List allows the LCC to communicate upward to the
HLP. Entries in the Response List allows the LCC to inform
the HLP of the current request, command, and system status.
There are two types of responses: solicited and unsolicited.
Solicited responses are those which are the result of a HLP
request. Unsolicited responses are those which are the re-
sult of some unexpected stream or system condition. Response
entries are 128 bits in length and are placed in a circular
buffer (see Figure 3.1-5)

The Response List operates in a circular manner by the use of
IN and OUT pointers. The pointers are 32 bit addresses. The
IN pointer always points to the next point in the list to be
filled. The OUT pointer always points at the next entry, to be
emptied. The list is defined to be empty if IN = OUT. The list
is defined as full when IN = OUT minus one entry. The LCC only
changes the IN pointer since it is filling the list. The HLP
only changes the OUT pointer since it is emptying the list.
Both the LCC and HLP compare the IN and OUT pointers. The
circular buffer allows the two processors to independently
operate on the list.

A common Response List is used by all versions of LCC software.

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Figure 3.1-4   Interface Lists Resident in the
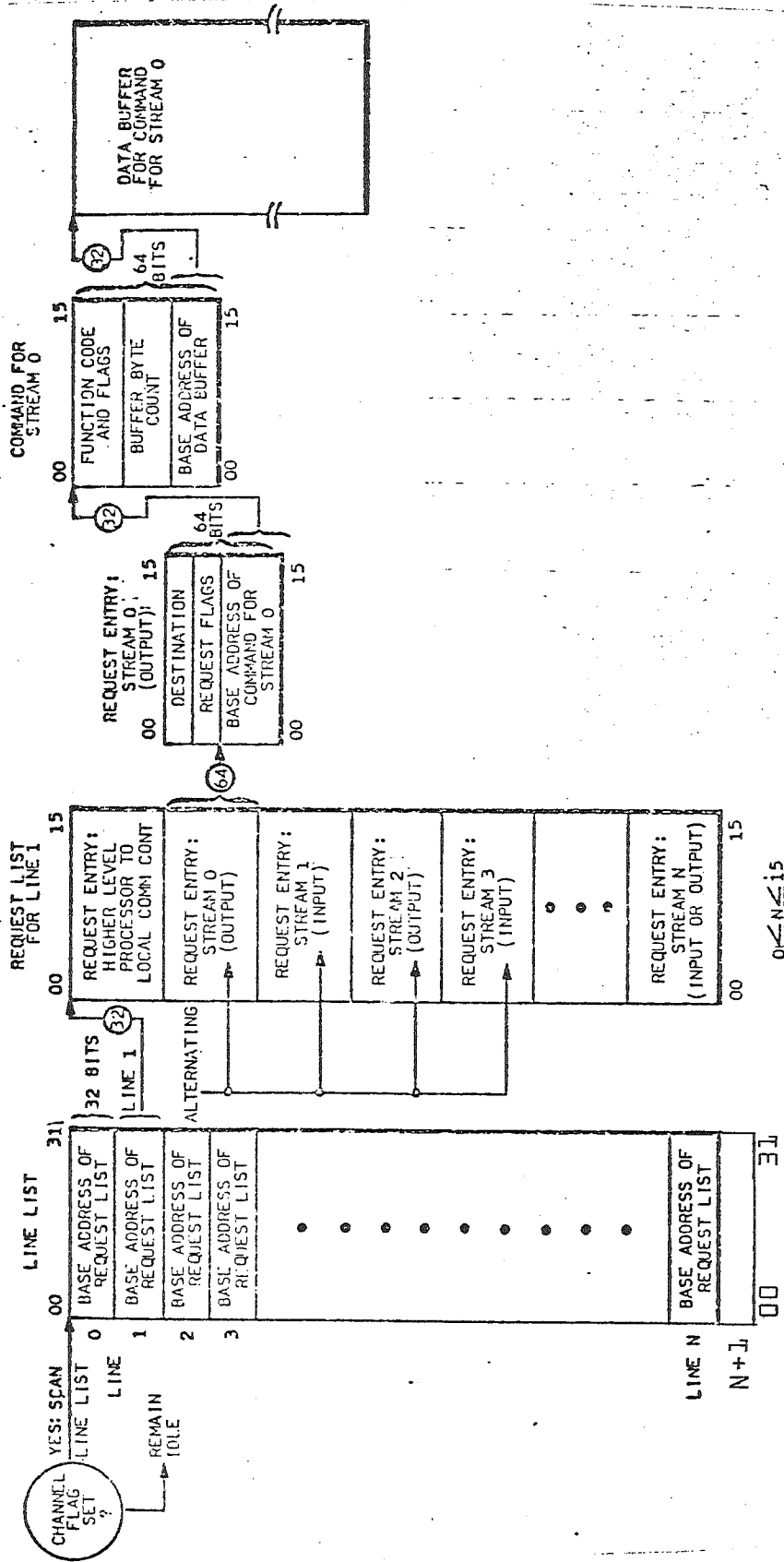
Higher Level Processor

$N+1 = FFFF,FFFF$ implies inactive slot
$= 00F3,FFFF$ implies the system is to be
suspended. See Section 3.2.5.4

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RESPONSE LIST

UPDATED BY LCC {
BASE ADDRESS OF
NEXT RESPONSE ENTRY
TO BE FILLED BY LCC
} 32 BITS

UPDATED BY HLP {
BASE ADDRESS OF
NEXT RESPONSE ENTRY
TO BE PROCESSED BY HLP
} 32 BITS

ENTRY: RESPONSE 1 } 128 BITS

ENTRY: RESPONSE 2
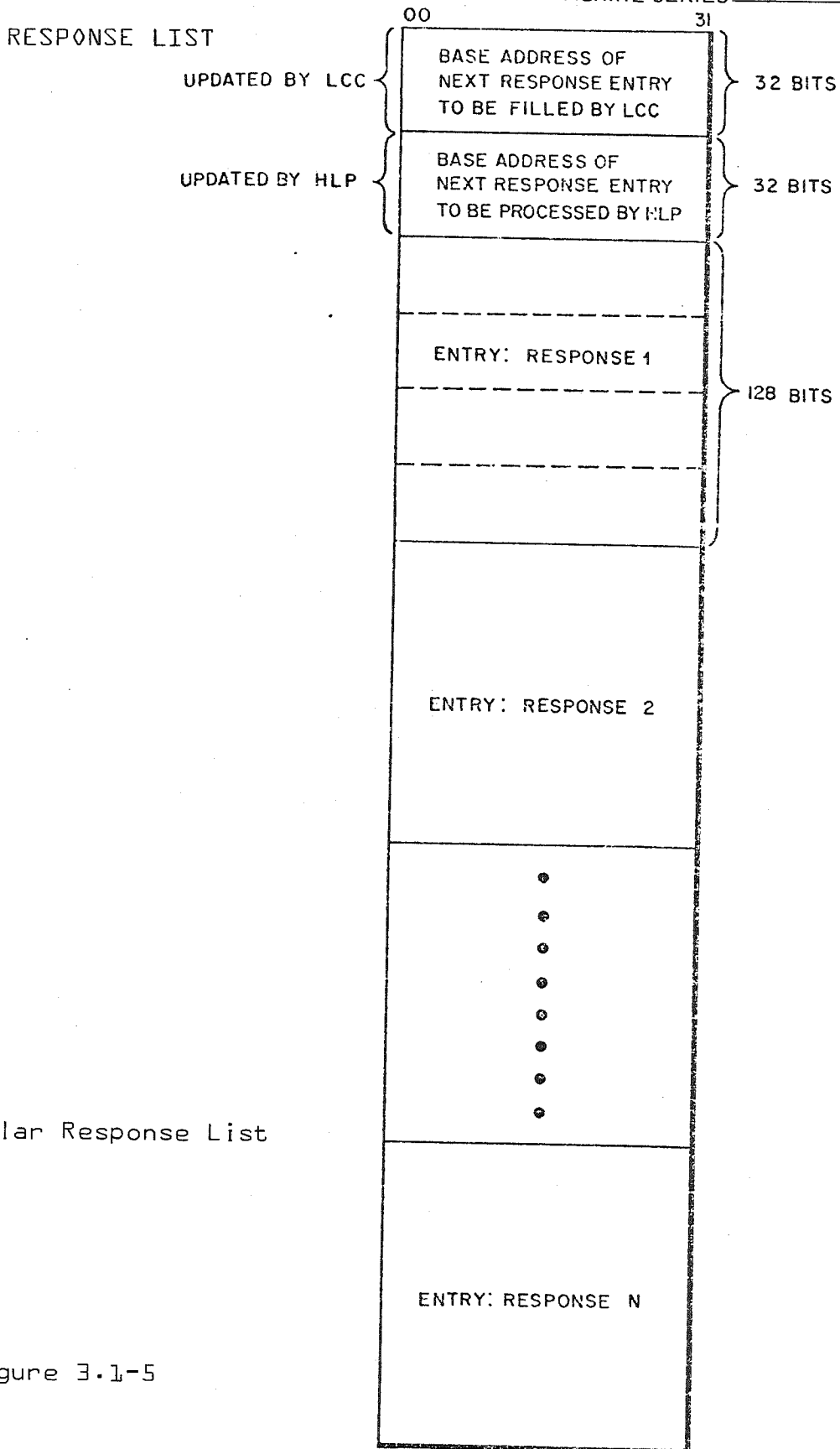
Circular Response List

ENTRY: RESPONSE N

Figure 3.1-5

N IS PREDEFINED BY LCC

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3.2 General Operating Characteristics

3.2.1 Multi-Lines

The LCC software scans all communication lines periodically to transmit or receive data at the rate dictated by the line. This is the traditional multiplexing operation.

Communication lines connected to the LCC on lower number DSA ports {Data Set Adapter I/O slot within the normal channels} are serviced more often than the higher numbered DSA ports. Therefore, when a system is configured, the high speed lines must interface with the lower number DSA ports. Note LCC hardware specification, #5242080O, Tables 2 through 8 for explanation on configurations.

3.2.2 Error Reporting

Error status is always reported to the HLP via the response field. Error status is reported even if successful recovery is made. Some of the error status consists of:

a. Error Recovery was initiated x times for the last block

b. The status of the Communications Adapter

c. The condition of last data block

d. The condition that the connected remote has its data set adapter carrier off

e. The condition that LCC buffers are saturated

3.2.3 Error Recovery

Error recovery for the CDC Compatible Trunk is initiated when the error status condition is detected. If the error occurs

during a data transfer from a line buffer, normal link error
recovery is initiated and a response is written to the HLP
reporting an intermittent coupler problem. If the error occurs
during LCC work cycle {non-link operation}, then the transfer
is repeated until it is successful

Error recovery on the link is described in the sections
describing the different modes of LCC software.

3.2.4 LCC Buffer Threshold

The LCC software has a buffering scheme which allows it to
dynamically rotate internal buffers. When use of these
buffers reaches a saturation threshold, the LCC reports to
the HLP that buffer saturation is present and aborts the request
which was being processed when the condition was discovered.
When the buffers are saturated, the LCC reports to the HLP
that the line is being closed by doing the following. As
each outstanding request is abnormally terminated, a response
is written and when all stream requests have been terminated
abnormally, a response is written that the line is closed.

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3.2.5 Basic HLP Operations

3.2.5.1 Activate 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 LCC
that new entries have been made in the Line List. The LCC
searches the Line List for all new entries. As each new entry
is found, the line is activated. When the Line List has been
completely searched, the Channel Flag is cleared and a response
written indicating that the lines are activated.

Once the HLP sets the Channel Flag, it should not attempt to
make new entries into the list until it receives the response
indicating the LCC is through searching. At this time the HLP
must set the newly opened line entries to -1.

3.2.5.2 Close a Line

The HLP has the option of declaring an active communication line
inactive.   The LCC discontinues servicing that line. No data
is sent or received. When this action is taken the LCC ter-
minates all requests for this stream.   When they are ter-
minated it notifies the HLP that the line is closed. The Request
List is no longer defined. For data to be sent on this line
again, the operation of activating the line is required again.

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3.2.5.3 Autoload and System Initialization

The system autoload function consists of loading the LCC
memory with the LCC software. The LCC system initialization
consists of maintaining a dialogue with the HLP to obtain
configuration information and to initialize the system. When
initialization is complete, control is transferred to the LCC
software which initiates standard HLP interface procedures,
Section 3.1.4.

Initiation of the autoload sequence can be accomplished by
program control; HLP initiates autoload across the CDC com-
patible trunk. {Program autoload is executable code.}

The HLP places the 64 16-bit autoload record {Fig. 3.2-1}
in CSM starting at address 0 prior to initiating the LCC
Subsystem autoload.

The 16-bit Autoload Control Word, Word 61 of the Autoload
Record {Fig. 3.2-1}, specifies the operation type as follows:

    0001   Autodump

    0002   Autoload

The 32 bit Autoload Table Address, Words 62 and 63 of the
Autoload Record, is a 32-bit HLP address that points to the
Autoload Table {Fig. 3.2-2} used to support the above operations
and communications via the software interface when the auto-
load phases are completed.

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The first 16 words of the Autoload Table are always present.

The last 16 words are present only when autoloading LCC soft-

ware which supports mode 4 terminals.

Autoload Record Format

```
0                                              15
┌─────────────────────────────────────────────┐  Word 0
│                                               │
│           AUTOLOAD PROGRAM                    │
│                                               │
│                                               │  Word 60
├───────────────────────────────────────────────┤
│            Autoload Control Word               │  Word 61
├───────────────────────────────────────────────┤
│            Autoload Table First                │
│                Word Address                    │  Words 62,63
└───────────────────────────────────────────────┘
```
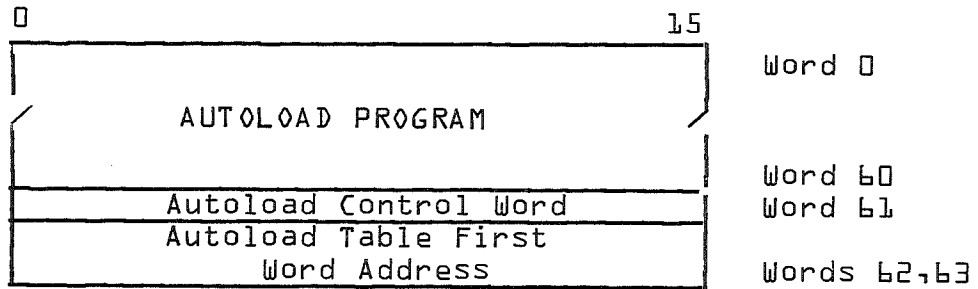
FIGURE 3.2-1

Autoload Table Format

```
0                                              15
┌───────────────────────────────────────────────┐
│               Autoload                          │
│               Response                          │  Word 0,1
├───────────────────────────────────────────────┤
│             Next Record                         │
│               Address                           │  Words 2,3
├───────────────────────────────────────────────┤
│           Next Record Length                    │  Word 4
├───────────────────────────────────────────────┤
│              Dump Address                       │  Word 5
├───────────────────────────────────────────────┤
│            Request Table                        │
│               Address                           │  Words 6,7
├───────────────────────────────────────────────┤
│           Response Table                        │
│               Address                           │  Words 8,9
├───────────────────────────────────────────────┤
│         Response Table Length                   │  Word 10
├───────────────────────────────────────────────┤
│             Parameter 1                         │  Word 11
├───────────────────────────────────────────────┤
│             Parameter 2                         │  Word 12
├───────────────────────────────────────────────┤
│             Parameter 3                         │  Word 13
├───────────────────────────────────────────────┤
│             Parameter 4                         │  Word 14
├───────────────────────────────────────────────┤
│             Parameter 5                         │  Word 15
├───────────────────────────────────────────────┤
│           Line Select Mask 1                    │  Words 16-18
├───────────────────────────────────────────────┤
│           Line Select Mask 2                    │  Words 19-21
├───────────────────────────────────────────────┤
│           Line Select Mask 3                    │  Words 22-24
├───────────────────────────────────────────────┤
│           Line Select Mask 4                    │  Words 25-27
├───────────────────────────────────────────────┤
│           Line Select Mask 5                    │  Words 28-30
├───────────────────────────────────────────────┤
│     No. of Code Conversion Tables               │  Word 31
└───────────────────────────────────────────────┘
```

FIGURE 3.2-2

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The Autoload Table {Fig. 3.2-2} resides in HLP memory and is
not relocated during the entire autoloading phase.

Autoload Response: The LCC writes 1 32-bit response into
this area. The following codes, right justified, are used.

1 - Error Switch: N/A.

2 - Ready to read or to write another autoload record: Used
    in autodump and autoload.

4 - Operation completed: When mode 4 is not present this is
    used at completion of autoload. When mode 4 is present,
    this response is used to indicate the completion of the
    autoload sequence and to request the first and subsequent
    initialization blocks {defined below}.

8 - Ready to dialogue through I/O software interface: Used
    after internal initialization following completion of
    autoload.

16 - Error Response: LCC aborted operation and requires auto-
     load to restart.

Next Record Address: This 32-bit HLP address indicates
where the LCC must read or write the next record.

Next Record Length: This 16-bit word indicates the length
{even number of 16-bit words} of the next record. A length
equal to 0 terminates a autoload and forces the autodump
operation to scan the Channel Flag.

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Dump Address: This 16-bit address, used only for an autodump operation, indicates from which address the LCC must start the autodump of its own memory into HLP memory.

Request Table Address: This 32-bit HLP address points to the Line List {Section 3.1.4.2} in HLP memory used by the LCC.

Response Table Address: This 32-bit HLP address points to the Response Table {Section 3.1.4.5} in HLP memory used by the LCC.

Response Table Length: This is the length {number of 32-bit words} of the circular Response Table. This length includes the IN and OUT pointers.

Parameter Word 1: Not assigned

Parameter Word 2: Defines number of lines attached to the LCC operating in MODE 2.

Parameter Word 3: Defines the number of MODE 3 lines.

Parameter Words 4-5: Not assigned.

Parameters needed if MODE 4 lines are being serviced by the LCC subsystem.

Line Select Mask 1: Not assigned.

Line Select Mask 2: This is a 48-bit parameter used to select those lines, out of the 48 possible, that are MODE 2 lines. Bit 0 corresponds to line 0; bit 1 to line 1, etc.

Line Select Mask 3: This is a 48-bit parameter used to select those lines, out of the 48 possible, that are MODE 3 lines.

Line Select Mask 4: This is a 48 bit parameter used to select those lines, out of the 48 possible, that are MODE 4 lines.

Line Select Mask 5: Not assigned

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<u>Number of Code Conversion Tables</u>: This parameter specifies

the number, from 0 to 6, of code conversion tables to be

allowed. This parameter need not be supplied if the code

conversion tables and table pointers are assembled into the

code by using the assembly option provided for this purpose.

As each autoload record is processed, the LCC will return an

autoload response of 2 to the HLP. The HLP will reply by

supplying the LCC with another autoload record, updating the

autoload table and setting the channel flag. The autoload

sequence will continue until the HLP replies to an autoload

response from the LCC with a value of zero in the ∇next record

length∇ field of the autoload table. The system initializer {SI}

will use these parameters to initialize the LCC subsystem.

When this has been done the LCC will respond to the HLP with an

autoload response code of 4, indicating that the SI is ready to

accept MODE 4 Terminal Model Records and Line Parameter Records.

If MODE 4 is not supported, the LCC subsystem is considered to

be totally initialized and the LCC initiates standard interface

procedures, Section 3.1.4.

If MODE 4 is supported, the LCC maintains a dialogue with the

HLP in which the LCC sends response codes of 4 to notify the

HLP to send TM and LC records. When the HLP replies with a

value of zero in the ∇next record length∇ field of the auto-

load table, the LCC is considered to be totally initialized

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and the LCC initiates standard interface procedures, Section
3.1.4.

For MODE 4, the HLP must first send all of the Terminal Model
Records and then send the Line Parameter Records to the LCC.
These records may be sent all in one buffer or in several
buffers. In addition, each individual Terminal Model Record
or Line Parameter Record must be a multiple of 32 bits in
length with a 16-bit padding word inserted in the record where
needed.

The format of the Terminal Model Record is shown in Figure 3.2-3.

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FIGURE 3.2-3

A terminal Model {TM} is a set of words describing a given
terminal. One TM is required for each unique terminal
configuration in the system. From 1 to 16 TM's may be used
on a single line and up to 32 may be defined for the system.
The TM consists of a 32-bit site descriptor and 1 to 16 32-bit
device descriptors, depending on the number of devices on the
terminal.

Each TM that can be assigned to a given line must have a site
address different from that of any other TM that may be
assigned to the same line. The reason for this is that the
site address will be used to determine what type of site is
present at any given time on a given line. Therefore, no
ambiguities can be allowed.

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Field A; this field is one bit in length and is equal to one

to indicate that this is a Terminal Model Record.

TM Number; this is the Terminal Model number. It has a value

from 0 to 31 {decimal}.

Protocol; this field is 3-bits in length and indicates the

communications protocol to be used. The following values

are defined:

    0 - 200 UT protocol is used

    4 - 216 protocol is used.

Code Set; this field indicates the code set used by the

terminal. The values are:

    0 = ASCII

    1 = internal BCD

    2 = external BCD

Screen Size; indicates the size of the CRT screen. Values are:

    0 = 20X50

    1 = 13X80

    2 = 8X80

    3 = 16X80

Field B, The Number of Devices on the Terminal; this field

indicates the number of devices attached to the terminal and,

therefore, the number of device descriptors in the TM {the

padding word is not included in this count if one exists}.

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<u>Terminal Type</u>; indicates the type of terminal as follows:

    0 = 200 UT

    1 = 214

    2 = 711

    3 =   {not used}

    4 = 241 grid

    5 =   {not used}

    6 = 216

<u>Site Address</u>; this is the site address to be used by all
terminals on switched lines if the terminals are exactly
described by this TM. A hex value of 0-F corresponds to the
hexadecimal site address 70-7F {160-177 octal} respectively.
If bit 11 equals one, then all possible site codes are to be
polled and this is the only TM allowed on lines that select
this TM.

<u>Device Type</u>; this is the first field in the device descriptor.
This field describes the type of device being described by
this device descriptor as follows:

    0 = CRT

    1 = card reader

    2 = printer

    3 = typewriter

    4 = cassette

    5 = paper tape

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Station Address; the station address to be used. If the

station code is not enabled for the particular terminal being

described, this value is set to zero. Otherwise a value of

1 to F {hexadecimal} is to be used corresponding to an octal

address of 141 to 157 respectively.

The format of the Line Parameter Records is shown in Figure

3.2-4. Words 0-3 of this record are present for all mode 4

lines, words 4-n are present only if the line is a dedicated,

multi-point line.

FIGURE 3.2-4

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Field A; always set to zero to indicate that this is a Line Parameter Record.

Field B; indicates 2 or 4 wire mode as follows:

    0 - 2 wire mode

    1 - 4 wire mode

Line Number; this field indicates the line number referred to by this record.

Field C; this field is reserved for future use when the ACU {Automatic Calling Unit} feature is implemented. This field when implemented will indicate whether autodial procedures are allowed on this line as follows:

    0 - autodial procedures are allowed

    1 - autodial procedures are not allowed on this line
        and ACU port number field has no meaning.

Field D; multipoint indicator with the following interpretation:

    0 - the line is point-to-point

    1 - the line is multi-point and words 4 to n are present.

Number of Sites; this field is used only if the line is a dedicated multi-point line. It indicates the number of terminals {sites} on the line, and also the number of TM/SITE words in this record {exclusive of the blank padding word if one exists}.

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DOCUMENT CLASS_____ERS_____ PAGE NO.____3-30____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039_____ MACHINE SERIES_____PL10_____

ACU Port Number Reserved; this field is reserved for future use
when the ACU feature is implemented. This field when implemented
gives the number of the port attaching the automatic calling
adapter to be used in automatic dialing procedures on this
line. This field has meaning only if field C is zero and
field D is zero.

TM Selection Mask; this field, 32 bits in length, contains the
bit mask used to select the Terminal Models that are allowed
on this line. Up to 16 bits may be set in this mask. See TM
description above.

TM Number; the TM number describing the terminal represented
by this word {TM/SITE record}.

Site Code; the value from 0-F {hex} corresponding to the site
address 160-177 {octal} to be used by the terminal represented
by the record in which this field is found.

3.2.8 Suspend

The HLP places the LCC into a suspended state which causes the
LCC to temproarily stop all references to the HLP memory until
the HLP sets the channel flag notifying the LCC to resume
normal operations. During the suspended state, the LCC dis-
continues normal operations with the remotes. The HLP is
notified when the LCC subsystem is in a suspended state.

In order to place the LCC into a suspended state, the HLP must

place the code, 00F3$_H$, into the N+1 slot of the line list,

Figure 3.1-4.

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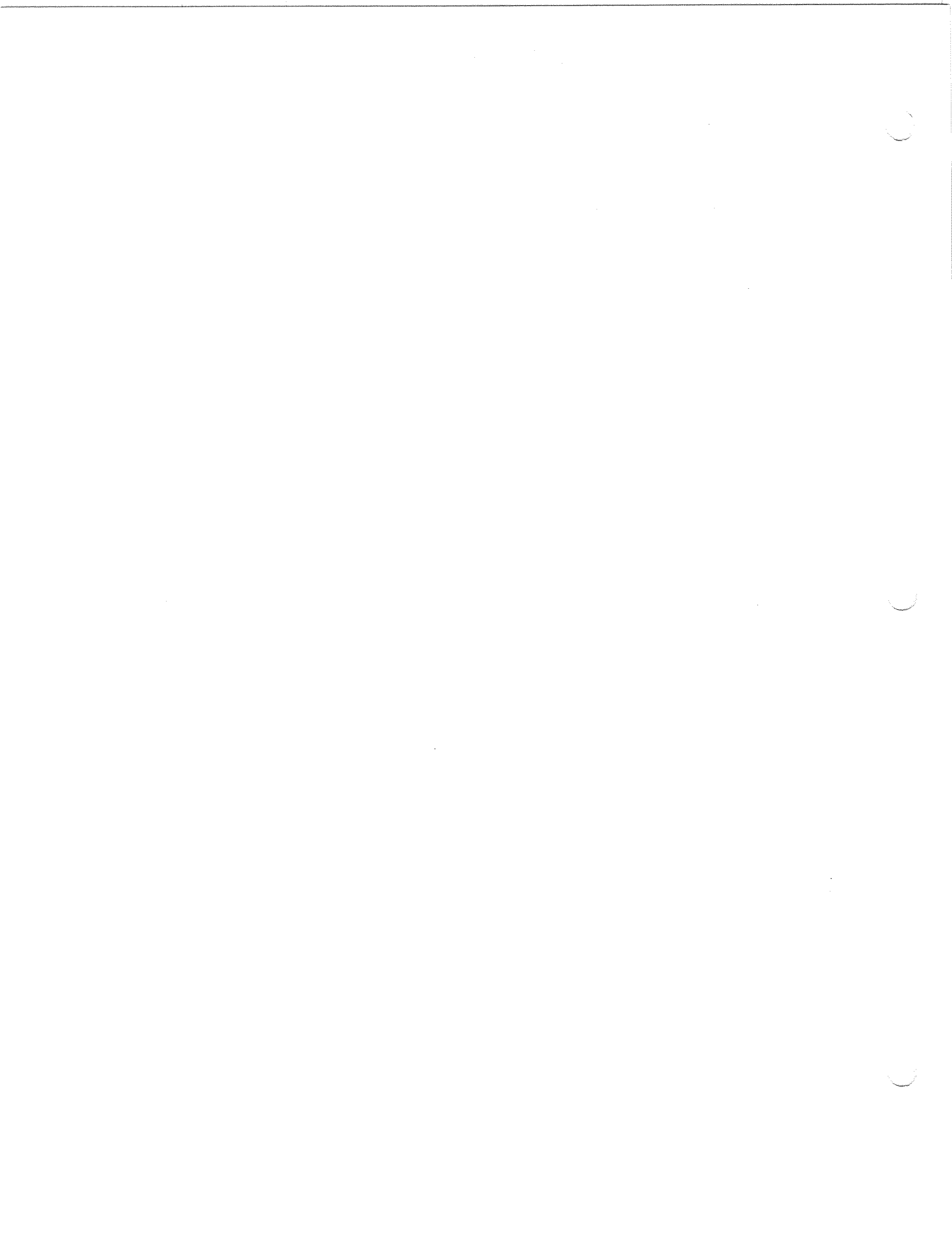
DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-1
PRODUCT NAME_____ LCC
PRODUCT MODEL NO.____ I039×1.0 _____ MACHINE SERIES_____ PL10

4.0   MODE 2 PROCEDURE

Mode 2 link protocol in the LCC is intended to support the new line batch terminals {HSBT, MSBT, and LSBT}. Mode 2 will only support synchronous lines which are point-to-point, full duplex, and non-switched. The transmission flow will be two-way simultaneous.

Mode 2 software resident in the LCC-11 memory provides a message framing and link control procedure.

This involves activities such as:

1.   Insertion or stripping of link control characters that enclose the data blocks.

2.   Addition or deletion of control characters that are required for transparent data block.

3.   Adding or deleting station status information transmitted between the terminals and LCC.

4.   Acknowledgment of transmissions.

5.   Error Detection and Recovery - Each message block is protected by a cyclic redundancy check code. If the LCC senses an error, it asks the distant end for transmission of the block. If an error is detected at the distant end, the terminal device notifies the LCC which responds by retransmitting the block. The LCC furnishes error status information to the higher level computer for control and error logging purposes.

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Station level control in the LCC permits transmission of
several streams on a time-shared basis over a single communi-
cation line, which is connected point-to-point with the remote
terminal. See Section 4.1.3.1 for a detailed explanation.

4.1 General Description of Mode 2

4.1.1 Configuration

Since Mode 2 interacts in a two-way simultaneous scheme, the
number of lines supported are: {See Section 3.1.3 for further
explanation}

            up to 4 lines at 50K bps
            up to 16 lines at 9600 bps
            up to 32 lines at 4800 bps
            up to 48 lines at 2400 bps

A mix of line speeds can be attained in the manner described
in Section 3.1.3.

The amount of core required for Mode 2 software and configura-
tion are as follows:

        Mode 2 words of core = $1600+36L_2+16AL_2+16S_2$

            1600 = fixed words of Mode 2 software

            L_2 = number of lines supported with Mode 2

           AL_2 = number of Mode 2 lines active {i.e., opened}

            S_2 = for all Mode 2 lines, the sum of active
                   streams {i.e., sum of stream requests being
                   processed by the LCC at an average operation
                   time}

The number of line and streams serviced is dependent upon
core size. In general, the maximum number of streams goes
down as the number of lines increases. The following is the
worst case under the given conditions:

   A 4K {16 bit word} LCC will support with -

      4 lines attached with 4 lines active up to 17 streams

      5 lines attached with 5 lines active up to 14 streams

   An 8K {16 bit word} LCC will support -

      16 lines attached with 16 lines active up to 297 streams

      32 lines attached with 32 lines active up to 183 streams

      48 lines attached with 48 lines active up to 131 streams

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4.1.2 Mode 2 Features

4.1.2.1 Control Characters Added/Deleted

For transmission, the LCC, which is dominant, frames all data blocks with a set of control characters. These control characters consist of an opening delimiter sequence, station control information, data {i.e., text}, framing control characters, and ending delimiters.

The LCC receives from the subordinate remote station data blocks which are bounded with similar control characters. The LCC interprets these control characters, ascertains if they are valid and strips them off of the data block before it records the data in the HLP data buffer.

4.1.2.2 Data Dependencies

Basically, the LCC is not data dependent. Data blocks must all be in the transparent format.

Transparency is invoked by the proper ASCII control characters {i.e., the LCC does not expect bit position eight of a data byte to reflect parity, and thus does not generate parity or check for valid parity} thus allowing any of the 256 possible bit combinations per data byte.

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4.1.2.3 Error Recovery

If on receipt of a beta { β } status block or an alpha { α } data block on a communication line, the LCC detects an error condition, the LCC initiates error recovery procedures for that block a maximum of N times {N is defined at assembly time}. When recovery procedures have been executed N times, the LCC exercises the Data Set Adapter to see if the condition is caused locally. The results of the exercise and the condition of a non-recoverable error are reported to the HLP, and then the line is closed and all HLP requests are terminated abnormally. The conditions which stimulate the LCC into recovery procedures are:

CONDITION CAUSING RECOVERY	LCC RECOVERY ACTION
1. Time out - a valid response block for an α {or β } transmission is not	The last α {or β } block transmitted by the LCC is retransmitted.

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received within the allowed

time frame.

2. Incorrect Parity - an interpretable response block is received. However, the block has a control character parity error or cyclic redundancy check error.

An α {or β }message which requests a Repeat of the remote stations last α {or β } transmission is sent to the remote.

3. Negative Response {NAK} - The remote station interpreted the last α {or β } transmission from the LCC as having a control character parity error or cyclic redundancy check error.

The last α {or β } block transmitted by the LCC is retransmitted

4. Improper Sequence - The expected α {or β } numbered response is not received. However, the parity and CRC are good.

The last α {or β } block transmitted by the LCC is retransmitted.

4.1.3 Station Level Functions

4.1.3.1 Multi-Streams

A stream is the simplex flow of data from one point to another

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{i.e. source to sink}. Streams are differentiated by numbers. For example, stream one has a different source/sink than stream two. Even numbered streams refer to output simplex flow of data from the LCC to a sink in the Remote Station and odd numbered streams refer to input simplex flow of data from a source in the remote station to a sink {i.e., buffer} in the HLP. The LCC coordinates the transmission of several streams {multi-streams} on a time-shared basis over a single communication line {note, that since this system is point-to-point, there is only one remote station per communication line}.

An example of multi-stream activity within an LCC is the following. A HLP has a data buffer for stream 2 and a data buffer for stream 4. Both data streams are to be sent to the same remote station. The remote station has defined stream 2 as the printer buffer and stream 4 as the card punch buffer. The LCC sends a block {block $\leq$ HLP buffer size} of data for stream 2. While the remote station is printing the printer buffer, the LCC sends a block of data for stream 4. Thus, the remote station has sufficient data to drive devices simultaneously. Because the system is two-way simultaneous, similar multi-stream transmissios can be sent from the remote station to the LCC.

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Figure 4.1-1   Graphical Description of Streams

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4.1.3.2 Blocking of Data

The HLP defines a buffer area or areas within its core and the
total data byte count for each buffer. This data is to be
output to a remote station, stream x, line y. The total byte
count may be greater than that which the remote station will
receive. The LCC breaks up the transmission of this data into
blocks of bytes {these blocks are multiples of four bytes} which
are acceptable to the remote station. Thus, the data is
transmitted in one or more blocks. The LCC inputs data from
stream z, line y in blocks. If the HLP buffer is larger than
the block size, the LCC packs successive blocks from stream z
into the HLP buffer. However, if there is not sufficient
buffer space for an input transmission block, the LCC does not
input the data. See Section 3.2 for further detail.

Figure 4.1-2 is a graphic example for a blocked buffer.

The LCC logically divides the byte count into blocks. The size
of a block is defined by an index passed to the LCC by the HLP.
This index is used by the LCC to reference an internal
assembled table which contains blocking values. The blocking
values must be multiples of four bytes. The interface between
the LCC and HLP has a hardware defined width of 32 bits
{4 bytes}. Transfers across the interface cannot be performed
in smaller units than 4 bytes.

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CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS ___ERS_____ PAGE NO.____4-10_____
PRODUCT NAME _____LCC_____
PRODUCT MODEL NO. ___I039 * 1.0_____ MACHINE SERIES_____PL10_____

NOTE

In this example, the block size is 512 bytes.

Input or Output Buffer
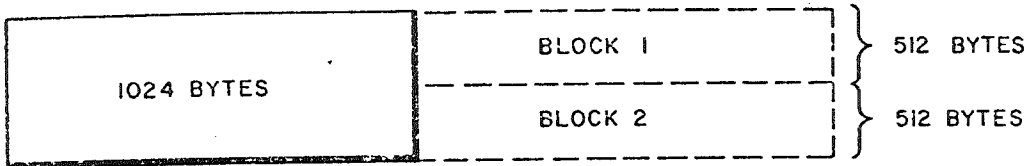
Input Buffer
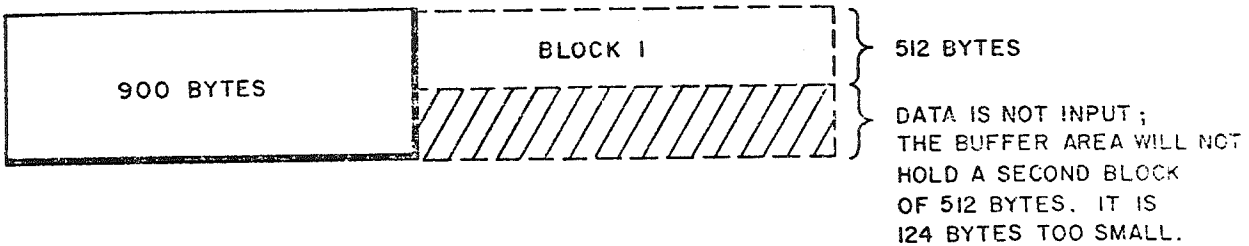
Output Buffer
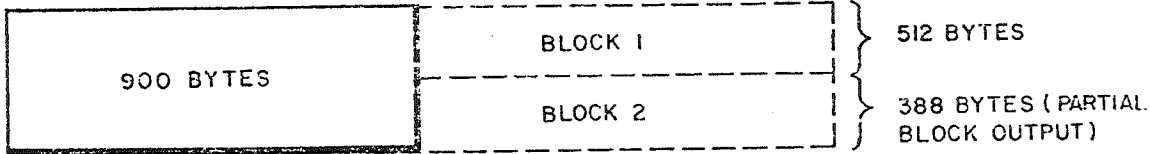
Figure4.1-2 Blocked Buffers

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO.____ 4-11 _____
PRODUCT NAME _____ LCC _____
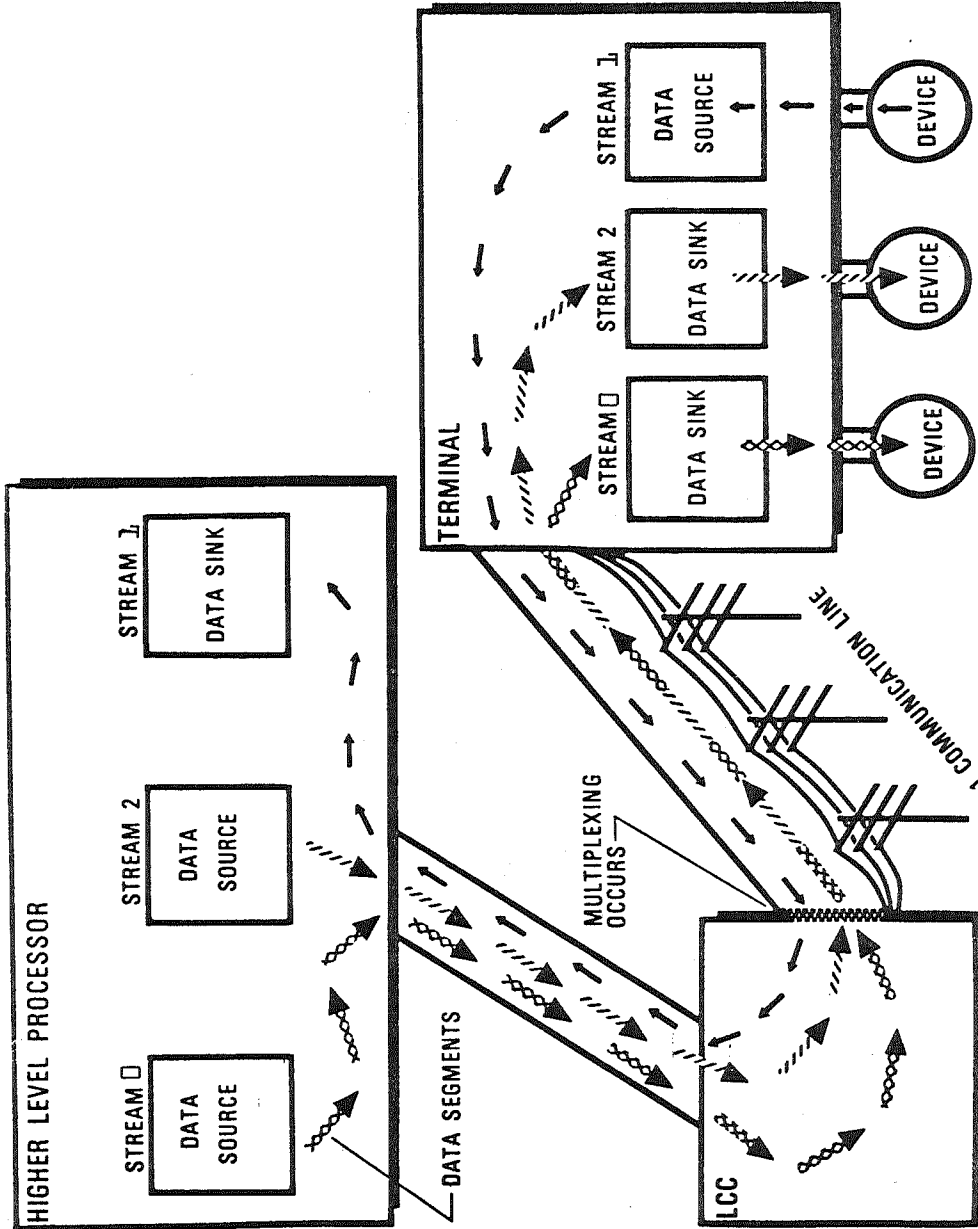PRODUCT MODEL NO. ___ I039×1.0 _____ MACHINE SERIES_____ PL10 _____

4.2   LCC/Remote Station Interface Procedure

4.2.1 Information Flow: Two-way Simultaneous

The LCC and the remote terminal interface by trading blocks of
information. The LCC is dominant; thus, all trades are initiated
by the LCC. There are three types of information trades:
Control block, alpha { α } and beta { β }. The LCC {with
type α and type β information trades merged } is two-way
simultaneous information flow. See Figure 4.2-1 for a graphic
description. Once communications is established the LCC
maintains this sequence of trades. Following every α
transmission, the LCC transmits a β block, then an α block,
then a β block, etc.

LCC   Remote

	Status	Data	Status	Data	Status	Data	Status
Sends	α →	β →	α →	β →	α →	β →	α →
Receives		← α	← β	← α		← β	← α ← β

Sends (LCC) / Receives (Remote) — Receives (LCC) / Sends (Remote)
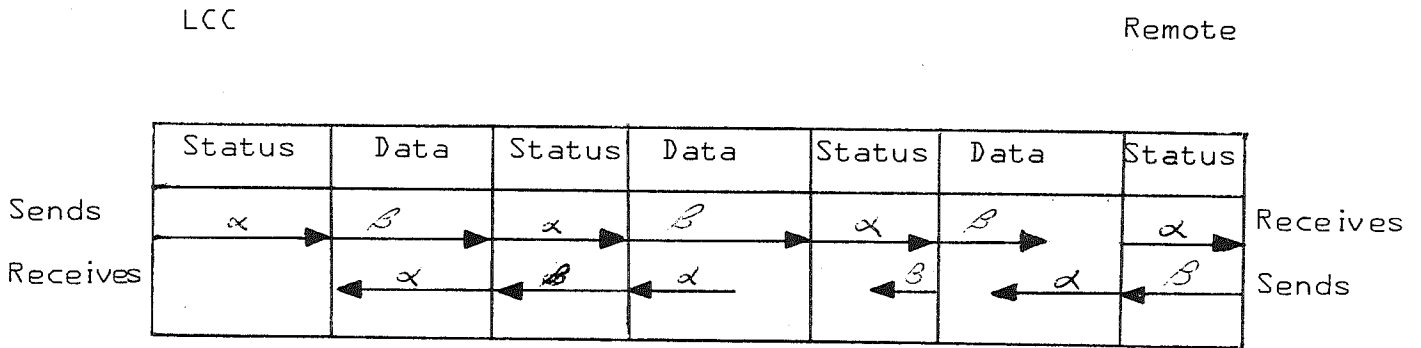
Figure 4.2-1

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ERS_____ PAGE NO._____4-12_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

Control Block Transmission

Control blocks are unique link trades which are done in a
two-way alternate scheme. Control blocks fit outside the
alpha/beta information trade. Thus the trade of control blocks
must be done before alpha/beta communication trade is initiated
or after the trade is terminated. Control blocks can carry a
variety of different codes {i.e. meanings}.

This version of the LCC is implementing a restart function.
The receipt by the remote or the LCC of a restart control
block implies that the alpha/beta numbers are to be reset to
an even state and that any outstanding trades of information
are negated. If the LCC is reautoloaded by the HLP when
exchanges of data information were being traded by the LCC
and the remote, the restart control block informs the remote
that the last data block was not accepted.

Once the remote acknowledges receipt of the restart control
block, the LCC considers communications to be established and
initiates the trade of alpha/beta transmission blocks. The
remote must always acknowledge receipt of a restart control
block by transmitting a restart control block back.

If the remote sends a control block during normal trade of alpha/
beta blocks, the LCC terminates all activity on that line until
it can reply with a corresponding block {i.e., the line is
closed and must be reopened}; See Section 4.3.5, unsolicited
responses for further detail.

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_____ DIVISION

DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-13
PRODUCT NAME _____ LCC
PRODUCT MODEL NO. ____ I039×1.0 _____ MACHINE SERIES _____ PL10

Graphic descriptions of restart control block trades are:

LCC   Remote

Sends | Restart →   Restart →   Restart →   α →   β → | Receives
Receives | ...   ...   ← Restart   ← α | Sends
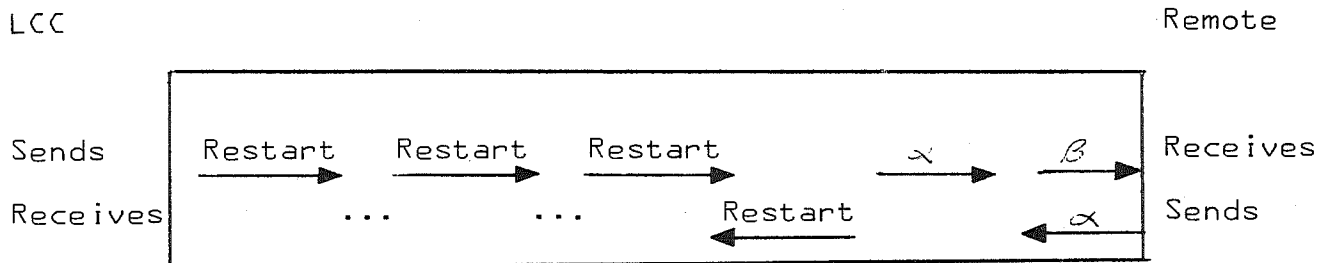
IDLE POLL {LCC initiates restart

in dormant system}

Figure 4.2-2

LCC   Remote

Sends | α →   β →   α → .... Restart →   α → | Receives
Receives | ← β   ← α   ← β {autoload   of LCC}   ← Restart | Sends
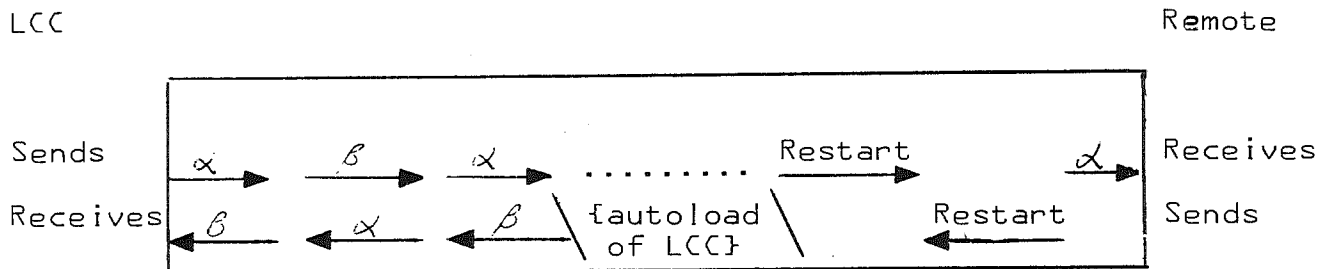
LCC initiates restart during trade

of information

Figure 4.2-3

LCC   Remote

Sends | α →   δ →   α →   Restart → | Receives
Receives | ← β   ← α .... ← Restart   ← Restart | Sends
                     {Autoload of remote}
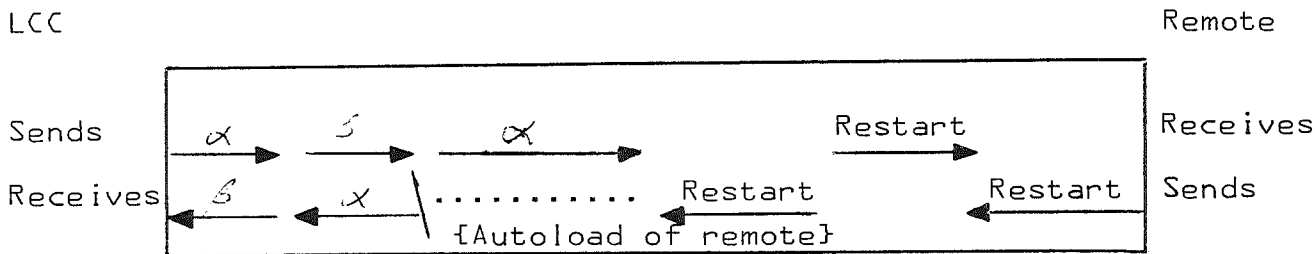
Remote initiates restart during trade of infor-

mation. When the LCC sends the restart it

is the same as in idle poll.

Figure 4.2-4

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ERS_____ PAGE NO._____4-14_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.__I039×1.0_____ MACHINE SERIES_____PL10_____

Alpha Transmission

Type ⋈ information trade consists of two information blocks
The LCC initiates the trade by transmitting a ⱽstatusⱽ block.
After the complete block has been received by the remote
station, the remote station replies with a ⱽdataⱽ block.
An ⋈ status block contains stream control information which
is used by the remote station to direct its activities. An
⋈ data block contains specific data or text which is associ-
ated with an input {odd number} stream and which is destined
for the HLP.

A graphic description of a sequence trade is the following.
An arrow denotes a block of information and its direction.
Read the graph left-to-right.

LCC   Remote
                                                         Terminal

Sends   ⋈ Status →   ⋈ Status →   Received

Receives   ⋈ Data ←   ⋈ Data ←   Send

Figure 4.2-5

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-15
PRODUCT NAME_____ LCC _____
PRODUCT MODEL NO._____ IO39×1.0 _____ MACHINE SERIES_____ PL10

Beta Transmission

Type β information trade also consists of two information blocks. The LCC initiates the trade by transmitting a $^\triangledown$data$^\triangledown$ block. After the complete data block is received by the remote, the remote responds with a $^\triangledown$status$^\triangledown$ block. A β data block contains data or text which is associated with an output {even numbered} stream and which is destined for the remote station. A β status block contains status of streams in the remote, i.e., they are busy, they can accept data, etc.

A graphic description of a sequence of trades is the following. An arrow denotes a block of information and the direction of flow. Read the graph from left-to-right.
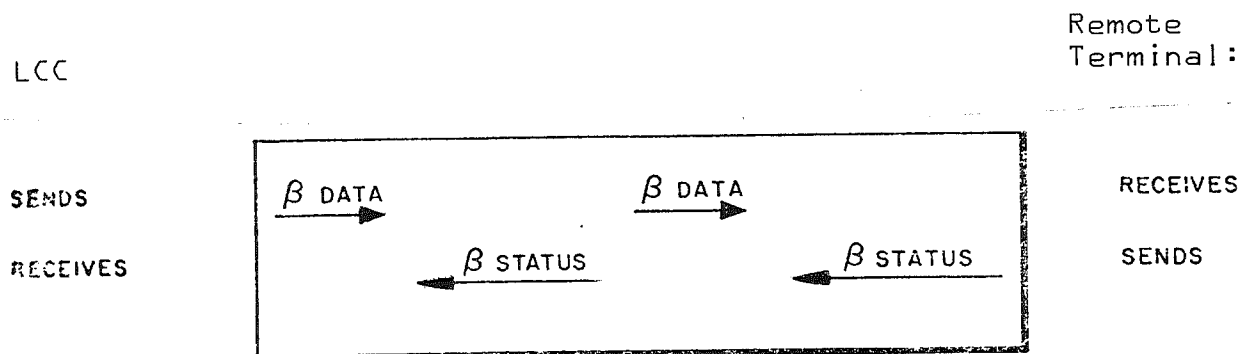
Figure 4.2-6

If there is no information to trade, but communications are to be maintained, the LCC and remote can send an IDLE block {a block with no data or status} in place of the data or status block.

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO. _____ 4-16 ____
PRODUCT NAME _____ LCC _____
PRODUCT MODEL NO. ____ I039×1.0 _____ MACHINE SERIES _____ PL10 ____

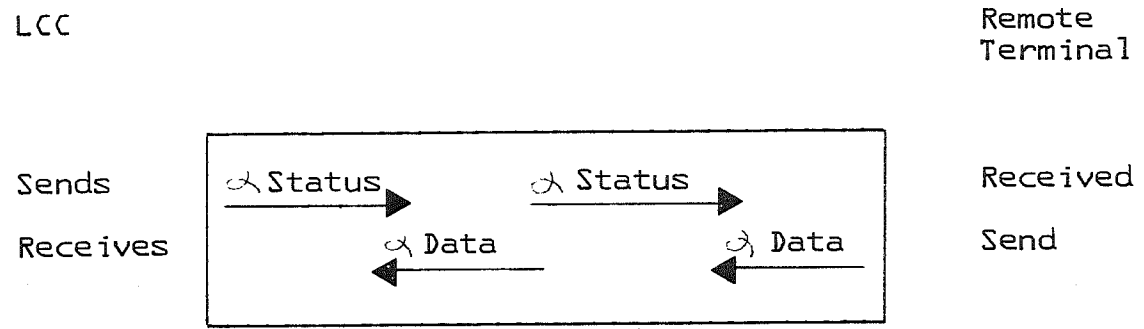LCC   Remote
                                                                       Terminal:

Sends   β DATA   β IDLE   β DATA

Receives   β STATUS   β STATUS   β IDLE   Receives

                                                                       Sends

                              OR   Remote
LCC   Terminal

Sends   α STATUS   α STATUS   α   IDLE

Receives   α DATA   α IDLE   α DATA   Receives

                                                                       Sends
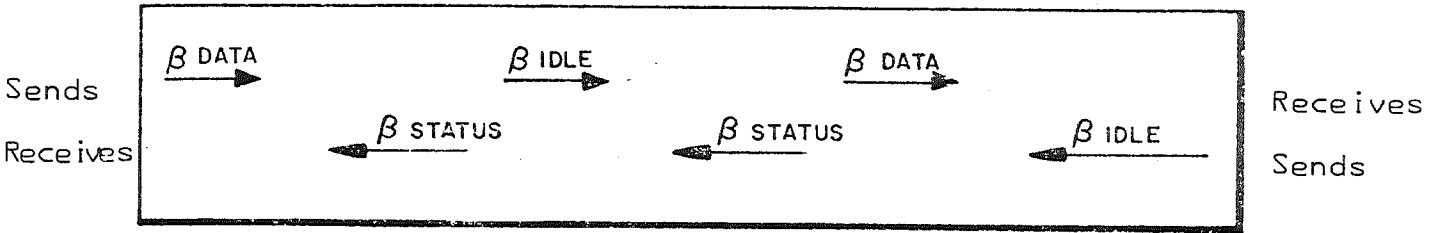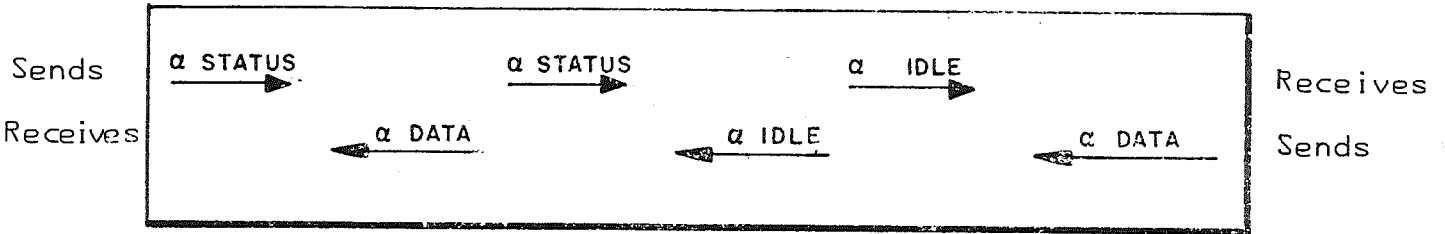
Figure 4.2-7

The LCC with type α and type β information trades merged; is

two-way simultaneous, non-continuous information flow.

See figure 4.2-8 for a graphic description. The LCC

always maintains this sequence of trades. Following every

α transmission, the LCC transmits a β block and then an

α block, etc.

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PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___IO39m1.0_____ MACHINE SERIES_____PL10_____

Alpha and beta blocks are differentiated from each other by a
sequential number scheme. Each block transmitted contains
an even or odd sequence number. The even/odd numbers trans-
mitted by the LCC 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 expected by the LCC in the responding blocks sent by
the remote for α type information blocks are the ASCII charac-
ters, 0 and 1, and for β type information blocks are the ASCII
characters, p and q. See figure 4.2-9 for a graphic description
of this numbering scheme. If the responding block number is
not as it should be, the LCC initiates error recovery.

There are two types of transmission blocks; information blocks
and error information blocks. There are two versions of in-
formation blocks; data information block and status information
block. Data information blocks contain data which is associated
with streams and which is destined for the HLP/or Remote
Station. Status Information blocks contain only stream
information. These blocks are the conversation media used
by the LCC and the remote batch to coordinate their activities.

Error information blocks also have two versions; repeat

block and negative response block. The repeat blocks are

sent by the LCC to the remote to inform the remote that

it must retransmit a block. The negative response block

is sent by the remote to the LCC to inform the LCC

that the remote could not accept the last information

block sent by the LCC. See figure 4.2-10 and 4.2-11 for

a graphic representation of the N/REP blocks.

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DOCUMENT CLASS___ERS_____ PAGE NO.___4-19__
PRODUCT NAME___LCC__
PRODUCT MODEL NO.___IO39×1.0_____ MACHINE SERIES___PL10__

LCC
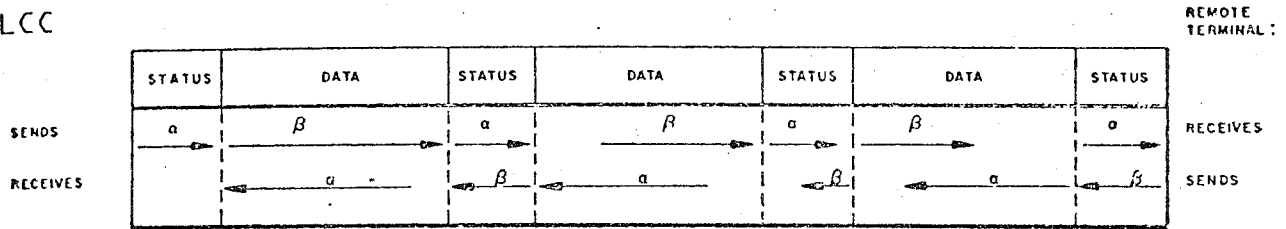
Figure 4.2-8

LCC
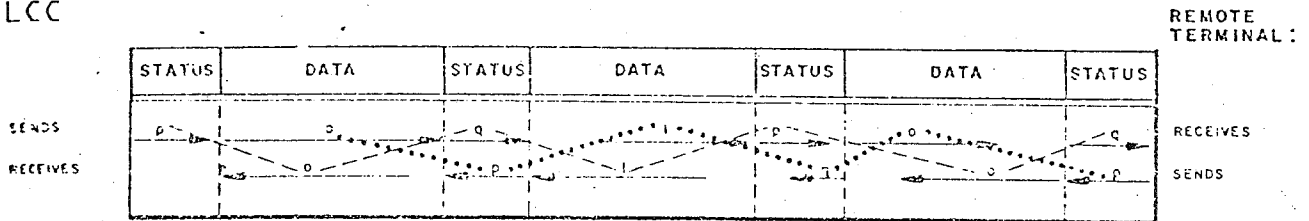
Figure 4.2-9

LCC
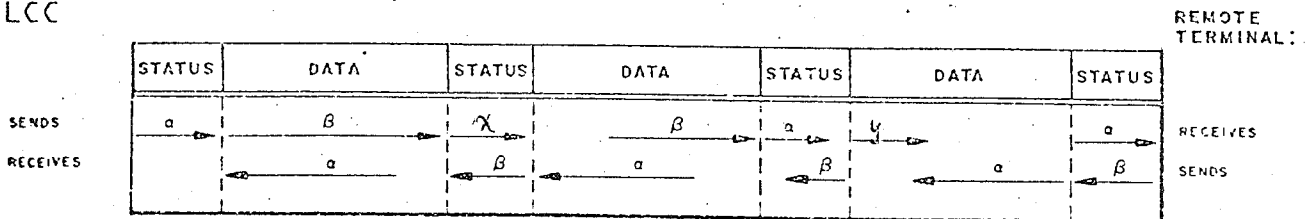
x=repeat   block
y=repeat   block   Figure 4.2-10   {See Section 4.2.2.1}

LCC
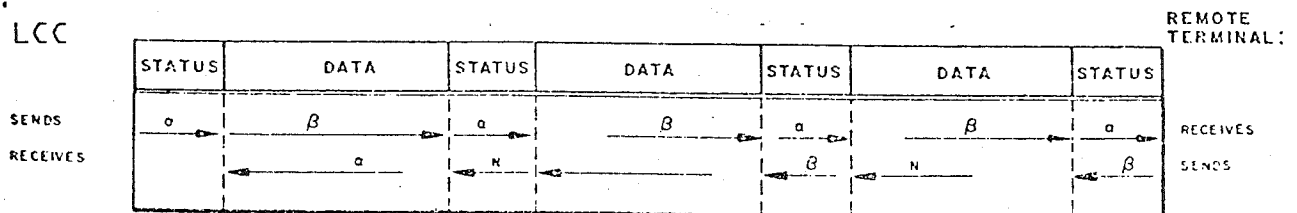
n=negative reply   Figure 4.2-11

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_____ **DIVISION**

DOCUMENT CLASS_____ ERS   PAGE NO._____ 4-20
PRODUCT NAME ___   LCC
PRODUCT MODEL NO. ___ I039×1.0 _____ MACHINE SERIES_____ PL 10

4.2.2 Format of Blocks

Both types of blocks, information blocks and error information blocks, are made up of a combination of the following fields:

OD, CI, DF, ED, CRC

where:

OD = Opening Delimiter. All blocks must have an opening delimiter. This sequence of ASCII characters define the beginning of a transmission block.

CI = Control Information. All information blocks contain some station control information. Station control information is passed with stream identifiers and the current status of those streams.

DF = Data Framing control characters. Data information blocks have the data {i.e., text or routing information} framed with ASCII control characters.

ED = Ending Delimiter. All blocks must have an ending delimiter which signifies the end of a block.

CRC = Cyclic Redundancy Check. All blocks must have this field. It consists of two eight bit bytes.

NOTE: All ASCII control characters must follow standard ANSI rules concerning character parity {i.e. odd parity}.

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PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

4.2.2.1 Opening Delimiters

Three forms of opening delimiters exist for blocks. There is
a form for control blocks, a form for information blocks and
a form for error information blocks.

Control block opening delimiter is:

      DLE   Z

DLE: is the ASCII communication control character referred
to as Data Link Escape.

Z: is the ASCII upper case character Z. This opening
delimiter flags that this block is a control block.

Information block opening delimiters are:

      DLE   XSN

DLE: is the ASCII communication control character referred
to as Data Link Escape.

XSN: Transmission Sequence Number

α XSN: is the odd/even sequencing number defined in Section
4.2.1 for α type information trades. The LCC transmits
the graphic characters p and q. The Remote Station
responds with the graphic characters 0 and 1. See
Figure 4.2-9.

β XSN: is the odd/even sequencing number defined in Section
4.2.1 for β type information trades. The LCC transmits
the graphic characters 0 and 1. The remote station
responds with the graphic characters p and q. See
Figure 4.2-9.

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PRODUCT MODEL NO. _____ I039x1.0 _____ MACHINE SERIES _____ PL10 _____

Error information block opening delimiters are:

1.   DLE   REP

2.   DLE   N

DLE: is the ASCII communication control character referred
        to as Data Link Escape.

REP: is the ASCII graphic character X in α type information
        trades and is y in β type information trades. This
        opening delimiter flags that this block is a REPeat
        block. See Section 4.2.3, Error Recovery.

N: is the ASCII character N. This opening delimiter is
        used by the remote to flag the last message was not
        received correctly. See Section 4.2.3, Error Recovery.

4.2.2   Control Information

Station Control Information

Station control information is made up of 8-bit bytes referred
to as SID {Stream IDentifier}. Each SID {8-bit byte} contains
the current status of a stream along with its identifier. A
SID has the following 8-bit structure.

          P1XXXXYY

where:

P: is the parity of the SID

1:      is the flag that says this is a non-communication
        control character.

XXXX: is the stream number of a source/link path. Even
        numbered streams refer to output simplex paths from
        a source {i.e. buffer} in the HLP to a sink in the

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PRODUCT MODEL NO. ___ IO39м1.0 _____ MACHINE SERIES _____ PL10 _____

remote station. Odd numbered streams refer to in-

put simplex paths from a source in the remote to a

sink {i.e., buffer} in the HLP. The maximum stream

number is 15 {decimal}, and the minimum stream number

is zero {i.e., $0 \angle XXXX \angle 15$}.

YY: defines the current status of this stream. See Figure

4.2-12 for the meanings of these bits.

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DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-23 _____
PRODUCT NAME_____ LCC _____
PRODUCT MODEL NO. ____ IO39ᴹ1.0 _____ MACHINE SERIES_____ PL10 _____

Control Block Information Code {CBC}

The control block information code is made up of 8-bit bytes.

The code has the following 8-bit structure:

$$P1XXXXXX$$

where:

P - is the parity of the code.

1 - is the flag that says this is a non-communication
    control character.

XXXXXX - is the actual code. The only defined code is 000001
         = restart.

WHEN LCC IS TRANSMITTING

INPUT STREAM (ODD NUMBER)	YY	OUTPUT STREAM (EVEN NUMBER)
CTS	OO	RTS
———	OI	DATA
———	IO	———
AS	II	AS

WHEN LCC IS RECEIVING

INPUT STREAM (ODD NUMBER)	YY	OUTPUT STREAM (EVEN NUMBER)
RTS	OO	CTS
DATA	OI	BUSY
SOURCE IDLE	IO	SINK IDLE
NA	II	NA

Figure 4.2-12

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DOCUMENT CLASS_____ ERS _____ PAGE NO._____4-24
PRODUCT NAME_____ LCC
PRODUCT MODEL NO.____ I039×1.0 _____ MACHINE SERIES_____ PL10

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 following

data to the sink.

BUSY = The stream sink is unable to receive data,

it is currently occupied with previous data.

IDLE = The source/Sink is idle, no activity is going

on - however, it is not yet prepared to

send/receive data.

N/A = Not available, the source/sink is not avail-

able for any activity. {Example of reason

for N/A is the remote sink, such as a printer,

is down.}.

A/S = Abort Stream, the LCC is terminating current

operations on this stream. {Example of

reason for this status is the HLP has gone down,

or the HLP has terminated the stream, etc.}.

4.2.2.3 Data Framing

Data Information blocks are the only blocks which contain

data framing characters. These characters precede the

data. They define the characteristics of the following

data characters. See figure 4.2-13 for a train graph

of block formats. The data framing characters are the

following ASCII Control Characters:

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PRODUCT MODEL NO. _____ I039×1.0 _____ MACHINE SERIES _____ PL10 ____

Block Format Train

Figure 4.7-13
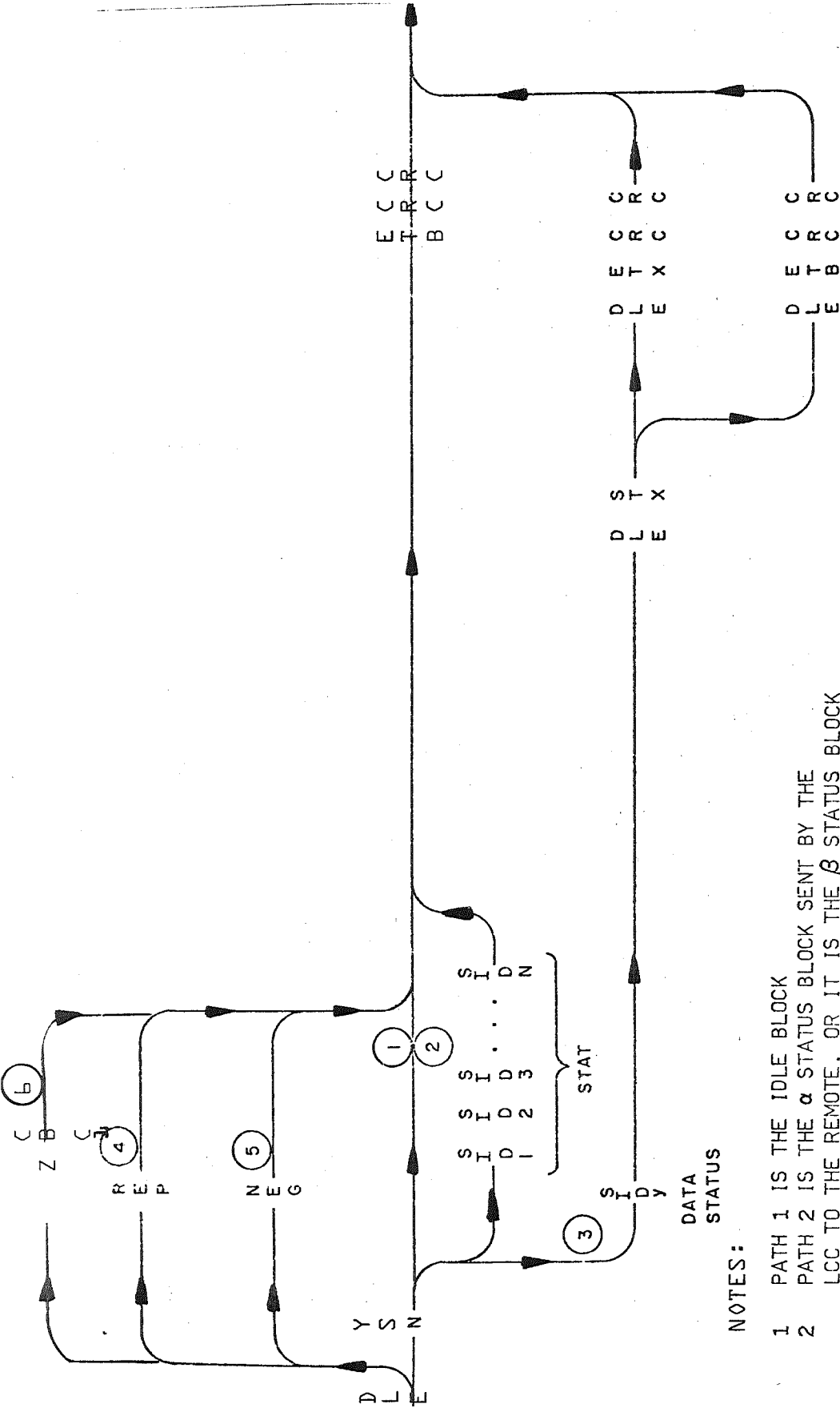
NOTES:

1 PATH 1 IS THE IDLE BLOCK
2 PATH 2 IS THE α STATUS BLOCK SENT BY THE
   LCC TO THE REMOTE, OR IT IS THE β STATUS BLOCK
   RESPONSE SENT BY THE REMOTE TO THE LCC.

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

4 PATH 4 IS THE REPEAT BLOCK SENT BY THE LCC
   TO THE REMOTE.

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

6 PATH 6 IS THE CONTROL BLOCK SENT BY EITHER THE LCC OR THE REMOTE
   XSN = SEQUENTIAL α or β number. (i.e. P, Q, 0, 1)
   STAT = STREAM STATUS yy

TSTX   = Start of Transparent Text. This character
{DLE, STX}

sequence delimits the end of station con-

trol information and the start of trans-

parent data {text} in a block. The

following data characters are 8-bit bytes

with no parity.

4.2.2.4 Ending Delimiters

All blocks must have an ending delimiter. The ending

delimiters are the following ASCII control characters.

ETB = End of this transmission block. This character

is used only on idle blocks or control blocks.

It is never used with a data block.

TETB = End of transparent text for this transmission
{DLE,ETB}
        block. However, more transparent text for this

        stream is pending {i.e. an implied Request to Send}.

TETX = End of transparent text for this transmission
{DLE,ETX}
        block and for this message or file.

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PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.____IO39×1.0_____ MACHINE SERIES_____PL10_____

4.2.2.5 <u>Cyclic Redundancy Check</u> {CRC}

A maximum of two CRC bytes must be accumulated at both

the sending and receiving stations during the transmission

of a message to facilities error detection. They are

transmitted following the ending delimiters of blocks.

<u>Function</u>:

1. The accumulation is started by the appearance of the

    first opening delimiter character of a block. The

    accumulation begins immediately with the opening DLE.

2. All characters, with the exception of those listed

    in 4 below, transmitted after the start of the

    accumulation are included in the accumulation, through

    and including the end-of-block or end-of-text

    delimiter. {ETB, TETB, or TETX}.

3. The CRC bytes are transmitted following the end-of

    block or end-of-text delimiter. The accumulation is

    reset and restarted with the appearance of the

    opening delimiter of the following transmission

    block.

4. Characters which are excluded from the accumulation
are as follows:

a. SYN characters {synchronization characters appearing
after the opening delimiter and before the TSTX.

b. TSYN characters {DLE, SYN} appearing after the open-
ing delimiter.

c. One DLE of DLE sequences that appear in transparent
text. All ASCII control characters
have character parity in bit 8. Trans-
parent text uses bit 8 for data, thus allowing all
256 bit combinations in each byte. The Data Link
Escape {DLE} character is used to introduce trans-
parent text transmission and subsequently to dis-
tinguish control character bit configurations which
may be present in the data stream. Once within the
text {i.e., subsequent to a DLE STX}, control codes
are recognized as such only when immediately preceded
by a DLE code. To preclude data simulation of this
sequence, the following procedure is followed: The
transmitting station monitors the data stream and
when the bits within a byte position duplicate the
DLE bit configuration, it inserts an additional DLE
character into the stream and follows it with the
data DLE character. The receiving station interprets
DLE, DLE character sequences to be representative
of a single data byte with a bit configuration

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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 code sequences.

The generating polynomial G {x} used in the LCC cyclic encoder
is: $G\{x\} = X^{16} + X^{15} + X^2 + 1$
The remote station must use the same polynomial.

All {n-k} data and control bits included in the accumulation,
along with the k redundancy bits transmitted after the data
and control bits, form a code polynomial of the form -
$X^{n-1} + X^{n-2} + ... + X+1$ - that is evenly divisible by G {x}.
With the LCC cyclic encoder unit, it is necessary to pass 16
binary zeros through the encoder after all data and control
bits have been passed through in order to come up with the
proper redundancy bits. It is important that a compatible
implementation at a remote station take these properties of code
polynomial into account.

4.2.2.6 Synchronization

The ASCII character used to maintain bit and character synchron-
ization {meaning the line is sampled at regular intervals} is
�SYN⌄. In Mode 2 a minimum of two SYN characters must precede
each transmission block. If the transmitting end must ⌄time-
fill⌄ once it has sent the data framing characters, see Section
4.2.2.3; it must time-fill with TSYN {DLE SYN}.

4.2.2.7 Specific Block Format

Each variation of block type has a unique combination of the above specified fields. See Figures 4.2-14, -15, -16 for examples of these combinations in an information flow.

A. Information Blocks

1. Data Blocks: OD, CI, DF, {DATA}, ED, CRC

OD = DLE, α or β XSN, XSN is sequential transmission number

CI = One SID {only} with YY status equal to DATA

DF = The data framing characters DLE, STX

ED = The ending delimiter characters DLE, ETX, or DLE, ETB

CRC

2. Status Blocks: OD, CI, ED, CRC

OD = DLE, α or β XSN, XSN is sequential transmission number

CI = A variable number of SID's

Example:

S	S	S	S	S	S
I	I	I	I	I	I
D	D	D	D	D	D
0	1	3	4	5	8
RTS	CTS	CTS	RTS	IDLE	RTS

ED = ETB

CRC

3. Idle Block: OD, ED, CRC

OD = DLE, α or β or XSN, XSN is sequential transmission number.

ED = ETB

CRC

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DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-31 _____
PRODUCT NAME _____ LCC _____
PRODUCT MODEL NO. ___ I039×1.0 _____ MACHINE SERIES _____ PL10 ____

B. Error Information Block

    1. Repeat Blocks: OD, ED, CRC

        OD = DLE, x, or y

        ED = ETB

        CRC

    2. Negative Response Blocks: OD, ED, CRC

        OC = DLE, N

        ED = ETB

        CRC

C. Control Block

    1. Restart Block: OD, CBC, ED, CRC

        OD = DLE, Z

        CBC = 11000001

        ED = ETB

        CRC

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-32 _____
PRODUCT NAME _____ LCC
PRODUCT MODEL NO. _____ IO39ᴹ1.0 _____ MACHINE SERIES _____ PL10

Above Figure Shows Data, Status, Idle Blocks

Figure 4.2-14

Above Figure Shows Data, Status, Idle, Rep Blocks
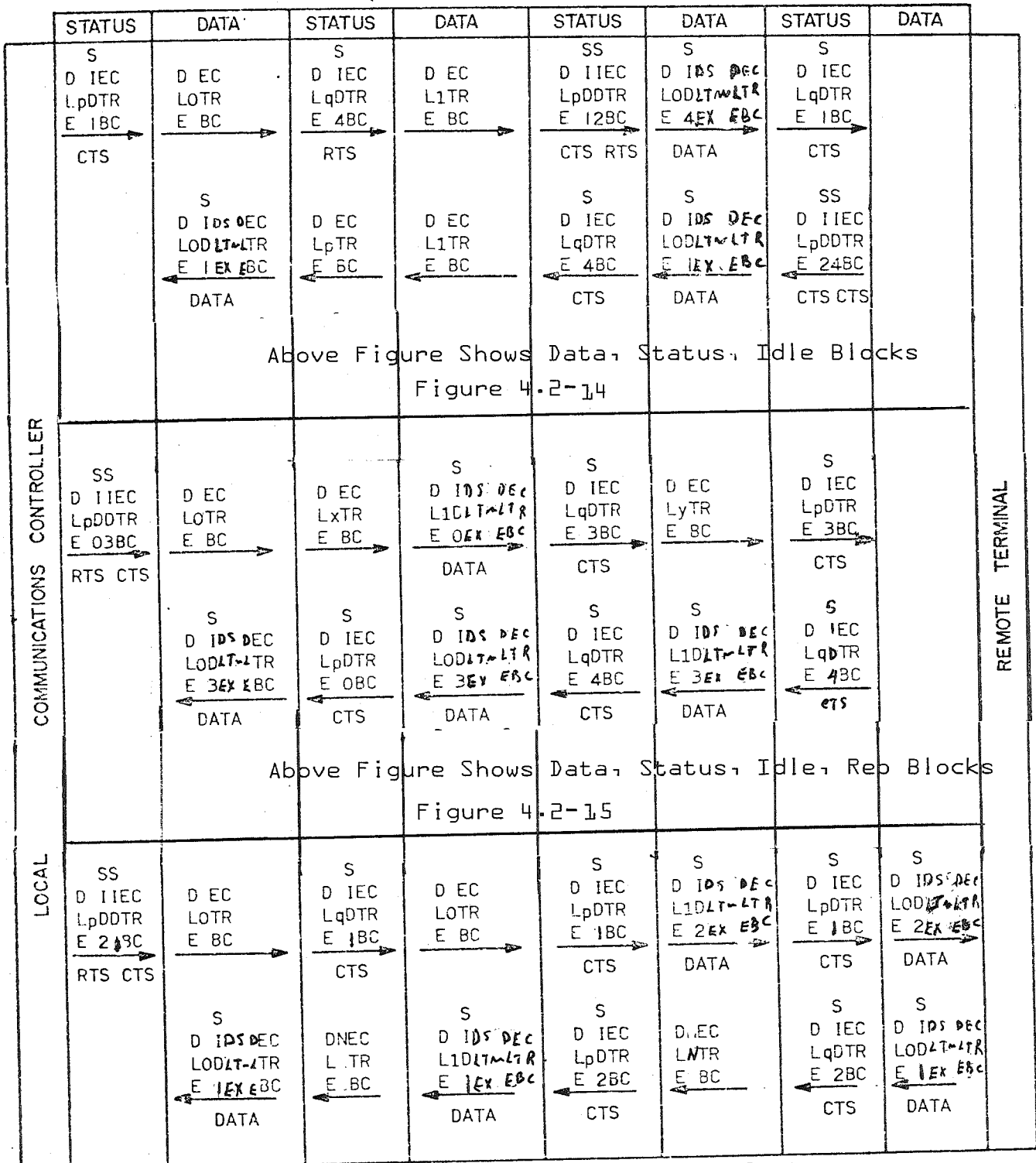
Figure 4.2-15

Above Figure Shows Data, Status, Idle, N Blocks

Figure 4.2-16

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ERS_____ PAGE NO._____4-33_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039*1.0_____ MACHINE SERIES_____PL10_____

4.2.3 Error Recovery

The LCC initiates a time out feature. After the completion
of a block transmission, the LCC sets a time of N milliseconds
{the value N is determined at assembly time}. If the value
N is reached before a valid response is received from the
remote, the LCC initiates error recovery.

The remote station will receive LCC transmission blocks
in one of the following three conditions:

a. Invalid - An invalid transmission block is one whose
    opening {DLE,XSN} and closing {ETB/ETX} delimiters were
    not recognized to be in proper form.

b. Valid and Incorrect - A valid and incorrect transmission
    block is one that is valid, but has character parity or
    CRC error.

c. Valid and Correct - A valid and correct transmission is
    one that is valid and has no character parity or CRC
    error.

Responses to transmission blocks depends on the condition and
content of the block as shown in Figures 4.2-17, -18.
Figures 4.2-19 through 4.2-27 graphically show information
flow and error recovery.

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-34 _____
PRODUCT NAME _____ LCC _____
PRODUCT MODEL NO. _____ I039 ×1.0 _____ MACHINE SERIES _____ PL10 _____

REMOTE TERMINAL RECEIVES	REMOTE TERMINAL RESPONDS WITH
1. Valid and Correct Block with:	
a. Data or Status Block in Proper Sequence	a. 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	b. A repetition of the last correct data or status block, if the corresponding block number is not correct.
c. Repeat Request Block (REP)	c. A repetition of the last correct data or status block.
2. Valid and Incorrect Block	2. DLE, N, ETB, CRC
3. Invalid Block	3. No response

Figure 4.2-17

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-35
PRODUCT NAME_____ LCC
PRODUCT MODEL NO. _____ ID39 ×1.0 _____ MACHINE SERIES_____ PL10

LCC RECEIVES	LCC RESPONDS WITH
1. Valid and Correct Block with:	
a. Data or Status Block in Proper Sequence	a. A new data or status block with an updated sequence number
b. Data or Status Block in Improper Sequence	b. A retransmission of the last correct data or status block
c. Negative Response {N}	c. A retransmission 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 time out and the last correct data or status block

Figure 4.2-18

CONTROL DATA CORPORATION

——————————————————————————— DIVISION

DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-36
PRODUCT NAME _____ LCC
PRODUCT MODEL NO. _____ I039×1.0 _____ MACHINE SERIES _____ PL10

REMOTE
TERMINAL

α BLOCK IS RETRANSMITTED

β BLOCK IS RETRANSMITTED

αl (LOST IN TIME OUT)
IS RETRANSMITTED

βq (LOST IN TIME OUT)
IS RETRANSMITTED

α BLOCK TIMED OUT

β BLOCK TIMED OUT

α BLOCK TIMED OUT

β BLOCK TIMED OUT

LOCAL
COMMUNICATIONS
CONTROLLER

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 4.2-19
4.2-20

Error Recovery Information Flow
Examples: α/β Invalid or No
Response Blocks With Time Out

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS____ERS_____ PAGE NO.____4-37____
PRODUCT NAME____LCC
PRODUCT MODEL NO.____I039×1.0_____ MACHINE SERIES____PL10____
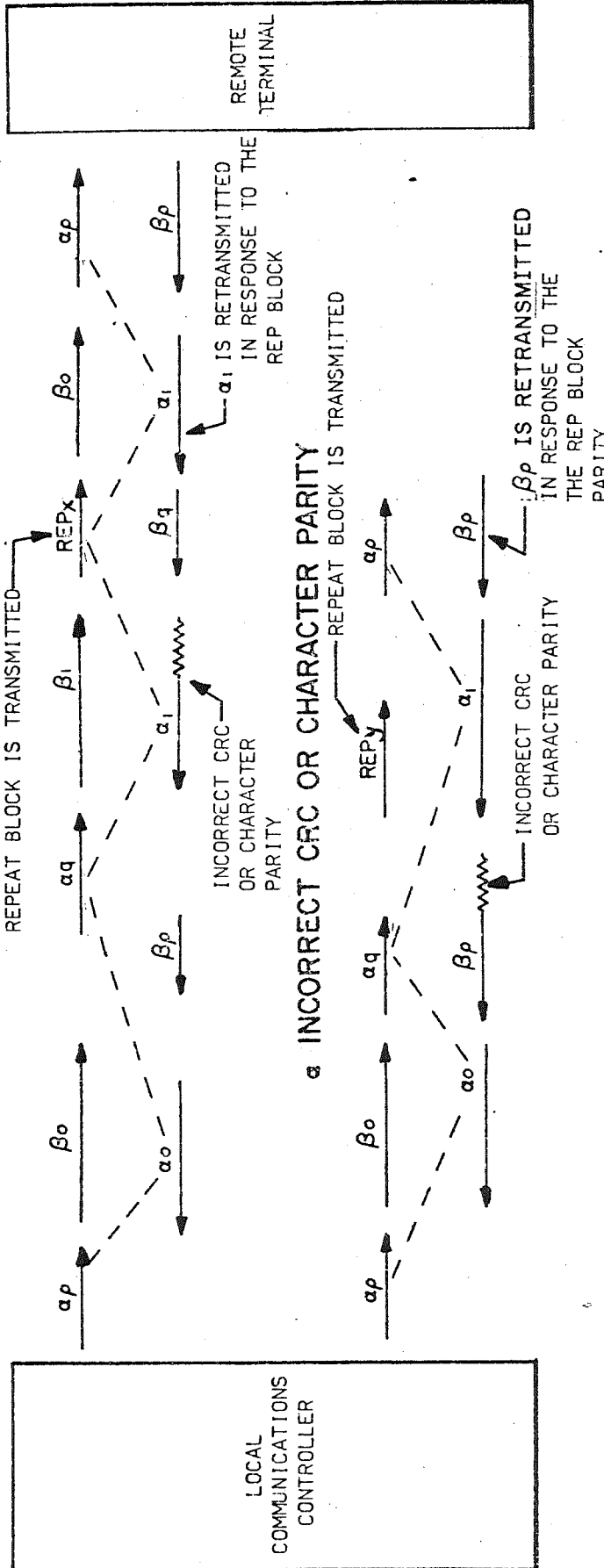
FIGURE 4.2-21 Error Recovery Information Flow

4.2-22 Examples: α/β Valid and Incorrect Blocks With Repeat Response

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-38
PRODUCT NAME _____ LCC
PRODUCT MODEL NO. ___ I039×1.0 _____ MACHINE SERIES _____ PL10
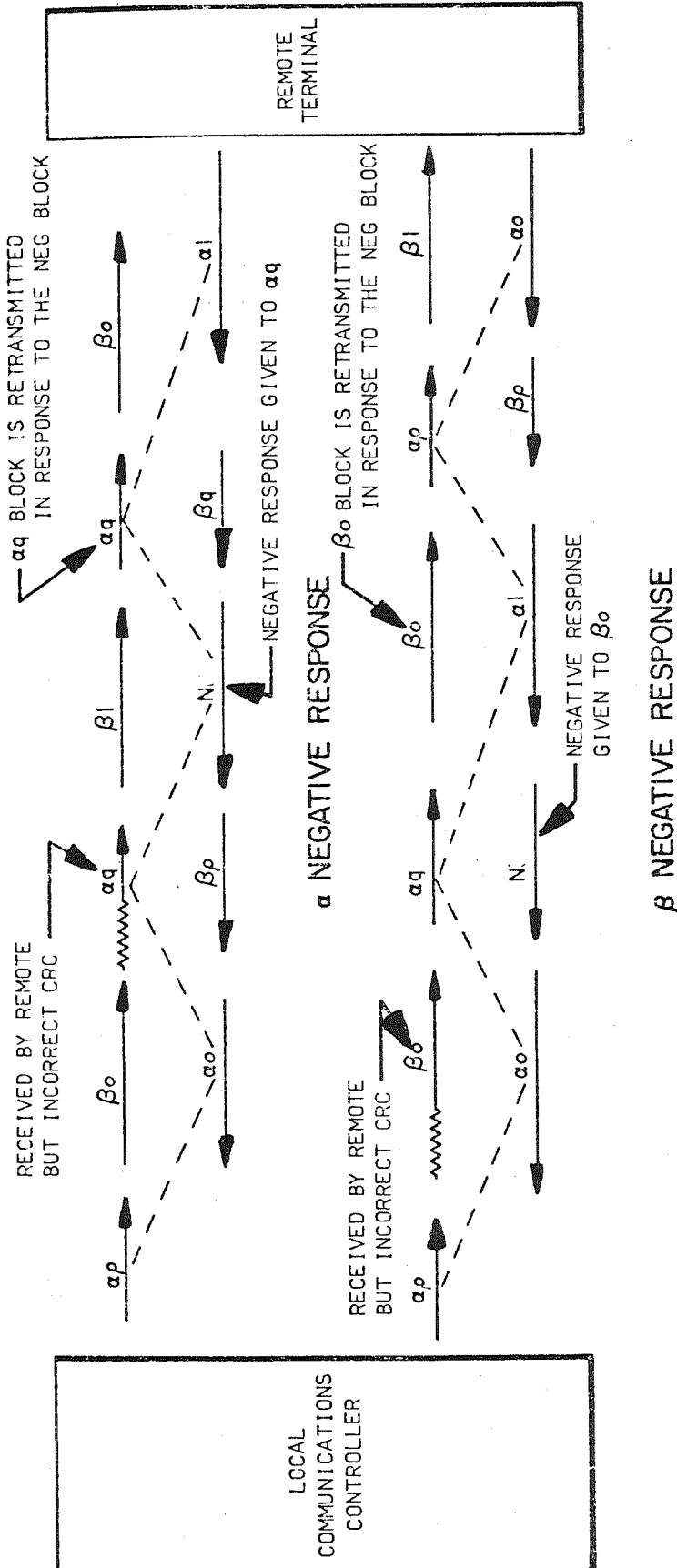
α NEGATIVE RESPONSE

β NEGATIVE RESPONSE

Error Recovery Information Flow

Examples: α/β Valid and Incorrect
Blocks With Negative Response

FIGURE   4.2-23

        4.2-24

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS___ERS_____ PAGE NO.____4-39____
PRODUCT NAME___LCC_____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

FIGURE 4.2-25

Error Recovery Information Flow

Example: Valid and Incorrect
Block With Repeat Response and
Invalid or No Response Block
With Time Out

REMOTE RECEIVES AN α BLOCK WHICH
IS OUT OF SEQUENCE (THAT IS, α p
INSTEAD OF α q). THE REMOTE
RESPONDS WITH THE LAST VALID
α BLOCK (THAT IS, αo).

LAST VALID α
BLOCK SENT
TO REMOTE

REPEAT RESPONSE
FOR αo BLOCK HAS
INCORRECT CHARACTER
PARITY
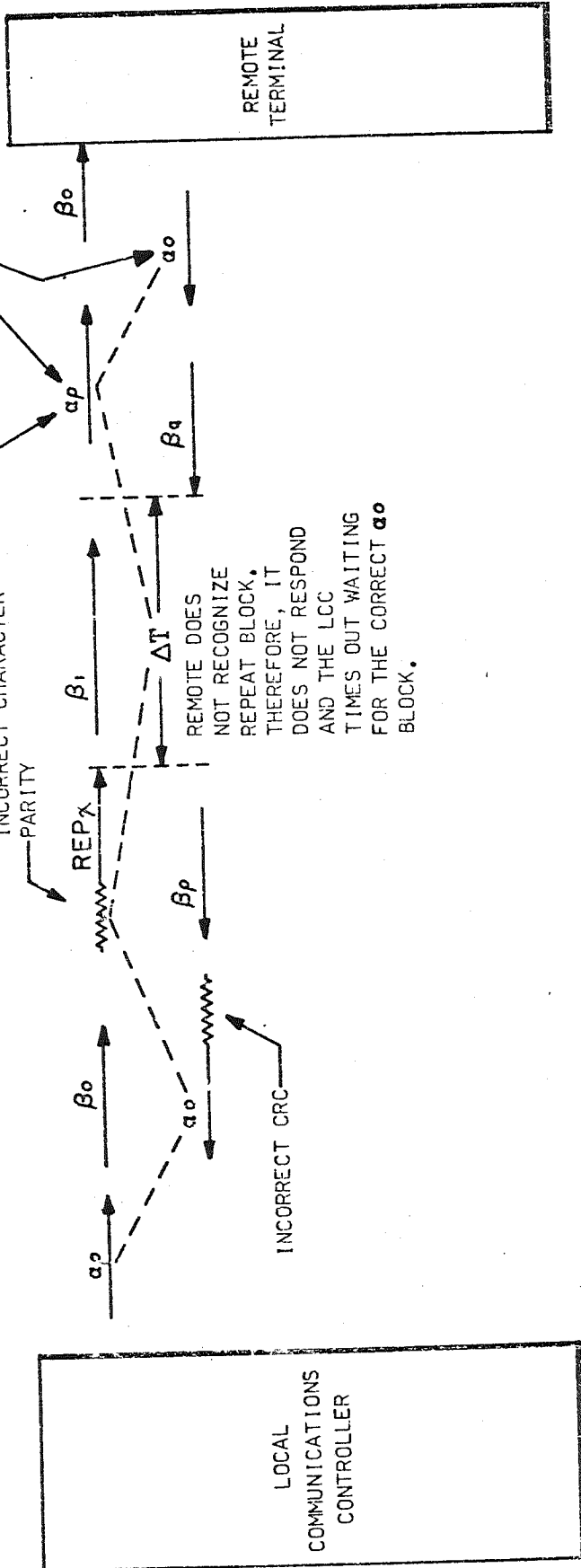
REMOTE DOES
NOT RECOGNIZE
REPEAT BLOCK.
THEREFORE, IT
DOES NOT RESPOND
AND THE LCC
TIMES OUT WAITING
FOR THE CORRECT αo
BLOCK.

INCORRECT CRC

REMOTE
TERMINAL

LOCAL
COMMUNICATIONS
CONTROLLER

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO.____ 4-40
PRODUCT NAME_____ LCC
PRODUCT MODEL NO.____ IO39 ×1.0 _____ MACHINE SERIES____ PL10

REMOTE TERMINAL

β_1

α_1

REMOTE RECEIVES
AN α BLOCK WHICH
IS OUT OF SEQUENCE
(THAT IS, α_p INSTEAD
OF α_q). THE REMOTE
RESPONDS WITH THE
LAST VALID α BLOCK
(THAT IS, α_o)

α_q

β_p

LAST VALID α
BLOCK SENT
TO REMOTE

β_o

α_o

α_p

β_q

REPEAT RESPONSE
FOR α_o BLOCK HAS
INCORRECT CRC

β_1

N

REP α

β_p

NEGATIVE
RESPONSE

β_o

α_o

INCORRECT CRC

α_p

LOCAL
COMMUNICATIONS
CONTROLLER

Error Recovery Information Flow
Example: Valid and Incorrect
Block With Negative Response
and Out of Sequence

FIGURE 4.2-26

AA 3777

PRINTED IN U.S.A.

FIGURE 4.2-27

Error Recovery Information Flow
Example: Valid and Incorrect
Blocks With Negative and Repeat
Responses

CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ ERS _____ PAGE NO.____4-42_____
PRODUCT NAME_____ LCC _____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

4.3   Operation With HLP

The HLP activates a line {i.e., tells the LCC to service a line} by establishing a Request List and entering its address in the Line List. The HLP then sets the channel flag causing the LCC to search the Line List. The LCC activates all new entries in the Line List, clears the channel flag, and reports to the HLP that the line or lines are in an idle poll state and that the channel flag is cleared.

When a line is in an idle poll state the LCC periodically polls the remote station to see if it is ready to establish communications {i.e. trade blocks of information}. If the LCC does not get a response to the poll {i.e. a time out occurs}, the LCC will poll the remote station again. When the LCC receives the required response to a poll, it initiates information trades with the remote and scans the HLP lists for requests.

If the HLP wants to take that line out of an idle poll state it must issue an HLP to LCC request to close the line. This request must be accompanied by a channel flag, because the LCC does not reference the Request List for a line when the line is in an idle poll state.

Once communications with the terminal has been established, the LCC continually scans the Request List for that line.

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PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.____I039*1.0_____ MACHINE SERIES____PL10_____

Associated with each request is a command. Commands direct the LCC to perform some function. Commands for streams have only two allowed functions to be executed. An input stream {odd numbered stream} can read data and an output stream {even numbered stream} can write data. Input stream requests to read will be rejected by the LCC if an unsolicited RTS has not been received from the remote terminal. Stream commands also define data buffers.

For input streams, the buffers should be a multiple of the transmission block size defined for this stream request. As each full transmission block {transmission blocks are multiples of four bytes} for the requested stream is received from the remote, the LCC does the following checks:

1. If the block received is not a full block {the maximum number of bytes for the requested transmission block size and not necessarily a multiple of four bytes}, and is terminated successfully with the byte count reflecting the number of bytes successfully received and the response status reflects that the ending delimeter was an ETB.

2. If the block received is a full block and is terminated with an ETB ending delimiter, the LCC checks the HLP buffer byte count to see if the remaining portions of the buffer is smaller than the block of bytes to be received from the remote. If there is sufficient room for another full block, the LCC continues to receive data. If there is not

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PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.__I039*1.0_____ MACHINE SERIES___PL10_____

sufficient room for another full block, the stream request

is terminated successfully with the byte count reflecting

the number of bytes successfully received, and the response

status reflects that the ending delimiter was an ETB.

3. If the stream request defines a transmission block size,

the value obtained via the block type index received in the

stream request, that is larger than the HLP data buffer

byte count, the stream request is rejected as abnormal. It

is up to the HLP to insure the integrity of the transmission

block size defined in the stream request. If the HLP

specifies a block type of zero, the LCC inputs data into

HLP buffer until it is full, i.e., only one block of data

is expected, or until an ending delimiter is received. See

Section 4.3.3 for an explanation of transmission block size

and Section 4.1.3.2 for an explanation of blocking of data.

4. If a transmission block is received from the remote which

is terminated with an ETX {denotes the last block of the

message} the stream request is terminated successfully. The

byte received successfully {byte count can be zero, if a

transmission block is received with no data bytes} and the

response status reflects that an ETX was received.

5. If an HLP data buffer is terminated with an ETB, the request

is terminated successfully with the byte count reflecting

the number of bytes successfully received. The response,

also, implies that the remote has more data to send {i.e.

implied unsolicited response of a RTS}. The HLP must issue

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DOCUMENT CLASS_____ERS_____ PAGE NO._____4-44.1_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039*1.0_____ MACHINE SERIES_____PL10_____

another read request for this stream. This implied RTS is

also true for the conditions stated above in 1 and 2.

6. If the LCC subsystem receives a data information block

from the remote, it accepts the block and increments the

HLP byte count by zero. Thus, if the block were terminated

with a TETX, the LCC could terminate a read request

successfully with a byte count of zero.

For output stream requests the LCC subsystem does the following:

1. The LCC transmits the HLP data in as many even multiples of

the transmission block size as possible. Each transmission

block is transmitted with the ending delimiter TETB. The

last block of data in the HLP buffer is transmitted with

the stream requested ending delimiter TETB or TETX.

2. The LCC subsystem software transmits the last block from

an HLP data buffer "even" if it is not a full transmission

block or an even multiple of four bytes. The intermediate

blocks transmitted from a buffer must be multiples of four

bytes.

3. A stream request defining an HLP data buffer byte count of

zero is treated as a proper request, a data information

block is transmitted with no data and the request is

successfully terminated with a byte count of zero. See

Section 3.2.3.

4. If the HLP specifies a block type of zero, the LCC outputs

data from the HLP data buffer in one transmission block.

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PRODUCT MODEL NO. ___ I039*1.0 _____ MACHINE SERIES ___ PL10 _____

It is up to the HLP to verify that the remote terminal will accept a transmission block of an indeterminate length.

5. If the HLP issues a write with ETB request, the LCC sub-system transmits all blocks with the ending delimiter TETB. The receipt of this by the remote terminal ending delimiter infers that more data is coming, i.e., the file is not complete. Thus it is important that the HLP issue consecutive write with ETB requests until the end of the file or write with TETX.

6. The LCC subsystem does not terminate a stream write with ETB request until the remote terminal replies {in a status transmission block} with a CTS status. Thus, the remote is ready to receive more data. {See Figure 5.2-12.}

7. The LCC subsystem does not terminate a stream write with ETX request until the remote terminal replies with an IDLE status. This implies that the remote terminal has successfully output the last block of data.

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DOCUMENT CLASS_____ERS_____ PAGE NO._____4-45_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

4.3.1 Request Entry Format: HLP to LCC

The following is the expansion of the first entry slot in the request list as shown in the second box of Figure 3.1-4.
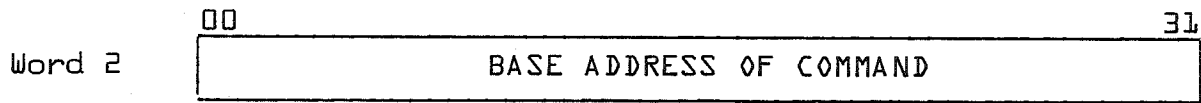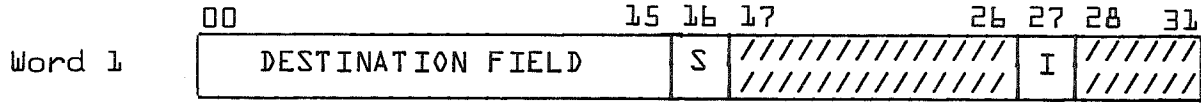
```
        00                          15 16 17        26 27 28   31
Word 1  | DESTINATION FIELD        | S |////////////| I |//////|
                                       |////////////|   |//////|
```

```
        00                                                    31
Word 2  |           BASE ADDRESS OF COMMAND                   |
```

Bits 17-26 and 28-31 should be filled with zeroes

WORD	BITS	DESCRIPTION
1	00-15	Destination Field: Supplied by the HLP and 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 LCC clears this bit when it initiates this request.
		˅1˅ - This request is ready for initation. The HLP sets this bit when it enters a new request.
	27	I Field: Interrupt and Response Options
		0 - Do not send interrupt with request response.
		1 - Send interrupt with request response.

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DOCUMENT CLASS_____ERS_____ PAGE NO.____4-46____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___I039×1.0_____ MACHINE SERIES_____PL10_____

4.3.2 Request Entry Format: Stream

The following is an expansion of the other entry slots used for streams as shown in the third box of Figure 3.1-4.

```
        00                    15 16 17 18 19 20 21   23 24     27 28   31
Word 1  | DESTINATION FIELD   |S|//|P|///////////|    I   |//////|
        |                     | |//| |///////////|        |//////|
```

```
        00                                                          31
Word 2  |            BASE ADDRESS OF COMMAND                        |
```
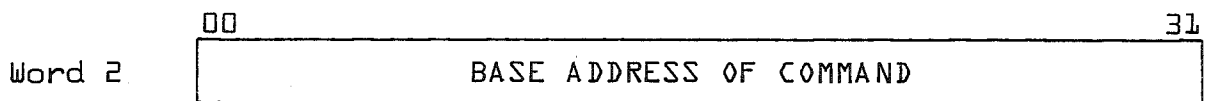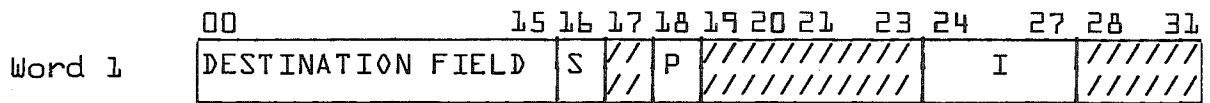
Bits 17, 19-23, and 28-31 should be filled with zeroes.

WORD	BITS	DESCRIPTION
1	00-15	Destination Field: Required in all requests. It is returned in the solicited response. This field is free for HLP use.
	16	S Field: Status of this request slot.
		"0" - This request is active or has been completed. The LCC clears this bit when it initiates this request.
		"1" - This request is ready for initiation. The HLP sets this bit when it enters a new request.
1	18	P Field: Priority Request
		"0" - Normal priority
		"1" - Preemptive priority

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DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-47 _____
PRODUCT NAME_____ LCC _____
PRODUCT MODEL NO. ____ IO39×1.0 _____ MACHINE SERIES_____ PL10 _____

WORD	BITS	DESCRIPTION
	24-27	<u>I Field</u>: Interrupt and Response Options
		00XX - Do not send response or interrupt when request is initiated.
		01XX - Not valid bit combination.
		10XX - Send response when request is initiated.
		11XX - Send response and interrupt when request is initiated.
		XX00 - Do not send interrupt when request is completed.
		XX10 - Send interrupt if request terminates abnormally.
		XX01 - Not valid bit combination.
		XX11 - Send interrupt when request is completed or terminated.

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DOCUMENT CLASS_____ERS_____ PAGE NO._____4-48
PRODUCT NAME_____LCC
PRODUCT MODEL NO._____I039×1.0_____ MACHINE SERIES_____PL10

4.3.3 Command Format: Stream

```
        00              07 08        15 16                    31
Word 1  | FUNCTION CODE  |  B FIELD  |      BYTE COUNT         |
```

```
        00                                                    31
Word 2  |          BASE ADDRESS OF DATA BUFFER                |
```

WORD	BITS	FUNCTION CODE {HEX}	DESCRIPTION
1	00-07	00	Read - The LCC stores the data it receives from the line and stream {defined in the request} into the data buffer.
	08-15		B Field - An index for a table containing various block byte counts. The index may range from 1-7. The index must point to the proper entry in the table describing the block size {block sizes must be multiples of 4 bytes} for this particular stream. The entries in the table are defined at assembly time. If the B field is zero, no blocking is associated with the request and the data buffer byte count is used as the blocking factor.
		80	Write transparent text with ETB.
		81	Write transparent text with EOM {i.e. ETX}.

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DOCUMENT CLASS_____ ERS _____ PAGE NO._____ 4-49 _____
PRODUCT NAME_____ LCC _____
PRODUCT MODEL NO. ____ I039×1.0 _____ MACHINE SERIES_____ PL10 _____

WORD	BITS	FUNCTION CODE {HEX}	DESCRIPTION
	16-31		Byte Count - This field specifies the number of 8-bit data bytes to be processed {read or write} from the data buffer. The byte count must be less than 7FFF hex.

4.3.4   Command Format: HLP to LCC

```
         00           07 08      15 16                          31
Word 1  │FUNCTION CODE │   A1    │            A                  │

         00                                                      31
Word 2  │                        B                               │
```

WORD	BITS	FUNCTION CODE (HEX)	DESCRIPTION
1	00-07	F1	Close a Communication Line
			This function causes the LCC to terminate all outstanding stream requests to this line. Since this is a requested action when the stream requests are terminated, their responses will reflect an abnormal termination. Before the LCC writes the completion response to this request it scans each entry in the Line Request Queue. If there is a new request it is a terminated abnormally. When all the entries have been scanned all references to this line are eliminated, the line is considered to be inactive.

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DOCUMENT CLASS _____ ERS _____ PAGE NO. _____ 4-51 _____
PRODUCT NAME _____ LCC _____
PRODUCT MODEL NO. ___ I039*1.0 _____ MACHINE SERIES _____ PL10 _____

WORD	BITS	FUNCTION CODE {HEX}	DESCRIPTION
		F2	**Terminate Stream Request**
			A normal response is given for successful completion of this request. The LCC can be in one of three conditions with the defined stream when a Terminate Stream request is issued.
			1}. For the defined stream the LCC has processed and is executing a stream request. The LCC will terminate that request, it's response will reflect an abnormal termination. The byte count in the response will reflect the number of bytes successfully received/transmitted.
			2}. For the defined stream the LCC does not have a stream request in the core. However, internal flags infer that implied RTS or CTS have been traded with the remote terminal. The LCC clears all internal flags. No special stream response is written.

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PRODUCT NAME ___ LCC _____
PRODUCT MODEL NO. ___ I039*1.0 _____ MACHINE SERIES ___ PL10 ___

WORD	BITS	FUNCTION CODE (HEX)	DESCRIPTION
1	00-07	F4	3). For the defined stream the LCC does not have a stream request in the LCC core and has no internal flags. In all the three cases, the LCC transmits an abort stream SID to the remote terminal, See Section 4.2.2.2. Field A = input or output stream number. Transfer the LCC storage to the HLP. Field A defines the beginning LCC address to be transferred. Field A1 defines the number of LCC words to be transferred. This number must be in increments of four words. Field B defines the 32-bit base address in the HLP.
		F5	Configuration definition for line X. This request should be issued at Open Line time only. If it is issued at other times, undetermined results may occur. This request defines the time-out type (bits 13,14,15 of Field B) and the maximum number of

WORD	BITS	FUNCTION CODE (HEX)	DESCRIPTION
			streams for this line {bits 27, 28, 29, 30, 31}. The time-out type is an index similar to that defined for the B {block-type} Field in a stream request. The index must point to the proper entry in the table describing the terminal supported on this line.
			The index values are the following:
			Index 0 = 733-10, CDC CYBER High Speed Batch Terminal.
			Indexes 1-7, not defined.
		F6	Data Set Adapter Loop Request. This request instructs the LCC to loop the Data Set Adapter, i.e., the data character in the request is transmitted 256 times out of the LCC and is immediately returned on the input side of the communication line. No data is transmitted to the remote terminal. The number of unsuccessful receipts is placed into the

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DOCUMENT CLASS___ ERS
PRODUCT NAME___ LCC
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PAGE NO ___ 4-53

			termination response which is written in the HLP.
			This request can be issued at open line time only. Upon completion of the test, the line is considered closed. The operation defined above is the same operation initiated by the LCC when the link reaches the maximum number of error recovery attempts and exercises {loops} the line. Bits 24 through 31 of field B contain the character to be involved in the loop-back operation.
		F7	Data Set Loop request. This request is similar to the one defined above, however it has to be issued to the AT&T 303 Modem Series, or to any other modem which conforms to the same loop function possible in the AT&T 303 modems. It is suggested that this request not be issued on a line which does not provide this function.

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PRODUCT NAME _____ LCC
PRODUCT MODEL NO. _____ I039*1.0 _____ MACHINE SERIES _____ PL10 ____

WORD	BITS	FUNCTION CODE	DESCRIPTION
2	16-31		Field A - See function codes for descriptions.
	00-31		Field B - See function codes for descriptions.

* **NOTE:** All commands which are stared {*} have the solicited response written in the HLP when the command is initiated. When the command is totally satisfied, an unsolicited response is written in the HLP, notifying it that the operation is complete {i.e., the line is closed, or the system is suspended, etc.}

4.3.5 Response Formats

Type 1   Normal Unsolicited Response

CONTROL DATA CORPORATION

_____ DIVISION
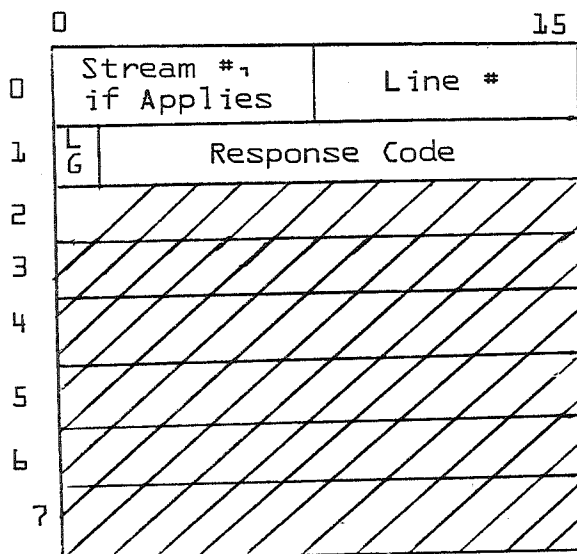
DOCUMENT CLASS_____ERS_____ PAGE NO._____4-55____
PRODUCT NAME_____LCC____
PRODUCT MODEL NO._____1039×1.0_____ MACHINE SERIES_____PL10____

Type 2
Normal Solicited Response to HLP-LCC Requests and to illegally
formated requests {HLP/LCC and Stream}
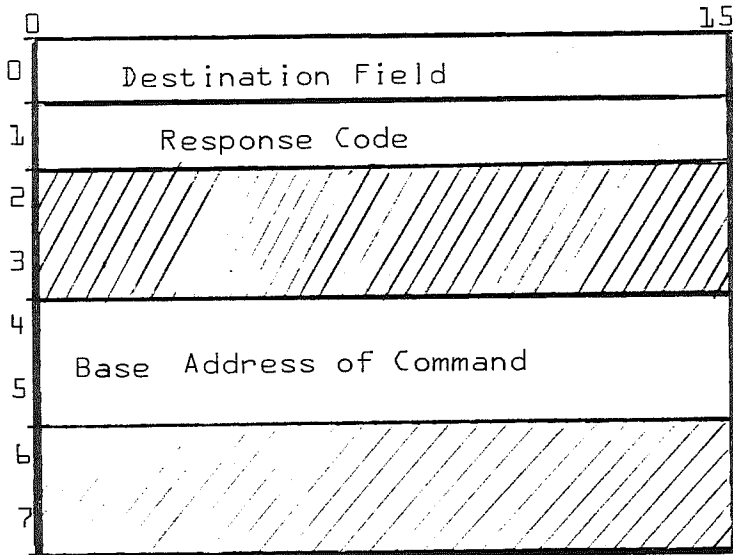
Type 3
Normal Solicited Response to a Stream Request
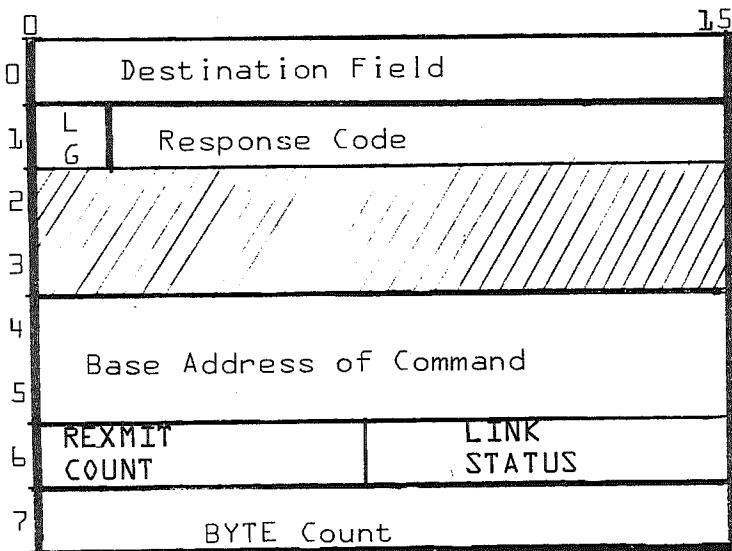
CONTROL DATA CORPORATION
_____ DIVISION

DOCUMENT CLASS_____ERS_____ PAGE NO.____4-56____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.____IO39×1.O_____ MACHINE SERIES_____

Type 4   Abnormal Unsolicited Response

```
    0                 7  8                    15
   ┌──────────────────┬──────────────────────┐
 0 │//////////////////│     Line No.          │
   ├─┬────────────────┴──────────────────────┤
 1 │L│                                        │
   │G│       Response Code                    │
   ├─┴───────────────────────────────────────┤
 2 │/////////////////////////////////////////│
   │                                         │
 3 │                                         │
   ├──────────────────┬──────────────────────┤
 4 │//////////////////│//////////////////////│
   │                                         │
 5 │/////////////////////////////////////////│
   ├──────────────────┬──────────────────────┤
 6 │     Field A      │     Field B           │
   ├──────────────────┼──────────────────────┤
 7 │     Field C      │     Field D           │
   └──────────────────┴──────────────────────┘
```

Type 4   Field Meanings

There are two Type 4 responses. They are response 44 {link

has errored out} and 45 {intermittent SAC problems}. Response

44 uses fields B, C, D.

Field B = Link Status = 8 bits: B, S, C, NE, N, NA, SAC, TO

     B = illegal data SID

     S = out of sequence block

     C = CRC or character parity error

    NE = no ending delimiter

     N = NAK was received

    NA = Not Assigned

   SAC = had intermittent SAC problem

    TO = link time out

Field C = DSA ERROR RESULTS = Data Set loop exercise results

                      = 0, All attempts were successful

                      ≠ 0, Number of unsuccessful attempts

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Field D = Carrier On/Off Status

    = 00 Carrier is on and data set is ready

    = 01 Carrier was on but data set not ready

    = 02 Carrier was not on, data set ready

    = 03 Neither carrier on or data set ready

Response 45 uses Field A.

Field A = Number of intermittent SAC rejects in this pass.

Type 3 Field Meanings

REXMIT Count = Number of error recovery attempts on the last
               block.

Byte Count   = Number of 8-bit bytes received/stored in data
               buffer.

RESPONSE CODE DEFINITIONS

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LG		INT							UN SOL						

Response Code
Word

LG   = Log

INT   = Interrupt

UNSOL = Unsolicited Response

Bits 8 to 15 = the response code specifying the status of the
operation.

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Code	Type	Associated Command	Meaning
0	2	80, 81	HLP solicited responses on initiation of a stream request.
1-20			Not assigned.
21	3	80	Write stream request {function code=80} terminated normally with an End of Block, another buffer of data is required.
22	3	00, 81	Stream request {read or write} terminated normally with an End of Message {ETX}, this file is completed.
23	2	F5	The HLP request to configure the line is completed.
24	2	F2	The HLP request to terminate an active stream request has been initiated. Response code 28 will eventually be given for this stream.
25	2	F4	Request to transfer LCC memory into the HLP is complete.
26	2	F1	Close line request is initiated.
27	2	F2	The request to terminate an inactive {LCC is not currently processing a stream request defined by the HLP request to terminate} stream request is complete and successful.
28	3	80, 81, 0	Stream request terminated abnormally.
29	2	All	Request rejected, illegal parameter.

Code	Type	Associated Command	Meaning
2A	3	80, 81, 0	System is at buffer threshold, this request is rejected.
2B	4	F6	Request to initiate DSA loop is completed. The format of this response is the same as the abnormal unsolicited response number 44, except the base address of the command is in words 4 and 5.
2C	4	F7	Request to initiate Data Set loop is completed. The format of this response is the same as the abnormal unsolicited response number 44, except the base address of the command is in words 4 and 5.
2D			Not assigned.
2E	2	F3	The HLP request to suspend the system has been initiated.
2F			Not assigned.

UNSOLICITED RESPONSE

Code	Type	Associated Command	Meaning
40	1		Stream has a RTS.
41	1		Stream has an Idle status.
42	1		Stream has Not Available status.
43	1		Stream has a Busy status.
⋈44	1		Link has errored out, this line as logically closing, all outstanding requests are being terminated abnormally. HLP must issue a close line request.

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Code	Type	Associated Command	Meaning
×45	1		System had intermittent SAC rejects. Field A of response contains the current count.
×46	1		System buffers are saturated, this line is logically closed, HLP must issue close line.
47	1		Illegal SID in status block.
×48	1		Had a disastrous DSA malfunction, this line is logically closed, HLP must issue close line.
49	1		Channel flag is cleared.
4A			Not assigned.
4B			Not assigned.
4C	1		Remote terminal has initiated restart {i.e., it is rewinding its files}. This line is logically closed, HLP must issue close line.
4D	1		Unsolicited response, the system is in a suspended state.
4E	1		Unsolicited response; the line is closed.
4F	1		Unsolicited response; the line is in an idle poll state.
50-60			Not assigned

BOTH SOLICITED AND UNSOLICITED RESPONSES

Code	Type	Associated Command	Meaning
61	3		Read stream request has terminated normally, it has an unsolicited RTS with it.

× Means logged

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4.4   Overview of Mode 2

Although it is not within the scope of this document to describe the precise nature of the HLP and terminal software, this section is included to give an understanding of the functions performed and the general flow of the operations.

The major functions of the HLP can be summarized as follows:

1. LCC Subsystem autoload - cause the LCC software to be established in the LCC memory.

2. Set up the Line Table in the HLP memory.

3. Format Request and Command Table entries in the HLP memory to direct LCC activities.

4. Scan the Response Table for completed operations.

5. Manage the allocation of data buffers in HLP memory.

6. Control the SAC interface.

7. Coordinate activities with remote batch terminal.

8. Data manipulation functions

    a. Code compressions/decompression

    b. Escape code processing

9. Interfacing with application programs.

On the other side of the LCC, the remote batch terminals {RBT} provides user access to the system. Its' major functions can be summarized as follows:

1. Maintaining communication with the LCC.

2. Inputting data from cards

    a. Code conversion

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    b. Code compression

    c. Data formatting

3. Outputting data to printers/punches

    a. Code conversion

    b. Code decompression

    c. Forms control

4. Controlling data to/from the CRT/keyboard.

5. Coordinating activities with the HLP.

6. Buffering the transmission blocks exchanged with the LCC
until acknowledged by the LCC.

Establishment of the communication system begins by autoloading
the LCC. A 64 word autoload/auto dump bootstrap is sent
across the CDC compatible trunk from the HLP memory to the
LCC memory. This bootstrap program then loads an initializer
program from the HLP memory. The initializer program in turn
loads the standard software program and constructs the necessary
tables in the LCC. At this point, the LCC has begun normal
operation and is waiting for a channel flag from the HLP {no
communication has started, the LCC is in a ready state}.

Some point in time after the autoload, the decision will be
reached in the HLP that communication should be established
with a terminal or terminals. The HLP must first build a
command configuring each terminal, then a Request List is
constructed for each terminal to be activated. The first request
points to the configuring command. The location of the Request

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List is entered into the appropriate slot in the Line List. The
Channel Flag is then set and the LCC goes into action. The Line
List is searched for all new entries and as each is found,
the line is considered opened {although communication has not
yet been established with the terminal}. The LCC enters each
new line into an Idle Poll state such that Restart control
blocks are repeated continuously until answered by the remote
terminal.

At the time the HLP opens a line to the LCC, the condition of
the remote batch terminal is unknown. The remote operator
may have autoloaded the RBT prior to the HLP opening the line.
In this case, the RBT will be in a ready state when the first
Idle Poll is sent by the LCC and communication will be established
immediately.

A second condition exists when the RBT is not ready when the
line is opened {i.e. off or in an off line mode}. The LCC
will continue in the Idle Poll state until the remote replies
or is told to close the line by the HLP. The remote operator
may autoload the RBT into the ready state when he desires to
communicate with the HLP.

The Idle Poll state in the LCC terminates when a Restart con-
trol block is received from the RBT. The LCC then changes
from Idle Poll to a state of normal communications {α/β sequences}.

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During normal communications, the LCC continually scans the
Request List looking for work.

Once communication has been established with the terminal, the
HLP may write data to the terminal and the RBT may send data
to the HLP.

At the terminal when the card reader becomes active, a RTS
is sent to the LCC. The LCC in turn notifies the HLP that the
RBT wishes to send data on a particular stream via an un-
solicited response. The HLP should then establish a data buffer
{potentially several hundred bytes long} describe it with a
read command and then points to the command with a request in
the Request List. The LCC then decodes the request and command
and returns a CTS to the terminal for that data stream. The
terminal is then free to send one block of data to the LCC. If
after putting the data into the HLP buffer, the buffer is not
full, another CTS is automatically returned to the terminal.
When the buffer is full, the request is completed and a response
written. If the LCC has not received an ETX indicating end
of message, the response will indicate that another buffer
and read command are required.

During the process of inputting data, the HLP may find the need
to send data to the terminal to be printed. The HLP would
allocate a convenient sized buffer, fill it with some of the
data to be printed, describe it with a write command and point

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to the command with a request. The LCC decodes the request/
command and sends a RTS to the terminal. The terminal in turn
determines that the device is operable and that buffer space
for one block of data is available. Given that these conditions
are met, a CTS is returned to the LCC. The LCC then responds
with the first data block. This sequence of the terminal
guaranteeing buffer space and the LCC responding with data
segments continues until the HLP buffer is empty. The LCC
then writes a response to the HLP indicating that the request
is complete. The HLP can then allocate the next data buffer
describing it with a command and request. The previously
described sequence would again be repeated. When the HLP
allocates the last buffer of the message, it should instruct
the LCC to identify the last block as the end of message {EOM}.

The HLP may wish to improve the response time between requests.
To accomplish this, the HLP may build a new request/command
sequence as soon as it determines that the $^\nabla S^\nabla$ bit in the
current request has been set to 0. The new request will be
picked up by the LCC automatically when the current request is
complete.

During the life of a request, the HLP may wish to terminate the
data flow on a particular stream. To accomplish this, the HLP
would issue a terminate command to the LCC. The LCC in turn
would send an Abort Stream code in the SID to the terminal
informing it of the HLP action. Upon completion of this

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action, the appropriate responses are written to the HLP.

Having completed the exchange of data with the HLP the remote
operator may wish to enter the terminal into an off-line mode.
He would enter a command at the keyboard to the HLP instructing
the HLP to relinquish control of the terminal. The HLP would
then respond by instructing the RBT to go off line, followed
by a close line command to the LCC. The LCC would cease
communicating with the terminal and the remote operator would
then be free to perform off line functions.

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5.0 MODE 3 INTERACTIVE TTY PROCEDURES

Mode 3 of the LCC is intended to support Model 33/35 teletypes
{ASR and KSR} and CDC's 713 terminal. These terminals are
collectively referred to as TTY in the remainder of this
section. In this implementation, asynchronous lines of speeds
110-300 bps are driven point-to-point, two-way alternate and
may be either switched or non-switched. Teletype transmissions
consist of a stream of data and format characters {e.g.
carriage return}. There are no communications control
characters framing a TTY message. This stream is passed
between the TTY and HLP without being examined by the LCC
software except as noted in Section 5.1.2.

5.1 General Description of Mode 3 {TTY}

5.1.1 Configuration

The Interactive Teletype software will support a strictly TTY
configuration or operate in conjunction with Mode 2 software
in supporting mixed TTY and remote batch configurations.

Mode 3 {TTY} terminals attach to lines of speed 110-300 bps.
The lines are operated point-to-point, two-way alternate and
may be either switched or non-switched. Note that Mode 3 {TTY}
terminals operate in the half duplex mode and require a direct
printing keyboard.

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The Mode 3 LCC and subsystem will support 48 TTY's on lines up to 300 bps. For mixed configurations involving batch terminals, refer to Section 3.1.1.

The amount of core required for a given Mode 3 configuration may be calculated by the following formula:

$$\text{Mode } 3 = 1750 + 36L_3 + 24AL_3$$

1750 = fixed Mode 3 program size

L_3 = number of Mode 3 lines

AL_3 = number of active Mode 3 lines

Applications of the above formula shows that:

- a 4K LCC will support 4 TTY lines

- a 8K LCC will support 48 TTY lines

5.1.2   Mode 3 Features

5.1.2.1   Communications Channels

Mode 3 supports 110-300 bps asynchronous communications channels in a half duplex manner. The channels may be either switched or non-switched.

Each line must be terminated at the LCC by a modem which conforms to the RS232 interface standard. For switched network operation, the modem may or may not be strapped for automatic answer. If the auto answer option is present, the LCC will automatically answer the call, but if auto answer is not present, manual intervention is necessary to place the modem in data mode.
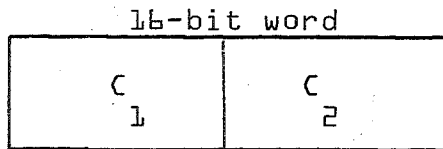
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PRODUCT NAME____LCC_____
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At the conclusion of a call {switched network} the LCC will automatically disconnect the line by dropping the Data Terminal Ready lead to the associated modem. If the users local common carrier exchange operates on the called-party-hold principle, special operator action is necessary to ensure that the line is disconnected.

5.1.2.2 Data Dependencies

In general, the LCC V.2.0 is not sensitive to the contents of the TTY data stream except as specified in Table 5.1.

During an input operation, the LCC packs successive characters into the HLP buffer which was previously defined by a Request/Command sequence. The format of the buffer is as follows:

16-bit word

C_1	C_2

{c_i represent 8-bit characters}

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 {i.e. the buffer fills before the end of message character is detected} an error response is returned to the HLP and all characters of the incoming message segment are lost.

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Each input message is subject to a lost data check. Should

this condition occur, the contents of the input buffer are

erased and the following message is sent to the TTY:

  {CR} {LF} {LF} {LF} REPEAT LINE {LF} {CR} {LF} {LF}

         {CR} = Carriage return

         {LF} = Line Feed

The TTY operator is expected to re-enter the message.

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

reverse. The LCC software does not form a parity bit for

each character. The HLP provides the bit if needed.

In either case {input or output} the data is passed between

the buffer in the HLP and the TTY without conversion or other

manipulations upon it on the part of the LCC software except

as noted below. The data stream is assumed to consist of

a series of 8-bit characters from the ASCII code set {USASI

X3.4-1968}.

The following table indicates the characters within the

TTY input data stream that the LCC software recognizes and

responds to:

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DOCUMENT CLASS ___ ERS _____ PAGE NO. ___ 5-5 ___
PRODUCT NAME _____ LCC
PRODUCT MODEL NO. I039*2.0 _____ MACHINE SERIES ___ PL10 ___

DATA INPUT

Code Detected in Input Stream	Operation Performed
LF {Line Feed}	When the LCC detects LF in the input stream, it sends a response to the HLP which indicates termination with LF. This response may be interpreted by the HLP as it sees fit {e.g. 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 LCC sends a carriage return to the TTY following a message that terminated with LF. This serves to position the carriage and to inform the operator of the TTY that more data can be entered.
CR {Carriage Return}	When the LCC detects CR in the input stream, it sends a response to the HLP which indicates termination with CR. This response may be interpreted by the HLP as it sees fit {e.g. 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 LCC sends a LF to the TTY following a message that terminated with CR.

TABLE 5.1

DOCUMENT CLASS_____ ERS

PRODUCT NAME_____ LCC

PRODUCT MODEL NO. __I039*2.0_____ MACHINE SERIES____ PL10

PAGE NO.____5-6

Code Detected in Input Stream	Operation Performed
NULL or DEL	NULL or DEL characters are ignored by the LCC. 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.
	Paper tape input:
	A. Used as message delimiters - X-OFF and EOT are assumed to terminate a message if either is encountered after a string of data characters with no intermediate LF or CR. The LCC sends a solicited response to the HLP which indicates termination with CR. This response may be interpreted by the HLP as it sees fit {e.g. the X-OFF or EOT may be used to indicate that the final segment of a message has been received}.

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PRODUCT MODEL NO. I039*2.0 _____ MACHINE SERIES ___ PL10 ___

Code Detected in Input Stream	Operation Performed
	The X-OFF or EOT is not placed into the HLP buffer.
	In addition to the above processing, the LCC sets up a .2 second timeout at the time the X-OFF or EOT is encountered.
	If no input is received within the .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. DEL/NULL characters received during the timeout interval cause the timeout to be reset. When it is determined that tape motion has stopped, the LCC 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.
	B. Used as single control characters - if X-OFF and EOT are not encountered immediately after a string of data characters, they are assumed to be control characters. No solicited response indicating termination with CR is sent to the HLP. The rest of the processing {i.e. they are not put into the HLP buffer, and the timeout processing} is the same as if they were message delimiters.

TABLE 5.1 Continued

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PRODUCT NAME ___ LCC _____
PRODUCT MODEL NO. I039*2.0 _____ MACHINE SERIES ___ PL10 _____

Any Input During An Output Operation	Whenever input is detected during an output operation, the LCC sends a response to the HLP which indicates that the remote operator has interrupted the the output cycle.
	The interrupted output is terminated by the LCC. This feature is useful when a long file is being transmitted in relatively short segments. The "interrupt" may be interpreted by the HLP as a request to discontinue or delay present output.

The LCC software does not inspect the TTY output data stream; therefore, the HLP software may insert as many carriage return {CR} and line feed {LF} characters as necessary for format purposes.

5.1.2.3 Automatic Answering

In order for the HLP to know when an open TTY line becomes active, the LCC issues a response to the HLP when Data Set Ready is detected.

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5.2 Interactive TTY Procedure

The interactive TTY procedure implemented for Mode 3 consists
of an implicit I/O scheme built around the concepts of
unsolicited input and preemptive output. That is, the LCC is
automatically prepared to accept data from a TTY line upon
occurrence of Data Set Ready status from the associated modem.
This occurs whether or not the HLP has issued a command which
defines the receiving buffer in the HLP.

Whenever the LCC is not actively transmitting/receiving data over
a TTY line, that line is in an unsolicited input mode. This
can be considered as the normal idle state of an opened TTY
line. Any input which occurs on a TTY line while it is idle is
assumed to originate from the keyboard. When data begins
appearing 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. The request from the LCC is via a
response inserted in the response list. Lost data will occur
if the LCC does not detect the READ when 9 bytes are input.

Commands for output 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 output received while the line is not idle {i.e.
an input is in progress} is held until the line once again
becomes idle.

5.3   Interface with the HLP

The HLP activates a line {i.e., tells the LCC to service a line}
by setting the Channel Flag, and by setting the line tables in a
predefined manner {see Section 3.1.4.2 for further details}. The
LCC activates all new entries in the line table, clears the
Channel Flag, and reports to the HLP that the line or lines are
activated.

A Teletype has two streams defined. 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}. TTY streams
are two-way alternate in nature; thus, input and output cannot
occur simultaneously.

There are three request entries associated with TTY. Stream
assignments for TTY are as follows:

HLP/LCC Request
Stream 0: TTY Printer or Paper Tape Punch
Stream 1: TTY Keyboard or Paper Tape Reader

5.3.1   Request Entry Format: HLP to LCC
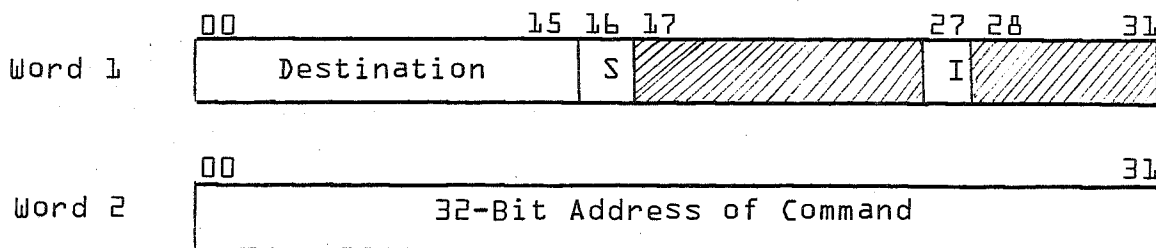
```
                    00                 15 16 17        27 28     31
        Word 1      | Destination      | S |/////////| I|////////|

                    00                                          31
        Word 2      |          32-Bit Address of Command         |
```

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Bits 17-26 and 28-31 should be loaded with zeroes.

WORD	BIT{S}	DESCRIPTION
1	00-15	Destination Field: Supplied by the HLP and is returned in solicited responses.
	16	S Field: Status of this request slot.
		"0" - This request is active or has been completed. The LCC clears this bit when it initiates this request.
		"1" - This request is ready for initiation. The HLP sets this bit when it enters a new request.
		I Field: Interrupt and Response Options
		0 - Do not send interrupt with request response.
		1 - Send interrupt with request response.

5.3.2 Command Format: HLP to LCC

```
      00            07 08        15 16                31
Word 1 |  Function    |    A1    |         A          |
       |    Code      |          |                    |
```

```
      00                                              31
Word 2 |                     B                        |
```

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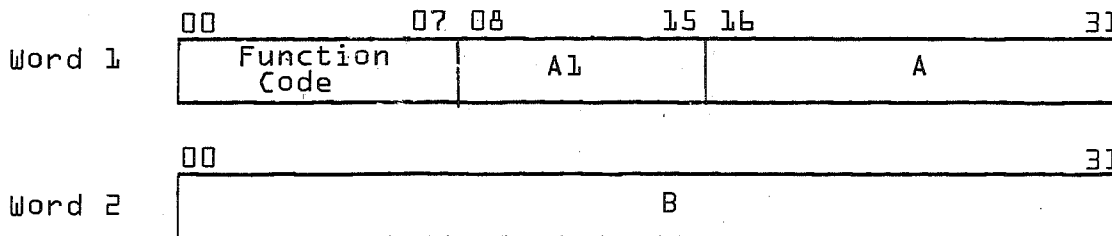
DOCUMENT CLASS_____ERS_____ PAGE NO.____5-12_____
PRODUCT NAME_____LCC_____
PRODUCT MODEL NO.___IO39*2.0_____ MACHINE SERIES_____PL10_____

WORD	BIT{S}	FUNCTION CODE {HEX}	DESCRIPTION
1	00-07	F1	*Close Line - Terminate all requests on the line specified in the request and eliminate all references to that line {i.e. make the line inactive}. On a switched line, the line is disconnected.
		F2	Terminate - Causes the in-progress operation on the given line and stream to be immediately terminated. The line returns to the idle state.
			Termination of stream activity applies only to output streams. Attempts to terminate input are rejected. The rationale behind this is that the LCC when having no out-standing commands is in an idle state awaiting keyboard input. Because of the asynchronous nature of TTY's, the termination of input would not result in cessation of data - this is especially troublesome with paper tape.

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PRODUCT NAME ___ LCC _____
PRODUCT MODEL NO. ___ I039*2.0 _____ MACHINE SERIES ___ PL10 ___

WORD	BIT{S}	FUNCTION CODE {HEX}	DESCRIPTION
			Dump - Transfer the LCC storage to the HLP. Field A defines the beginning LCC address to be transferred. Field A^1 defines the number of LCC words to be transferred. This number must be in increments of four words. Field B defines the 32-bit base address in the HLP

* <u>NOTE:</u> All commands which are starred {*} have the solicited

response written in the HLP when the request is initiated.

When the command is totally satisfied, an unsolicited

response is written in the HLP, notifying it that the

operation is complete {e.g., the line is closed}.

5.3.3 Request Entry Format: Stream

```
        00                 15 16 17              23 24    27 28    31
Word 1 | DESTINATION         | S |//////////////////|   I    |/////////|
       |     FIELD           |   |//////////////////|        |/////////|

        00                                                            31
Word 2 |            32-Bit Address of Command                          |
```
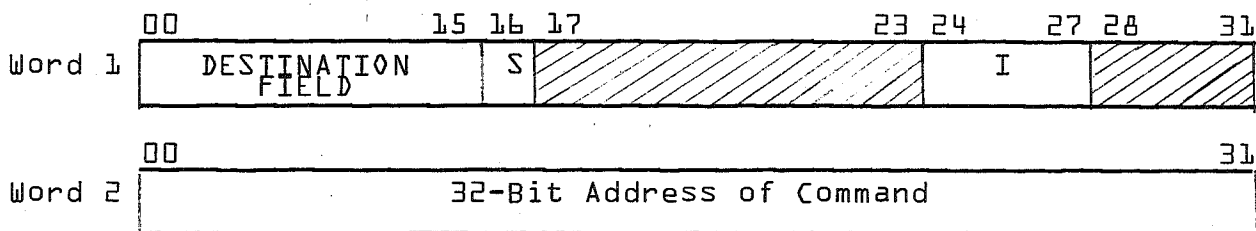
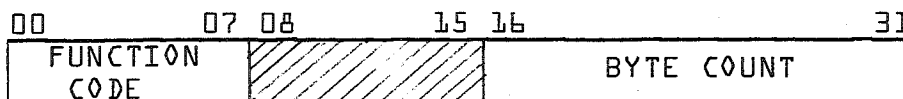Bits 17-23 and 28-31 should be zero filled.

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WORD	BIT{S}	
1	00-15	Destination Field: Required in all requests. It is returned in the solicited responses.
	16	S Field: Status of this request slot.
		"0" - This request is active or has been completed. The LCC clears this bit when it initiates this request.
		"1" - This request is ready for initiation. The HLP sets this bit when it enters a new request.
1	24-27	I Field: Interrupt and Response Option
		0XXX - Do not send response or interrupt when request is initiated.
		10XX - Send response when request is initiated.
		11XX - Send response and interrupt when request is initiated.
		XX00 - Do not send interrupt when request is completed.
		XX10 - Send interrupt if request terminates abnormally.
		XX11 - Send interrupt when request is completed or terminated.

5.3.4   Command Format: Stream

```
 00           07 08            15 16                            31
┌────────────┬────────────────┬──────────────────────────────┐
│  FUNCTION  │////////////////│         BYTE  COUNT          │
│  CODE      │////////////////│                              │
└────────────┴────────────────┴──────────────────────────────┘
```

AA 3777   PRINTED IN U.S.A.

```
00                                                    31
┌─────────────────────────────────────────────────────┐
│          32-Bit Address of Data Buffer              │
└─────────────────────────────────────────────────────┘
```

Bits 08-15 should be loaded with zeroes.

WORD	BIT{S}	FUNCTION CODE{HEX}	DESCRIPTION
1	00-07	00	Read - The LCC stores the data it receives from the line and stream {defined in the request} into the data buffer.
		01	READTI - The initial read command when input from paper tape is expected.
		80	Write {an ETB Response is returned}.
		81	Write {an EOM Response is returned}.
	16-31		Byte Count - This field specifies the number of 8-bit data bytes to be processed {read or write} from the data buffer.

5.3.4.1 Input Stream Commands

There are two forms of input commands - those associated with keyboard input and those associated with paper tape input.
It is tacitly assumed by the LCC that the HLP is aware of which device of the TTY is sending data and is directing the LCC accordingly.

All DEL and NULL characters which appear in the TTY input stream are discarded by the LCC.

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Note that there are two descriptions of the READ command
{function code 00}. The first describes the operation when
input is from paper tape and the second describes the operation
when input is from the keyboard.

5.3.4.2   READTI {Function Code 01}

This command is to be issued prior to the initial input from
paper tape. This command differs from {paper tape} READ
{function code 00} only in that X-ON is sent to the TTY prior
to data input.

Note that READTI is to be issued prior to data input from paper
tape. It is assumed that the HLP is aware of the forthcoming
PT input through either prior entry at the keyboard or some
other stimulus.

It may happen that tape input occurs before the LCC recognizes
the READTI. In this instance, the input is assumed to originate
from keyboard, the 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.

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5.3.4.3   READ {Function Code 00} Paper Tape Operation

This command is issued for all subsequent inputs from paper

tape after READTI. READ, unlike READTI, does not send X-ON

prior to data input.

The primary function of READ is to identify the HLP buffer

and buffer length in which input data from the associated TTY

line is to be placed. READ may be issued either before or

after the input flow has begun. Should the TTY input begin

before the HLP buffer is defined, a response is sent to the

HLP which demands READ be promptly issued.

The buffer defined by READ is terminated normally upon the

LCC encountering any of the following conditions:

1. Line Feed {LF}

2. Carriage Return {CR}

3. X-OFF {if immediately preceeded by data}

4. EOT {if immediately preceeded by data}

The terminating character {LF, CR} is defined as the first

encountered in a message segment. This determines the

response which will be sent.

The terminating character is not placed into the HLP buffer and

succeeding DEL characters are ignored as is the CR or LF

which occurs after the initial LF or CR. See examples below.

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The character X-OFF and EOT may be used as message delimiters
as well as their usual control functions. X-OFF and EOT are
assumed to terminate a message if either is encountered after
a string of data characters with no intermediate LF or CR.
The message response indicates termination with CR when X-OFF
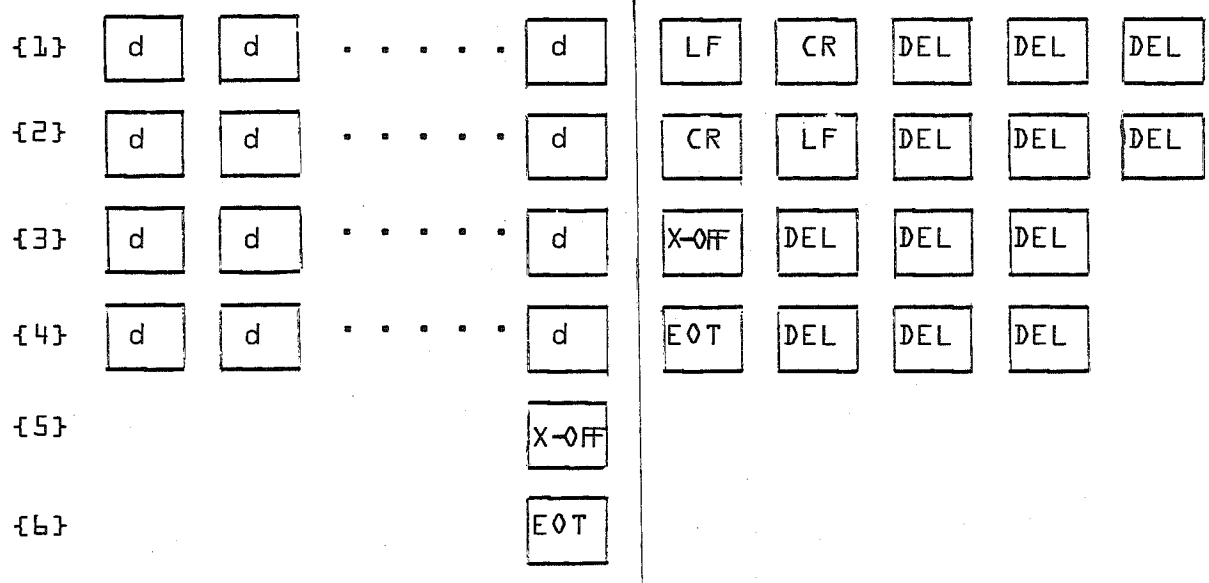and EOT terminated the message.

Message segments from paper tape are assumed to be in one of
the following forms and the various forms may appear in any
order on the tape insofar as the LCC is concerned.

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	This portion is passed to the HLP memory buffer.	This portion is not passed to the HLP memory buffer.

{1} | d | d | . . . . . | d | | LF | CR | DEL | DEL | DEL |

{2} | d | d | . . . . . | d | | CR | LF | DEL | DEL | DEL |

{3} | d | d | . . . . . | d | | X-OFF | DEL | DEL | DEL |

{4} | d | d | . . . . . | d | | EOT | DEL | DEL | DEL |

{5} | X-OFF |

{6} | EOT |

d = data

In the above forms, the number of DEL or NULL characters is assumed to be a minimum of three. It is recommended that not fewer than 3 DEL or NULL characters be sent to provide adequate time delays in HLP-LCC communications.

The characters of X-OFF and EOT are handled in a special manner by the LCC. When either is encountered in the input stream, a response is not immediately sent. Rather, a timeout of .2 seconds is set up.

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If no input is received within the .2 seconds, it is assumed
that tape motion has stopped and a response which indicates X-OFF
or EOT is sent to the response list. DEL/NULL characters
received during the timeout interval cause the timeout to be
reset. When it is determined that tape motion has stopped,
the LCC 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, input does occur before 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.

5.3.4.4 READ {Function Code 00} Keyboard Operation

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 encoun-
tered in a message. Should the input flow begin prior to
issuance of READ, a response is sent to the HLP demanding that
READ be given to define the HLP input buffer.

The READ command is terminated whenever one of the following
characters are encountered.

1. LF

2. CR

3. EOT ⎫
      ⎬ Treated as CR, but timeouts not set as with
4. X-OFF ⎭ tape; and no LF is returned as for CR.

The ending character determines which response is to be sent.

If the message terminates with LF, the LCC automatically sends a CR prior to expecting a subsequent message, and conversely, if the message terminates with CR, the LCC sends a LF.

5.3.4.5 Output Stream Commands

Commands for output are honored whenever the line is open and idle. In no instance of output does the LCC inspect the output stream for special characters as it does for input. It is assumed that proper format codes are contained in the message and that the carriage is properly positioned for the subsequent input/output.

5.3.4.6 WRITE {Function Codes 80 and 81}

These commands are used to output data to the TTY. They operate with either the printer or paper tape.

When the LCC outputs data to the TTY, it does not inspect the output stream for special characters as in the case of input; therefore, the HLP may insert as many carriage control characters into the output stream as necessary for format purposes and must insure proper positioning of the carriage for the following I/O operation.

The output operation of WRITE may be issued at any time by the HLP. The LCC initiates this operation whenever a message is

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PRODUCT NAME_____LCC_____
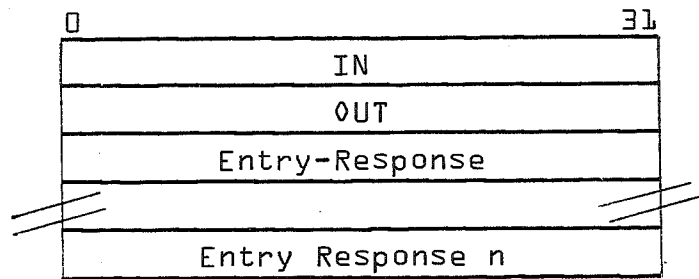PRODUCT MODEL NO.__I039*2.0_____ MACHINE SERIES_____PL10_____

not presently being received. If an input is in progress when

the WRITE is issued, the input is allowed to continue to

completion. The termination of WRITE occurs when the given

number of bytes has been transmitted.

The LCC 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.

5.3.5 Response List

The LCC informs the HLP of current request, command and system

status by updating the response list.

The response list is a circular list contained in the HLP

memory module that is preceded by two 32 bit pointers: the IN

and OUT pointers.

```
0                                               31
┌───────────────────────────────────────────────┐
│                      IN                         │
├───────────────────────────────────────────────┤
│                     OUT                         │
├───────────────────────────────────────────────┤
│              Entry-Response                     │
├───────────────────────────────────────────────┤
│              Entry Response n                   │
└───────────────────────────────────────────────┘
```

The IN pointer is updated by the LCC and specifies the next

response entry to be filled by the LCC. The OUT pointer is

updated by the HLP and specifies the next entry to be processed

by the HLP.

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PRODUCT MODEL NO. ___ 1039*2.0 _____ MACHINE SERIES ____ PL10 ____

There are two types of Responses; solicited and unsolicited. Solicited responses are those which are the result of a HLP request. Unsolicited responses are those which are the result of some unexpected stream or system condition.

Responses are 128 bits in length and either provide the central system with information about a previous request or tell the central system that something requires attention. There are four formats of responses. The response code reflects which type it is.

Normal Unsolicited Response {Type 1}

Normal Solicited Response to HLP-LCC Request {Type 2}

Normal Solicited Response to a Stream Request {Type 3}

Abnormal Unsolicited   Response {Type 4}

Byte Count = Number of 8-bit bytes received/stored in data buffer.

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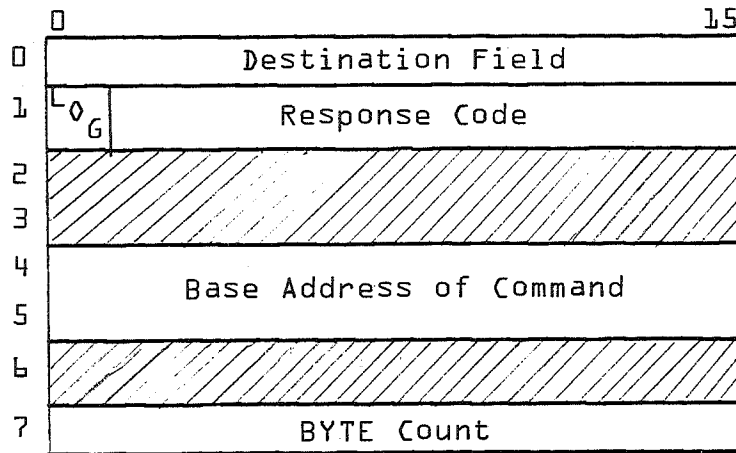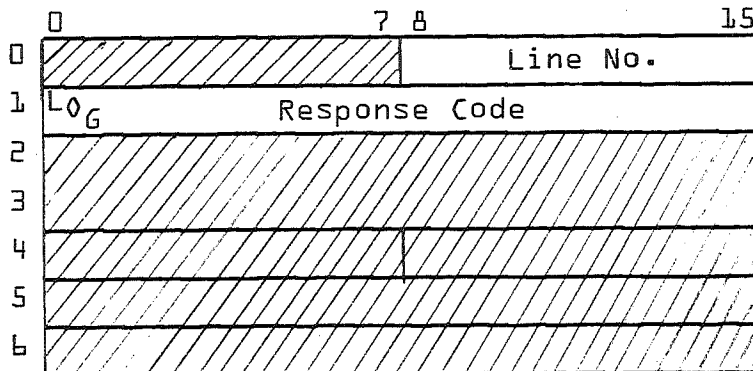TERMINAL SYSTEMS OPERATIONS _____ **DIVISION**

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5.3.5.1 Response Code Meanings

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L O G		I N T							UN SOL						

LOG = Log Flag. When set, this flag indicates conditions
      which should be logged on an error file.

INT = Interrupt Flag. This bit is set, as is the SAC I/O
      port interrupt line, when the associated request
      specified response with interrupt.

Bits 8 to 15 specify the response code which indicates the
status of the operation.

UNSOL = Unsolicited response flag. This flag is set with
        an unsolicited response, that is, a response that
        cannot be directly associated with a request.

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The following responses are returned to the response list upon

conclusion of a command associated with a TTY line.

Resp. Code {Hex}	Resp. Type	Associated Command	Cause of the Response
0	2	All TTY	HLP requested a resonse upon command initiation.
1-20			Not Assigned
21	3	WRITE{fc 80}	The output is complete.
22	3	WRITE{fc 81} READ {fc 00} READTI{fc 01}	The associated WRITE command has terminated. This response has no inherent meaning to the LCC for subsequent I/O operations. In the case of output the response implies the entire buffer has been transmitted; in the case of input, the response implies the message terminated with CR.
23			Not Assigned.

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Resp. Code {Hex}	Resp. Type	Associated Command	Cause of the Response
24	2	TERMINATE	The command to terminate the associated output stream is accepted. When the termination is complete, response 28 is sent.
25	2	DUMP	The command to dump LCC memory is completed.
26	2	CLOSE	The CLOSE line command is initiated; when the request is completed, the response 4E is sent. The CLOSE may terminate an active stream command in which case response 28 can also be expected.
27			Not assigned.
28	3	TERMINATE CLOSE	This response indicates that the indicated stream request is abnormally terminated. This can result from a TERMINATE or CLOSE command or from a forced closing of the line by the LCC.
29	3	All	The command is unrecognizable and/or the command contained illegal values.
2A	3	All	The internal buffer pool in the LCC has reached a threshold level, this request is rejected.

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Resp. Code (Hex)	Resp. Type	Associated Command	Cause of the Response
2C-2D			Not Assigned.
2E	2	SUSPEND	The command to suspend the LCC has been initiated. It may happen that the LCC sends response 40 during the same interval that the HLP must be aware of this possibility and ignore the response if the last issued READ for the line is incomplete.
41-43			Not Assigned.
*45	4	N/A	System had an intermittent SAC reject.
*46	4	N/A	System buffers are saturated, this line is closing.
47			Not Assigned.
*48	1	N/A	The DSA connected to this line is malfunctioning, the line is closing. If a stream is active, response 28 is sent.
49	1	N/A	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-4C			Not Assigned.
	1	N/A	The LCC is in a suspended state.

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PRODUCT NAME _____ LCC
PRODUCT MODEL NO. _____ I039*2.0 _____ MACHINE SERIES _____ PL10

Resp. Code {Hex}	Resp. Type	Associated Command	Cause of the Response
4E	1	N/A	The indicated line is closed. This response is returned following either a CLOSE command or forced line closing caused by an abnormal condition. If any stream commands are active when closing the line, they are terminated. Response 28 is returned for each stream so terminated.
4F	1	N/A	The indicated line is open but a call is not yet answered.
50	1	N/A	The LCC has answered a call on a TTY line. This response is sent when the Data Set Ready lead from the modem is on and occurs with either a switched or dedicated line. The line is prepared for unsolicited keyboard input.
51	1	N/A	X-OFF has been received from the paper tape reader and there has been no non-DEL/NULL input for .2 seconds. It is assumed that tape motion has stopped. If a READ command is active and the X-OFF did <u>not</u> occur with data, the READ is <u>not</u> terminated and will be used for subsequent keyboard input.

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Resp. Code {Hex}	Resp. Type	Associated Command	Cause of the Response
52	1	N/A	EOT has been detected; otherwise as above for X-OFF.
53-57			Not Assigned.
58	1	N/A	The receive carrier lead from the modem indicates that a carrier signal is not being received. The line is closing. If a stream is active, response 28 is sent. When the close is complete, response 4E is sent.
59	1	N/A	The Data Set Ready lead from the modem is off - the call has been disconnected and the line is closing. If a stream is active, response 28 is sent. When the close is complete, response 4E is sent.

Resp. Code {Hex}	Resp. Type	Associated Command	Cause of the Response
5A	1		One or more characters of the TTY message are lost due to:
			1. The HLP did not supply an input buffer in time.
			2. Internal LCC 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 as the LCC has initiated re-transmission of the message.
5B	1		Input is arriving on the indicated TTY line. The HLP must promptly issue a READ request to define the receiving buffer.
5C	1		Input was detected during an output operation. The active output is terminated. This response is to be interpreted as an interrupt by the remote operator.
5D	1		The input buffer filled before an ending delimeter {CR or LF} was encountered.

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Resp. Code. {Hex}	Resp. Type	Associated Command	Cause of the Response
			This is an informative response - no special recovery actions are required by the HLP as the LCC has initiated re-transmission of the message.

Both Solicited and Unsolicited Responses

| b1 | 3 | READ {fc00} READTI{fc01} | The TTY input stream has terminated normally with ending delimeter of LF. |

Note: All responses that are starred have the LOG flag set.

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5.4 Overview of Mode 3

Although it is not within the scope of this document to
describe the precise nature of the HLP software and the ter-
minal operation, this section is included to give an under-
standing of the functions performed and the general flow of
the operation.

The major functions of the HLP can be summarized as follows:

1. LCC Subsystem autoload - cause the LCC software to be
    established in the LCC memory.

2. Set up the Line Table in the HLP memory.

3. Format Request and Command Table entries into the HLP
    memory to direct LCC activities.

4. Scan the Response Table for complete operations.

5. Manage the allocation of data buffers in HLP memory.

6. Control the SAC interface.

7. Coordinate activities with the terminal operator.

8. Interfacing with application programs.

On the other side of the Mode 3, the TTY provides a user inter-
face to the system. The operation of the TTY is very simple
when compared to that of a remote batch terminal. The TTY
basically provides a keyboard input and a graphic output. An
optional form of input and output is the TTY paper tape. The
TTY provides no buffering or control over the interaction with
the HLP.

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Establishment of the communication subsystem begins by auto-

loading the LCC. A 64 word autoload/autodump bootstrap is sent

across the CDC compatible trunk from the HLP memory to the

LCC memory. The bootstrap program then loads an initializer

program from the HLP memory. The initialization program in

turn loads the standard software program and constructs the

necessary tables in the LCC. At this point, the LCC has

begun normal operations and is waiting for a channel flag

from the HLP {no communication has started, the LCC is in a

ready state}.

Some point in time after the autoload, the HLP will decide to

allow communications with a terminal. For this to be accom-

plished, the HLP must open the line.

To open a line, the HLP constructs a Request List and enters

its pointer into the Line List. It also sets the Channel

Flag. When the LCC detects that the Channel Flag is set, it

searches the Line List to determine which line or lines are

to be opened. It also determines the location of the Request

List. Then it sends the Data Terminal Ready signal to the

modem enabling the modem to automatically answer any incoming

call. The LCC then waits for the Data Set Ready and Carrier

On signals from the modem to indicate that a call has been

answered. Using a Model 33 teletype as an example, these

signals will be generated when the ORG button is pushed and

the number of the local Data Set is dialed. The HLP is

notified by a response when the call is answered.

At this point the user is now able to use the resources of the

system. The HLP may indicate this to the user by outputting

some message to the TTY and positioning the carriage at the

beginning of a new line.

As an example, assume the user wishes to send the HLP a data

file which is greater than 80 characters in length. The user

would input the data file 80 characters at a time until the

entire file was inputted. Each 80 characters would be

followed by a LF {line feed} or CR {carriage return} to

terminate the message segment.

When the LCC detects the LF in the input stream, it would send

a response to the HLP which indicates termination with LF.

This response may be interpreted by the HLP as it sees fit

{e.g. 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 would not

be placed into the HLP buffer.

The LCC would then send a carriage return to the teletype

following these messages that terminated with LF. This

positions the carriage and informs the TTY operator that the

next 80 characters {or less} of the data file can be entered.

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If a CR was inputted to terminate a message segment, it would

be processed by the LCC in a manner similar to that of the

LF. The LCC would send a response to the HLP which indicates

termination with CR. Again, this response may be interpreted

by the HLP as it sees fit {e.g. the CR may be used to indicate

that the final segment of a message has been entered}. The

CR would not be put into the HLP buffer and the LCC would

send a LF to the teletype.

The HLP may attach special meaning to certain characters.

For example, a shift 0 inputted by the user may indicate to

the HLP to ignore the preceding character. Or an X^C {control X}

may indicate to the HLP to ignore all characters from the

preceding LF or CR up to the X^C. The LCC is transparent to

these characters with special meaning. It just passes them

on to the HLP as data characters.

If a problem such a lost data occurs in the system while the

user is inputting data, the LCC notifies the HLP via the

Response List mechanism.

Now assume the TTY has paper tape capability. As an example,

the user could submit a small program to the HLP via the

keyboard. He then could request the HLP to compile it and

punch it out on paper tape so it can be entered more easily

later. The user should turn on the paper tape punch before

the LCC sends the program out to be punched. Later, when the

user wishes to resubmit the program via paper tape to the HLP,
he would type an appropriate message in to the HLP indicating
paper tape mode. The HLP would issue a READTI command and
the LCC would output an X-ON to turn the paper tape reader on,
and paper tape reading could then begin. When the LCC detects
an X-OFF or EOT condition, it times out for .2 seconds. If no
data comes in during this time, it assumes that paper tape
motion has stopped.

In the above case the user can terminate the paper tape input
by turning the paper tape reader off. The LCC will inform the
HLP via an unsolicited response.

A user can use paper tape capability in another way. He can
create a paper tape off-line and later submit it to the HLP
when the line is open. In this case comments above regarding
characters with special meaning to the HLP such as shift 0 and
X^C would apply here also. In addition, the message segments
excluding all control characters {LF, CR, X-OFF, and EOT}
and DEL/NULL should not exceed 80 characters. Refer to section
5.3.4.3 for a detailed explanation of how message segments
and messages should be terminated on a paper tape.

For both keyboard and paper tape input, LF, CR, X-OFF, EOT,
and DEL/NULL characters are not sent on to the HLP.

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Line closing can be initiated by either the user or the HLP.

The HLP can send a close line request/command to the LCC in

reaction to a typed in message from the user, or on its own

initiative {e.g. specified time of day}. In either case,

all input is immediately cut off, and the line is closed and

disconnected.

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6.0   MODE 4.0 {200UT/216 PROTOCOL} PROCEDURE

The LCC mode 4 software supports terminals using the 200 UT or

216 communication protocols. The terminals supported are

listed in Table 6.1. Mode 4 protocol is a two-way alternate,

asymmetric protocol having two varients; 200 UT and 216.

Mode 4 link control procedures are provided on the following

synchronous communication channels:

1.   Lines of speed 2000 bps. point-to-point, half duplex,

     switched.

2.   Lines of speed 2400 to 9600 bps. point-to-point, full or

     half duplex, non-switched.

3.   Lines of speed 2400 bps. to 9600 bps. multi-drop, full or

     half duplex, dedicated leased or private.

The following capability is provided by the mode 4 software:

1.   Switched network automatic answer/disconnect for mode 4

     terminals.

2.   Multi-drop capability on dedicated leased or private, mode 4

     links to reduce overall customer cost per line.

3.   Code conversion, specified on an individual request basis,

     for mode 4 terminals.

4.   Mode 4 link control procedures which:

     - Insert and delete link control characters that enclose

        the data blocks.

     - Calculate and check the message parity character.

     - Ensure that the proper sequence of messages are sent to

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and received from the remote terminal in order to

perform the operation specified by the HLP.

- Provide error detection and recovery procedures. Each

message character is checked for proper character

parity. Each message block is protected by a "message

parity character". When the LCC software senses an

error, the proper steps are taken to cause retransmission

of the message block in error. The LCC furnishes error

status information to the HLP for control and error

logging purposes.

TERMINAL	PROTOCOL
711 IAT/CRT	216
241 GRID	200 UT
200 UT BCD	200 UT
216 BCD	216
216 ASCII	216
731-12 LSBT	200 UT
732-12 MSBT	200 UT
200 UT ASCII	200 UT

TABLE 6.1

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6.1 Mode 4 Software Description

6.1.1 General Description of Mode 4

The mode 4 software is designed to allow full use of the various features found on mode terminals and also provides for future support of additional features with little change to the software.

The mode 4 software has logically two interfaces; one with the HLP and another with the terminal. The interface with the HLP enables the HLP to:

    send messages to a terminal,

    receive messages from a terminal,

    begin and stop communication with terminals,

    determine the cause of errors, and tell the LCC <u>how</u> to
    perform an operation.

This interface allows the LCC to:

    tell the HLP when it has completed an operation,

    notify the HLP of internal {to LCC} problems,

    report the occurance of errors, and

    give information to the HLP that allows the HLP to be more
    efficient.

The following paragraphs present a brief discussion of the interface with the HLP. The HLP communicates with the LCC by issuing "requests" and "commands", as discussed in Section 3.

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To send a message to a terminal the HLP sets up a command with
one of the following function codes:

- write {80}

- clear write {81}

- reset write {82}

- alert write {83}

- graphic write {85}

- write ASCII and send index {86}

There are several reasons for providing more than one function
code to send a message to a terminal rather than only one:

1. Several function codes are recognized by mode 4 terminals
   and different operations are performed because of them.
   {Only one function code is allowed per message.}

2. Because of the general nature of the mode 4 software, the
   HLP is not restricted in the kind of operation it can ask
   the terminal to perform. In this way the HLP can take full
   advantage of the features of any mode 4 terminal.

3. Because the mode 4 software performs the duties of a
   driver rather than the duties of a front end device, the
   HLP application is transparent to the mode 4 software. The
   HLP must be aware of the relationship between the messages
   being received from and sent to a terminal since the mode 4
   software makes no assumptions of this nature. The several
   "write" function codes give the HLP its needed level of
   control to do this.

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Several "read" function codes are also provided. These
are:

- read {00}

- read wait {01}

- read all {02}

More than one "read" function code is provided for the following
reasons:

1. The read request is provided to allow the HLP to quickly
   determine whether a particular terminal has data to send
   to the HLP. If no data is available the HLP will be notified
   quickly, the read will be terminated by the LCC and the
   HLP may release the buffer used in the read for another use.
   If data was available when the read was issued, the data
   will be transmitted to the HLP.

2. The "read wait" request is provided to relieve the HLP
   of the burden of continually "polling" a terminal to obtain
   data from the terminal. The read wait will be satisfied
   only when the specific terminal referenced has data to
   send. Unlike the "read" command, the "read wait" command
   may tie up a buffer for a long time.

3. The "read all" request is provided to relieve the HLP of
   the burden of polling a group of terminals or stations for
   data and to lessen the HLP's requirement for buffers.
   This request will be satisfied when any terminal or
   station on a given line has data to send.

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4. All of these function codes are provided to increase

    the flexability of the mode 4 software and thereby allow

    the HLP to use a variety of techniques to obtain data from

    a terminal. This is in keeping with the general purpose

    nature of the mode 4 software.

Another function of the interface with the HLP is to allow

the HLP to start and stop communication with the terminals.

The following function codes are provided to facilitate this:

1. Close line. This command notifies the mode 4 software that

    the HLP wishes to discontinue communication with terminals

    on a certain line.

2. Terminate active request. This command allows the HLP to

    terminate a request before it has been completely

    processed by the LCC.

The HLP starts communication with terminals by putting the

address of the lines it wishes to begin communication with

in the Line List.

The HLP is able to determine the cause of errors by initiating

a data set or data set adapter loop test on the line.

Command codes are provided for this purpose. This provision

is in addition to the information contained in the responses

sent to the HLP by the LCC.

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Another function of the HLP interface, as stated above, is to
enable the HLP to indicate to the LCC how operations are to be
performed {rather than what operation to perform}. Thus,
the HLP is able to:

- Tell the LCC what type of terminals are allowed to dial
  into a switched line. This is done at autoload time
  when the HLP presents Line Parameter Records containing
  a terminal model selection mask to the LCC for each
  mode 4 line. The HLP can also reselect the terminal
  models allowed on a line after the system has been
  autoloaded by using the "configure line" request to
  respecify the TM selection mask.

- Tell the LCC how to perform code conversion by sending
  code conversion tables to the LCC. A command function
  code is provided for this purpose. By being able to
  do this the HLP can specify the code to be processed
  by the HLP; the number of members in the code set eg.
  64, 96, 128 or 256; whether the code set is to be
  folded eg. converting a 96 member code set into one
  with only 64 members, and change flag codes into other
  flag codes. In addition, the HLP can specify whether
  code conversion is to be done at all and which of
  several code conversion tables are to be used if conversion
  is to be performed. This is accomplished by a field
  in the request that is provided for this purpose.

- Tell the LCC what action to take after an error has
  occurred. In some situations buffers could be processed
  out of sequence when an error occurs. A flag in the
  request is provided to direct the LCC's actions when
  this happens.

- Determine how the LCC will poll terminals. The mode 4
  software is designed to allow any mode 4 terminal to
  dial into any mode 4 line. To do this, restrictions
  are placed on the site codes that various terminals
  can use. However, sometimes it may be advantageous
  to restrict the terminals in the configuration or to
  assign certain terminals to certain lines, with the
  HLP having knowledge of the configuration. A bit in
  the terminal model site code field is provided to
  allow the HLP to instruct the LCC to expect any site
  code configuration without restriction if this is
  desired.

- Select which of the 48 lines are to be assigned to
  which communication mode. This is done at autoload
  time by the Line Select Masks in the Autoload Table.

Information also flows from the LCC to the HLP through the
interface with the HLP. The LCC notifies the HLP that it has
completed a requested operation by writing responses in the

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HLP's response list. This type of response is a solicited
response {because it is always associated with a request} and
provides the following information in addition to flagging the
end of an operation:

- The number of errors that occurred while the LCC
  attempted to perform the operation.

- That the operation was or was not successfully completed.

- The amount of data processed {in bytes}.

- That the LCC has begun processing on a request.

- That an exception condition {as distinguished from an
  error condition} has occurred. An example of this is
  the notification that the operator has depressed the
  ▽intervene▽ key while reading cards or printing data on
  the line printer of a 200 UT.

In the same manner the LCC uses responses, both solicited and
unsolicited, to report problems internal to the LCC. Some of
the internal problems reported by solicited responses {and
therefore associated with a particular request} are the
following:

- The LCC has reached a point where it has too few internal
  buffers to continue normal processing and must reject
  the present request.

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- The LCC found an illegal parameter in the request or command it is processing and must terminate this request.

The following internal problems, not associated with a particular request are reported by unsolicited responses.

- A fatal error has been detected on a communication link and this line is being closed because it is not possible to do additional processing on it.

- Intermittent errors were detected on the data path between the HLP and LCC.

- A fatal error was detected on a Data Set Adapter. The LCC is closing the line involved because it cannot continue processing on the link.

The LCC also uses the interface with the HLP to report errors. Some of the conditions discussed above also fall in this category. Error conditions reported include the following:

- A peripheral device referenced by a request is in a not-ready state.

- A request could not be successfully completed in the number of error retries allowed.

- A request could not be successfully completed before it was terminated by HLP request.

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- A fatal error occurred in the data link.

- A DSA had a fatal malfunction.

- Errors were detected on the data path between the LCC
  and the HLP.

The final type of information that is reported to the HLP by
the LCC through the interface with the HLP is that which allows
the HLP to operate more efficiently and thereby increase
system throughput. The following procedures are provided to
accomplish this:

- When a terminal dials into an opened mode 4 switched
  line, the mode 4 software will send a response to the
  HLP identifying the type and configuration of the
  terminal. This information provides the basis by which
  the HLP decides to specify code conversion, addresses the
  various stations on the terminal by the coded ᵛdestinationᵛ
  field in the request, controls the reading of cards
  and printing by the line printer, etc.

- When a terminal or a station on a multi-station terminal
  has data to send to the HLP for the first time after
  the line has been opened, the LCC will send an
  unsolicited response to the HLP to indicate this. This
  response will be sent only once for each station from
  which an operator can directly communicate with the
  system each time the line is opened. This will relieve

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the HLP of the burden of polling each inactive terminal

or station to determine when it will become active.

This capability is especially useful on multi-drop

lines and with multi-station terminals such as the 216.

- The "read wait" command is provided to relieve the HLP

   of the burden of polling an active station. Because the

   ability of the HLP to read data from a CRT is limited

   by operator response time, many attempts to read may

   be needed before data is actually obtained.

- The "read all" command will similarly relieve the HLP

   of the duty of successively polling active stations to

   obtain data. However, this command is provided

   essentially to reduce the requirement for HLP resident

   buffer space by allowing the HLP to read data from any

   terminal or station on a multi-drop line or any station

   on a multi-station terminal. The "read all" request is

   satisfied by any terminal on the line for which it is

   issued. Without this command several buffers would

   be allocated to receiving data from several terminals

   or stations for an indefinite amount of time. The

   system throughput will be reduced if the HLP runs out of

   unused buffers.

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The second logical interface to be discussed is the LCC's
interface with the terminal. Significant aspects of this
interface are the following:

- The LCC will identify the terminal that dials into a
  switched line. This is done without HLP action by
  sending poll messages to the terminal. These poll
  messages are generated internally by the LCC.

- In like manner, the LCC will determine initial station
  activity without any action being required by the HLP
  to enable the LCC to do this.

- The LCC will add/delete message framing characters in
  messages exchanged with the terminals. The LCC will also
  check these for validity.

- The LCC will attempt to recover from errors detected
  while communicating with terminals. Either a finite or
  an infinite number of retries will be allowed.

- The LCC will perform all link control procedures needed
  to communicate with the terminals. Included in this are
  link initialization and disconnect, message sequence
  control, code conversion and polling for data.

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6.1.2 Configuration

Since mode 4 is a two-way alternate communication scheme, the number of lines supported are: {see Section 3.1.3 for further explanation}.

> up to 30 lines at 9600 bps.

> up to 48 lines at 4800 bps. or less

The number of lines serviced as stated above must be reduced by 10% when code conversion capability is used, since code conversion adds 2 microseconds to the processing time for each data character.

A mix line speeds can be attained in the manner described in Section 3.1.3.

The amount of core required for mode 4 software is as follows:

> mode 4 words of core $= 2500 + 36L_4 + 8AL_4 + 16S_4 + 8Q + TMA + 65CCT + 8TMP$

where,

L_4 = the number of mode 4 lines

AL_4 = number of active {i.e. opened} mode 4 lines

S_4 = sum of active mode 4 streams

Q = sum of the queued $^\nabla$read wait$^\nabla$ or $^\nabla$read all$^\nabla$ requests for all mode 4 lines.

TMA = Terminal Model Area. The size of this area varies with the number and type of TM's in the system from 3 to 448 words.

CCT = the number of code conversion tables.

TMP = the number of terminals on multi-drop lines

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6.1.3 Mode 4 Features

6.1.3.1 Terminal Identification

A major problem faced with communications systems in which
more than one kind of terminal is supprtted, is the identifi-
cation of a terminal as it becomes active with respect to its
type or class so that its nature and configuration will be
known and it can be properly controlled or driven. The
restrictions imposed to accomplish this often result in much
equipment being required, the number of different kinds of
terminals controlled being severely limited, and inflexible,
restrictive rules being imposed.

To help solve this problem, the LCC Version 3.0 software, when
concerned with mode 4 terminals, will identify terminals
as they dial in on switched lines. This capability will not
be provided on non-switched lines because the terminals on
such lines are known. The following procedure is used:

1. After the LCC has been autoloaded and initialized, the
    HLP will open each line with which it wishes to
    communicate.

2. As a line is opened, the LCC will determine whether a
    terminal is present on the line and determine its type
    and configuration, if present.

3. The LCC will send a response to the HLP when the kind of

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terminal on the line is known or when all allowable types

are tried whichever occurs first. The response will

contain a code identifying the terminal or indicating that

it can't be identified or that none are dialed in.

4. If the response sent to the HLP indicated that the terminal

could not be identified at the time that the line was

opened, the LCC will continue to attempt to identify the

terminal until it is identified or until the HLP terminates

the procedure by issuing a � close line⁷ request. If the

terminal can be identified in this manner, an unsolicited

response will be sent to the HLP and will contain a code

identifying the terminal. If a ⁷close line request is

received, an attempt will be made to disconnect the

terminal. To be able to identify a terminal in this

manner, the following is required:

1. At autoload time the HLP must describe each unique

terminal in the system by a Terminal Model {TM}.

These terminal models will be read by the System

Initializer and stored in LCC memory, unless they

are preassembled into LCC memory {see Section 3}.

2. For each line in the system, a 32-bit parameter

selecting up to 16 TM's must be sent to the LCC at

autoload time, or be assembled into LCC memory.

3. Each of the 16 TM's selected for a given line must

contain a site address code different than the site

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address code of any other TM selected for that
line.

4. Each terminal in the system must have its site address
code set equal to the site address code of the TM
which uniquely describes it.

The LCC will identify a terminal as follows. The LCC will
issue a poll message to the connected terminal. If a reply
is received, the LCC matches the site code of the received
reply with the site code in a Terminal Model that describes
a type of terminal allowed on that line. When a match is
made, an identifying response containing the terminal model
number is sent to the HLP. The reply from the terminal may
be any valid response eg. READ, REJECT, ERROR.

This capability will allow the following techniques to be
used:

1. For all practical purposes, the HLP does not need to
restrict a certain kind of terminal to a certain line or
group of lines {e.g. BCD 200 UT's, ASCII 200 UT's, 241
graphics terminals and 216's could all dial into the same
line.}

2. Only one LCC-11 is needed to control a diverse array of
mode 4 terminals.

3. Only one LCC driver in the HLP is required.

4. Unauthorized terminals dialing in are identified. When

   the ⁰data set ready⁰signal is present for the dialed line

   and the terminal does not respond to poll messages in which

   every valid site address has been sent, the terminal will

   be considered to be unauthorized and a response to the

   open line request will be sent indicating this condition.

6.1.3.2   Determination of Initial Activity of Terminals and Stations of Multi-Station Terminals

The LCC will notify the HLP, by an unsolicited response, that

an inactive station wishes to become active. In this

context, a station is defined to be one of the following:

- A terminal whose station address is not enabled,

- A CRT station on a terminal with the station address

  enabled. The station can be referenced through its

  unique site/station address.

An inactive station is one that has not replied to a poll

message with a read message since its line was last opened.

A response will be sent for each station on a terminal having

more than one station. The unsolicited response will be sent

only once for each station each time the line is opened.

This procedure will be used on dedicated and switched lines
and with terminals utilizing either 200 UT or 216 protocol.
The determination of initial activity will be made by sending
a poll message, generated internally by the LCC, to the
terminal. The poll message may have been sent when attempting
to identify the terminal, as described above, and a read reply
received at that time. If so, one poll message will serve
to identify the terminal and to determine that a single station
terminal is ready to become active. If a reject was received
when attempting to identify the terminal, or if the terminal
uses 216 protocol, additional poll messages will be generated
by the LCC to determine initial activity. In any case, no
data will be sent to the HLP as a direct result of determining
initial activity since the operator of the station or terminal
is trying to gain initial access to the communications facility.

This feature is provided to reduce the amount of data sent
through the coupler and thus improve performance since the HLP
need not issue repeated requests to determine this condition.
The HLP is also relieved of the burden of polling, in turn,
each inactive station of a multi-station terminal.

6.1.3.3 Read Command Option for Mode 4 Terminals

The LCC will respond to three read commands sent to mode 4
terminals as follows:

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1. Read. The Terminal will be polled once for data and an
    immediate response will be sent upon completion of the
    read sequence. The response will indicate whether or not
    data was received and will signal the completion of the
    request.

2. Read Wait. The terminal will be repeatedly polled by the
    LCC until a read message is received in response to the
    poll message. The LCC will then send a response to the
    HLP indicating completion of the read request with data
    sent to the HLP. This request will not prevent communi-
    cation with other stations or terminals on the line.
    If reject messages are being received from a terminal
    for which a ᐁread waitᐁ request is being processed the
    ᐁread waitᐁ request will be queued in LCC memory to
    await further processing so that requests for other
    stations or terminals on the line can be processed.

3. Read all. A ᐁread allᐁ request will be satisfied when
    data is obtained from any station or terminal on the line
    for which the request was issued. As in the case of the
    ᐁread waitᐁ, this request will not prevent communication
    with other stations or terminals on the line. The
    response sent when this request is completed will identify
    the station and terminal that satisfied the ᐁread allᐁ
    in the DESTINATION field of the response. The LCC will
    generate the SITE ID and the STATION ID codes of the

DESTINATION field. The lower 8 bits of this field will

be the same as the lower 8 bits of the ▽read all▽ request

DESTINATION field. The upper 8 bits of the request

DESTINATION field will be ignored by the LCC and

therefore the ▽read all▽ request cannot be used to read

data from a card reader. The ▽read all▽ request is

provided to reduce the buffer memory requirements of

the HLP.

If an irrecoverable error is detected on a terminal or station

while the LCC is processing a ▽read all▽ request, the request

will be abnormally terminated and the terminal and station

identified in the response. This terminal will be flagged

internally to the LCC so that it will not be polled again

when trying to satisfy a ▽read all▽ request until the LCC

clears the flag. The LCC will clear the read all lock out

flag when it has successfully completed any other type of read

or write operation on the terminal.

When a ▽read all▽ request is being processed on a line, the

LCC will not initiate another read of any kind on that line

until the ▽read all▽ is completed.

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When a "read wait" request is being processed for a terminal

or station on a line, no other read request will be initiated

for that station until the "read wait" request is completed.

The LCC will not initiate a "read all" request on a line if

a "read wait" request is outstanding for any station on the

line.

6.1.3.4 Code Conversion

The LCC will provide a limited code conversion facility for

mode 4 terminals only. By code conversion is meant the trans-

lation of an 8-bit byte into another 8-bit byte. No validity

or range chacks will be made nor will codes be added or

deleted. Code conversion must be specified in each request

whenever the capability is desired.

At autoload time, the HLP must specify in the Autoload Table

{see Section 3} the number of code conversion tables to be

used. If code conversion tables are assembled into LCC

memory this value should be set to zero. Sixty-four words

will be allocated in LCC memory for each table. If more than

one table is allowed, the last word of table N will be

immediately followed in LCC memory by the first word of

table N+1. Pointers to the first word of each table will be

established in the direct core area of LCC memory. An area

immediately following the code conversion tables will be

allocated to hold a bias for each code conversion table. This

bias will be subtracted from the first word address of the

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respective code conversion table to allow for code sets whose lowest numbered code has a value other than zero.

Each code conversion table record when sent to the LCC will contain 65 16-bit words. The first word will contain the code bias and the second through the 65th words contain the code conversion table that is stored in the LCC.

Each 16-bit word of this table will contain two 8-bit characters. The high order character will be used in output {from the LCC to the terminal} operations while the low order byte will be used in input {to the LCC from the terminal} operations. Each conversion character must have proper parity when the table is sent to the LCC. The format of the table is shown below as it appears in the HLP buffer.

	0 7	8 15
Word 0	Output Code Bias	Input Code Bias
Word 1	Output Conversion Char.	Input Conversion Char.
Word 64	Output	Input

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It is the responsibility of the HLP to:

1. Transmit the required code conversion table to the LCC prior to the initiation of I/O on a line requiring code conversion, unless the table is assembled into memory.

2. Determine when code conversion is needed on a request basis and notify the LCC by putting the code conversion table number in the request for which code conversion is desired.

3. Determine how many code conversion tables can reside in LCC memory and not transfer more than this number to the LCC. The LCC software does not impose a restriction on the number of tables allowed, but nevertheless there is a restriction imposed by memory availability. Code conversion tables lessen the number of internal {to the LCC} buffers available to the LCC to perform its operations. If these are inadequate, the autoload procedure could be aborted, requests could be abnormally terminated and lines closed.

Normally code conversion will be performed on code sets with 64 members. When code conversion is needed on a terminal and a code set with more than 64 members is involved, the following procedure is used:

1. The first 64 words of the table set sent to the LCC as table N.

2. The second 64 words of the table are sent to the LCC as table N+1.

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3. Additional 64 word blocks of the table are sent as

    table N+2 or N+3.

4. When code conversion is specified, the first 64 word table

    number is specified.

As an assembly option the code conversion tables and pointers

may be assembled into the LCC memory at system generation

time. If this is done, the tables need not be sent to the

LCC by the HLP.

6.1.3.5 Dynamic Selection of a TM on a Line

A request function code will be provided to allow the HLP to

select a different subset of up to 16 TM's from the original

32 TM array for use on a given line, at any time. Once the

LCC has been autoloaded, no change to the TM's or to the

number of TM's in the system is possible. Selection is on

a line for line basis and is made by providing a 32-bit

selection parameter.

6.1.3.6 Multi-drop Lines

The LCC will control up to 16 terminals on a dedicated leased

or private line. Terminals on a dedicated line must be

completely specified by the HLP through proper TM definition

and selectionas for point-to-point lines. In addition, site

codes must be supplied for each terminal at autoload time.

Station codes, where applicable, must equal those in the

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appropriate TM. Only mode 4 terminals are supported on

multi-drop lines. The same mixture of terminal types and code

sets are allowed on dedicated lines as are allowed on

switched lines.

Responses to indicate initial activity on stations will be

sent for all terminals on dedicated lines in the same manner

as for dialed lines.

6.1.3.7 Line Disconnect

An attempt will be made to disconnect the terminal from a

switched line when a "close line" request is received by the

LCC. This capability will enable the HLP to terminate a call

when communication with the terminal is complete, e.g. when

the terminal operator logs out.

6.1.3.8 Error Handling Option for Mode 4 Terminals

When the LCC completes a stream request the next request on

that stream is scheduled to be read from the HLP memory.

If an irrecoverable error has occurred on a stream request,

reading of the next request queued on that stream could

result in buffers being processed out of sequence. This is

possible if the HLP sets up the next "write printer" request

as soon as the LCC begins to process the current "write

printer" request, and the HLP rewrites the buffer if an

irrecoverable error occurs, as part of its error recovery

process.

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To help solve this problem the LCC will have the following

capability when controlling mode 4 terminals:

1. Stream requests will have an "error option" flag bit {E}

   having the following meaning:

   E=0. Process any request in this stream slot if an

        irrecoverable error has occurred.

   E=1. Abnormally terminate all requests present for

        this stream when the error occurred. When this

        has been done the LCC will continue to abnormally

        terminate all requests for this slot until a

        request is found having its E flag set to zero.

This capability will allow the HLP to issue a new request

before the previous request for a given slot has been

completed to ensure high speed operation. If an irrecoverable

error occurs a queued request can be removed and the HLP can

reissue the unsatisfied request if that is desired.

6.1.3.9 Control Characters Added/Deleted

For transmission from the LCC to the terminal, the LCC frames

all data blocks with a set of control characters. These

control characters consist of four sync characters, a start

of header code {SOH} a site address, a station address, a

function code, any sync codes required after the function

code, data, an escape code {ESC} and E code, an end of text

{ETX} and a block parity code {BPC}.

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The LCC receives from the terminal data blocks which are
bounded with similar control characters. The LCC interprets
these control characters, ascertains if they are valid and
strips them off of the data block before it records the
data in the HLP data buffer.

6.1.3.10   Generation and Validation of Messages Between the
           Terminal and the LCC Needed to Perform the Operation
           Requested by the HLP

To cause a data buffer to be sent to a terminal, the HLP issues
a single "write" command {several varieties} to the LCC. To
receive a data block from a terminal the HLP issues a single
"read" command {several varieties} to the LCC.

To perform these operations, data is transmitted between the
LCC and the terminal as a series of messages which allow for
the transmission of data as well as additional information
in the form of parity bits and check messages so that many
kinds of errors occurring during transmission can be discovered
and corrected. This will result in a sequence of two or four
messages being transmitted. Whenever a message is sent to
the terminal, a reply is expected from the terminal.

Messages sent by the LCC to the terminal are of two types:

1. The "write" message which is used to send data to the
    terminal.

2. The "poll" message, which is used to request data from
    the terminal.

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Messages sent by the terminal to the LCC are of four types:

1. The "acknowledge" message to indicate satisfactory receipt of a write message.

2. The "reject" message to indicate that there is no data to send to the LCC.

3. The "error" message to indicate a transmission error on the previous "write" or "poll" message.

4. The "read" message to send data to the LCC.

It is the responsibility of the LCC to initiate and monitor these sequences. The HLP merely specifies that data be written or read without regard to the processes needed to accomplish this.

6.1.3.11 Error Recovery

When the LCC detects an error condition while exchanging data and control messages with a terminal, it initiates error recovery procedures a maximum of N times. A positive value of N is used as a retry count, a negative value is interpreted as an infinite number of retries. When N is positive and recovery procedures have been executed N times, the LCC exercises the Data Set Adaptor {DSA} to see if the condition is caused locally. The following action is then taken:

- The results of the test and the condition of a non-recoverable error are reported to the HLP by an unsolicited response {code 44}.

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- The request being processed at the time is abnormally
  terminated.

- All internally queued {to the LCC} requests for the
  terminal in question are abnormally terminated.

- If the line is a switched line or a point-to-point direct
  line, the LCC will process no stream requests until it
  finds and processes a "close line" request. If the line
  is a multi-drop line the LCC will process no stream
  requests until it finds and processes a "terminate stream"
  or "close line" request.

- When a "close line" request is received, the LCC will send
  a solicited response indicating that the close line request
  is initiated {code 26}. All requests in the request list
  for the line will be abnormally terminated by a response
  with response code 28 and when this has been done a response
  with response code 4E will be sent indicating that the
  line is closed.

- When a "terminate active stream request" request is found,
  the LCC will send a solicited response with response code 24
  to indicate that the request to terminate a stream has been
  received, any stream request in the Request List for the
  stream in question will be abnormally terminated by a
  response with response code 28. If no active stream

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request is present in the Request List for the stream

in question, a response with response code 27 will be issued

to the HLP.

When N is negative and recovery procedures have been executed

10 times, the LCC will read the HLP to LCC request for the

line, looking for a "terminate active stream request" request.

If this request is not found, error recovery attempts will be

executed again as described above. If a "terminate active

stream request" request was found, the LCC exercises the DSA

and reports the results of the test and the condition of the

non-recoverable error to the HLP as described above.

Following this the procedure for abnormally terminating stream

requests when a "terminate active stream request" request is

received is used as described above.

The conditions which cause the LCC to perform error

recovery are:

ERROR CONDITION	RECOVERY ACTION
1. TIME OUT - A valid response to a previous transmission is not received within the allowed time frame.	Terminal status is checked if the last output was a write. The last message will be retransmitted if required.
2. ERROR response {NAK}. The last message transmitted by the LCC was not correctly received by the terminal. See terminal hardware manual for specific conditions.	The message is retransmitted to the terminal.
3. Parity error detected in reply to a poll or status message.	The message is retransmitted.
4. Incorrect MPC detected in reply to a Poll or Status message.	The message is retransmitted.
5. Parity error or MPC error detected in reply to a Write message.	The LCC transmits a POLL message to the terminal to determine the status of the last Write. The previous message may or may not be retransmitted depending upon status received.
6. Station address toggle error detected in reply to a write message. Message Parity is correct.	The last Write message is retransmitted.

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6.1.3.12 Site Polling Option

An option is provided to allow all possible terminal site
codes to be polled on a line. This situation is found in a
computer utility environment where a large number of terminals
of a single type are found among the user population and it is
not desired to place restrictions on the site codes allowed.
When this option is used, all possible site addresses will be
used while the LCC is trying to identify the terminal on a
dialed line provided that the following restriction is met:

> Only a single terminal model can be selected on any
> line using this option. However, if this option is to
> be used on more than one line, each such line may select
> a different terminal model.

This option is selected on a line basis by setting the high
order bit of the 5 bit site address in the site descriptor
of the terminal model selected, to one. It should be noted
that the same TM {Terminal Model} cannot be used on a line
utilizing the site polling option and one not using the
option. When this option is selected, the 4 low order
bits of the site address in the TM are not used and can be
set to any value.

6.1.4 Interface with the HLP

The interface by which the HLP and the LCC communicate is
composed of tables and buffers resident in HLP memory and
the set of rules governing their use.

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The table portion of this facility is composed of the

following parts:

1. Line List

2. Request List

3. Commands

4. Response List

6.1.4.1 <u>Line List</u>

The Line List, whose location in HLP memory is passed to the

LCC at autoload time, contains up to 48 entries, 32 bits in

length. They serve to locate the Request List for each line

in the system. The Line List is ordered {ascending} according

to line number, there being one 32 bit entry for each line

attached to the LCC, and each empty port up to the highest

numbered port with a line attached. The last entry in the

Line List is a 64 bit entry containing the "suspend operation

on the LCC" command {command code F3 {hex}}. If there is no

new activity for the line, the corresponding entry in the

Line List {slot} will be negative. Otherwise, a non-negative

address of the Request List will be stored. It will be the

responsibility of the HLP to set each slot negative for

which there is no new activity. The HLP will put a new entry

in the Line List for the following reasons:

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1. The HLP wishes to suspend the LCC.

2. The HLP wishes to begin processing on a line.

6.1.4.2 Request List

The Request List serves as the primary means of indicating
to the LCC that a certain type of action is requested by the
HLP. This action is further specified in the command that
is associated with the request.

The LCC periodically references the Request List to determine
if a new request has been entered. Upon completion of the
request, a response is sent to the HLP.

The request list for mode 4 lines contains three {3} request
slots. The first slot is reserved for communication between
the HLP and the LCC. The second slot is used to indicate an
output operation from the LCC to the terminal. The third
slot is used to indicate an input operation to the LCC from
the terminal.

With this request list format the slot position of the
request does not identify the station for which the request
was issued as in mode 2 or mode 3. Therefore, mode 4 stations
must be identified by the DESTINATION field of the request.
This 16 bit field is formatted as follows:

0 3	4 7	8 15
SITE ID	STATION ID	FOR HLP USE

DESTINATION
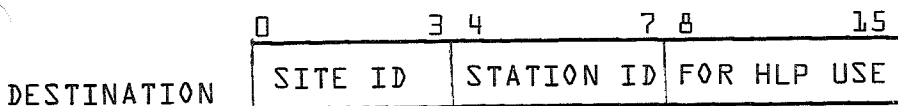
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SITE ID - This field contains an ordinal from 0 to F {hex}

selecting one of 16 terminals on the line. For a

point-to-point line where only one terminal is

present this value should be zero. For multi-drop

lines a code of 0 {zero} will select the terminal

described by the first TM/SITE record of the Line

Parameter Record for the line,sent to the LCC at

autoload time. A code of 1 {one} will select the

terminal selected by the second TM/SITE record, etc.

STATION ID - This field contains an ordinal from 0 to F {hex}

selecting one of several stations on the

terminal. A value of zero will select the

device described by the first device descriptor

of the Terminal Model that describes the

terminal referenced. A value of one selects the

the device described by the second device

descriptor etc.

FOR HLP USE - This field is not defined by the LCC but can be

used by the HLP, probably to define the line.

This field is returned to the HLP in the

destination field of the response as are the

site and station ID fields.

To allow the LCC to process requests as quickly as possible

so as to drive the terminals at the highest speeds possible,

the HLP should do the following:

1. Set the I-field of the request {see below} to request

    that a response be sent to the HLP when the request

    is initiated.

2. When the response indicating that the LCC has initiated

    the request is received, the HLP should set up the next

    request.

It should be noted that in normal high speed operation with

a 200 UT, the amount of time from receipt of the "request

initiated" response until the LCC reads the next request for

the same terminal with 1000 character buffers, is on the order

of several seconds. Thus the HLP software will be able to

perform the above listed operations at a leisurely pace.

A problem arises with high speed operation of a terminal when

requests are queued {as above for instance}. When an

irrecoverable error occurs, it may be necessary for the HLP

to send a message to the terminal to inform the operator that

manual intervention is required. After the operator corrects

the problem, the HLP may want to retransmit the buffer on

which the error was detected. If the LCC has begun to

process the next queued request, buffers could be processed

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out of sequence. To help prevent this from happening, the
following capability is provided:

1. An error handling option flag is provided in the stream
    request {the E-field}. If set, the LCC will abnormally
    terminate all queued requests for an unbuffered terminal
    when an irrecoverable error is found. If the terminal
    is buffered, requests queued on the station on which the
    error occurred will be abnormally terminated.

2. After the queued requests have been terminated, the LCC
    will again process stream requests. {See Section 6.1.3.8}

This will allow the HLP to send a message to the terminal to
request operator intervention, reissue the buffer on which the
irrecoverable error occurred and reissue all queued requests
that were abnormally terminated. This will preclude buffers
being processed out of sequence.

6.1.4.2.4 <u>Format of Requests</u>

The format of the HLP to LCC request is shown below:

	15 16	17 18	26 27 28	31	
DESTINATION	S		I		Word 1
BASE ADDRESS OF COMMAND					Word 2

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Word	Bits	Description
1	0-15	Destination field, supplied by the HLP and returned in the solicited response. Used to identify the terminal and station involved in the request.
	16	S-Field: Status of this request slot.
		0 - This request is active or has been completed. The LCC clears this bit when it initiates this request.
		1 - This request is ready for initiation. The HLP sets this bit when it enters a new request.
	27	I-Field: Interrupt and response options.
		0 - Do not send interrupt with request response.
		1 - Send interrupt with request response.

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The format of the stream request is shown below:

0	15 16 17 18 19	23 24	27 28	31	
DESTINATION	S E	I	C		Word 1
BASE ADDRESS OF COMMAND					Word 2

Word	Bits	Description
1	00-15	Destination Field: Required in all requests. Used to identify the terminal and station involved in the request. It is returned in the solicited response.
	16	S-Field: Status of this request slot. 0 - This request is active or has been completed. The LCC clears this bit when it initiates this request. 1 - This request is ready forrinitiation. The HLP sets this bit when it enters a new request.
1	17	E-Field: Error handling option field. 0 - Process the next request upon termination of present request if an error occurs. 1 - If this request must be terminated due to an irrecoverable error abnormally terminate all requests for this stream if any are queued. Continue to terminate requests in this request slot until a request is found with its E flag set to zero.

Word	Bits	Description
	24-27	I-Field: Interrupt and Response Options.
		0XXX - Do not send response or interrupt when request is initiated.
		10XX - Send response when request is initiated.
		11XX - Send response and interrupt when request is initiated.
		XX00 - Do not send interrupt when request is completed.
		XX10 - Send interrupt if request terminates abnormally..
		XX11 - Send interrupt when request is completed or terminated.
1	28-31	Code conversion table number.

6.1.4.3 Commands

Commands are 64 bits in length and give detailed information
to the LCC for proper execution of a request. Only one command
per request is allowed. There are two command formats, one
for HLP to LCC requests and one for stream requests. The
formats are shown in the following two sections.

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6.1.4.3.1 Command Format, HLP to LCC

0 7	8 15	16 31	
FUNCTION CODE	A1	A	Word 1
B			Word 2
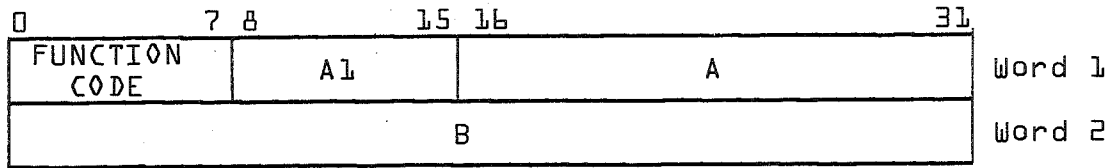
The use of fields A, A1, and B depends on the function code.
Generally, field A1 defines the number of words to transfer.
Field A defines the stream number. Field B is the HLP buffer
address.

Function Code {Hex}	
F1	Close Line: Terminate all requests on the line specified in the request and make the line inactive. If the line is a switched line, the LCC will attempt to disconnect the terminal.
F2	Terminate the active request on stream X defined in Field A. Field A contains the DESTINATION field of the stream request to be terminated.
F3	Suspend operation on the LCC until the HLP responds to resume operations by setting the channel flag. NOTE: This command is found as the last entry in the Line List and is read when a channel flag is set by the HLP.

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Function Code {Hex}	Description
F4	Transfer the LCC storage to the HLP. Field A defines the beginning LCC address to be transferred. Field A1 defines the number of LCC words to be transferred. This number must be in increments of 4 words. Field B defines the 32-bit base address in the HLP.
F5	Configuration definition for line X. This request is used to change the TM selection mask for the line. Field B contains a 32 bit selection mask used to select up to 16 TM's on on the line. Care should be exercised in the use of this command.
F6	Data set adapter loop request. This request instructs the LCC to loop the data set adapter; i.e. the data character supplied in the request is transmitted 256 times out of the LCC and is immediately returned on the input side of the communication line. No data is transmitted to the remote terminal. The number of unsuccessful receipts is put into the termination response which is written in the HLP. The line is then closed. It is suggested that the line have no outstanding

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Function Code (Hex)	Description
	stream requests when this request is issued. This operation is the same operation initiated by the LCC when the link reaches the maximum number of error recovery attempts and loops the line. Bits 24 to 31 of Field B contain the character to be involved in the loop back operation.
F7	Data set loop request. This request is similar to the one defined above, however, it must be issued to the AT&T 303 series modem or the equivalent. It is suggested that this request not be issued on a line that does not provide this function.
F8	Read code conversion table X into LCC memory. The code conversion table specified in Field A is to be read into LCC memory. Field B gives the HLP address of the 65 word (16 bit) code conversion table.

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6.1.4.3.2 Command Format, Stream

0	7 8	15 16	31	
FUNCTION CODE	/////////// ///////////	BYTE COUNT		Word 1
BASE ADDRESS OF DATA BUFFER				Word 2

Function Code	Description
00	Read {normal}. The LCC stores the data it receives from the line into the data buffer. This is the normal read command to be used for CRT's, graphic stations, etc. When a non-error reply to the poll message sent by the LCC is received, an immediate response is sent to terminate this request whether the reply was a reject or a read.
01	Read wait. Similar to the operation described above except a response will be sent to the HLP only when data has been received from the terminal.
02	Read All. This request will be satisfied by any station on any terminal on the line for which this was issued. It is provided to reduce the amount of HLP memory that must be devoted to buffers. When data is received from a terminal it is stored in the data buffer provided by the HLP. The terminal and station

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Function Code	Description
02 {continued}	that satisfied this request will be identified in the DESTINATION field of the response to the read all. The LCC will generate the SITE ID and the STATION ID. The lower 8 bits of the DESTINATION field will be the same as those of the "read all" request. Data from the card reader cannot be read by the "read all" request.
80	Write. Write transparent text to the terminal. The byte count field specifies the number of 8-bit data bytes to be processed from the data buffer.
81	Clear Write. The write described for function code 80 is to be performed with a clear write command code sent to the terminal.
82	Reset write. The write operation described for function code 80 is to be performed with a reset write command code sent to the terminal.
83	Alert write. No data will be sent. The alert will be turned on at the terminal.
84	Diagnostic write. The data in the buffer specified by the command is sent to the terminal with a diagnostic write function code. The data will then be read from the terminal and placed in the buffer specified by the first 32 bits of

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Function Code	Description
84 {continued}	the buffer containing the data to be output. The 32 bits of received buffer address is not transmitted to the terminal. See buffer discussion in Section 6.1.4.4.
85	Graphic write. The write operation described for code 80 is performed with a graphic write command code sent to the terminal.
86	Write ASCII and send index. The write specified for function code 80 is performed but an E4 code will be sent in place of the normal E1 code at the end of the message. This command will erase from the terminals CRT memory any previously sent E4, and will begin writing the data in the buffer pointed to by this command at the first location after the previous E4 code. The E4 sent with this message will be stored and denotes the beginning point of the next message.

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6.1.4.4 Buffers

The responsibility for ensuring that data buffers used with

mode 4 terminals are properly formatted belongs to the HLP and

not the LCC. Mode 4 buffers must have the following character-

istics:

1. Within a single mode 4 buffer there is only one data mode.

    A data mode is a particular format of data according to

    byte size, the arrangement of bytes within a 16 bit word,

    and the code set represented by bits. An example of a

    data mode is a buffer of 8 bit ASCII characters packed

    2 per 16 bit word.

2. Data bytes are 8 bit bytes with 2 bytes per 16 bit word.

3. When writing to the CRT, the HLP data buffer must contain

    an escape code {ESC}, carriage return {CR} sequence when-

    ever line truncation is needed.

4. When writing to the line printer, the HLP data buffer must

    contain an escape code, end of line {EOL} or an escape

    code, carriage return sequence whenever line truncation is

    needed.

5. The first character in a buffer and the first character

    following an EOL or CR in a message sent to the line printer

    must be a format control code. Format control codes cause

    the printer to perform single space, double space, page

    eject or suppress space functions.

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6. From 3 to 15 zeros may be compressed when writing to the line printer by inserting the ESC, "compression character" sequence in the buffer whenever compression of zeros is required. The "compression character" has a value in the range 03 {hex} to OF {hex}, indicating the compression of from 3 to 15 zeros respectively.

7. From 3 to 31 blanks {or spaces} may be compressed when writing to the line printer by inserting an ESC, "compression character" sequence in the buffer whenever compression of spaces is desired. The "compression character" has a value in the range 23 {hex} to 3F{hex} indicating the compression of from 3 to 31 spaces respectively.

8. Buffers must be large enough to allow an entire message from a terminal to be read into a single buffer or an entire message to be written to a terminal from a single buffer. Buffer tanking is not handled by the LCC. If the receiving buffer is not large enough to hold all of the data bytes being read from a terminal, the read request will be terminated with error due to lost data.

9. Buffers must be a multiple of 4 bytes in length. This is true of both input and output buffers.

Buffers for use in a diagnostic write operation constitute a special case. When a data buffer is output to a mode 4 terminal during a diagnostic write operation, the terminal will

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immediately transmit the data it received back to the HLP

through the LCC. The HLP will then compare the transmitted data

with the received data to determine error conditions. Two

buffers are needed to do this, although the structure of the

command allows only one buffer to be specified. The LCC will

handle this problem in the following manner:

1. The "base address of data buffer" field of the "diagnostic

    write" command will point to the buffer containing the

    data to be sent to the terminal.

2. The first 32 bits of the buffer containing the data to be

    sent to the terminal will contain the address of the buffer

    in HLP memory into which the data received from the terminal

    in response to a diagnostic write command is to be placed.

    The 32 bit buffer address is not considered part of the

    data and will not be sent to the terminal by the LCC.

6.1.4.5 Response List

The response list is a circular list whose entries are responses

to requests. The list contains IN and OUT pointers used to

enter and remove responses from the list. Responses are used

by the LCC to indicate the occurrence of an event such as the

initiated or completion of a request or the occurrence of an

abnormal condition and to provide information about the event.

There are two types of responses, solicitied and unsolicitied.

Solicited responses are in reply to a request while unsolicited

responses are initiated by the occurrence of an unexpected

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condition on a stream or in the system. Responses are 128

bits in length and have the following formats.

6.1.4.5.1   Normal Unsolicited Response Format - Type 1

```
      0   1                    7 8                    15
    ┌─────────────────────────────┬────────────────────┐
  0 │ STREAM NUMBER               │                    │
    │ (IF APPLICABLE)             │  LINE NUMBER       │
    ├───┬─────────────────────────┴────────────────────┤
  1 │LOG│          RESPONSE CODE                        │
    ├───┴──────────────────────────────────────────────┤
  2 │                                                  │
  3 │                                                  │
    │                                                  │
  4 │              NOT USED                            │
  5 │                                                  │
    │                                                  │
  6 │                                                  │
    ├──────────────────────────────────────────────────┤
  7 │              FIELD A                             │
    └──────────────────────────────────────────────────┘
```
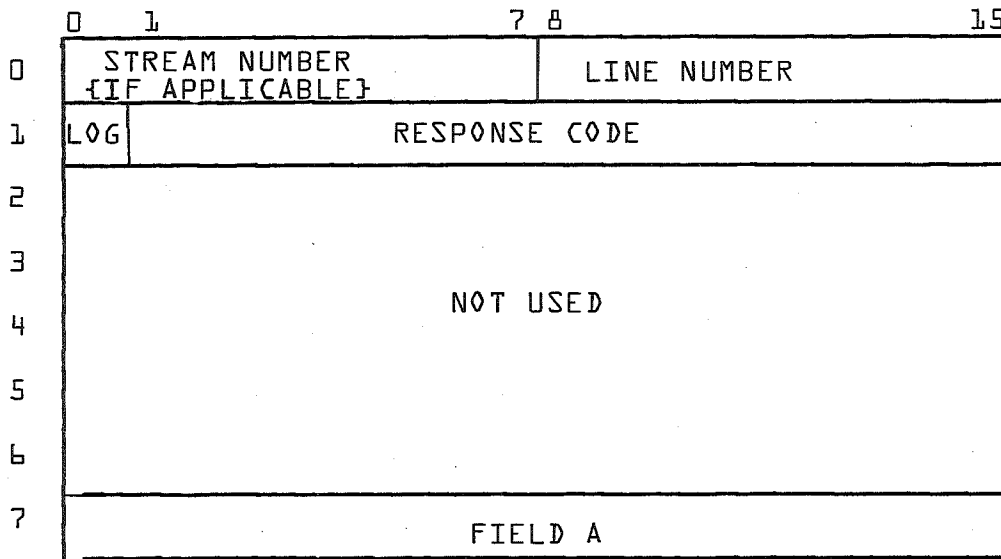
6.1.4.5.2   Normal Solicited Response - Type 2

This response format is type 2 and is sent in response to HLP

to LCC requests and to illegally formatted stream requests.

```
      0                                              15
    ┌──────────────────────────────────────────────────┐
  0 │              DESTINATION                         │
    ├──────────────────────────────────────────────────┤
  1 │              RESPONSE CODE                       │
    ├──────────────────────────────────────────────────┤
  2 │//////////////////////////////////////////////////│
  3 │//////////////////////////////////////////////////│
    ├──────────────────────────────────────────────────┤
  4 │          BASE ADDRESS OF COMMAND                 │
  5 │                 (32 Bits)                        │
    ├──────────────────────────────────────────────────┤
  6 │//////////////////////////////////////////////////│
  7 │//////////////////////////////////////////////////│
    └──────────────────────────────────────────────────┘
```
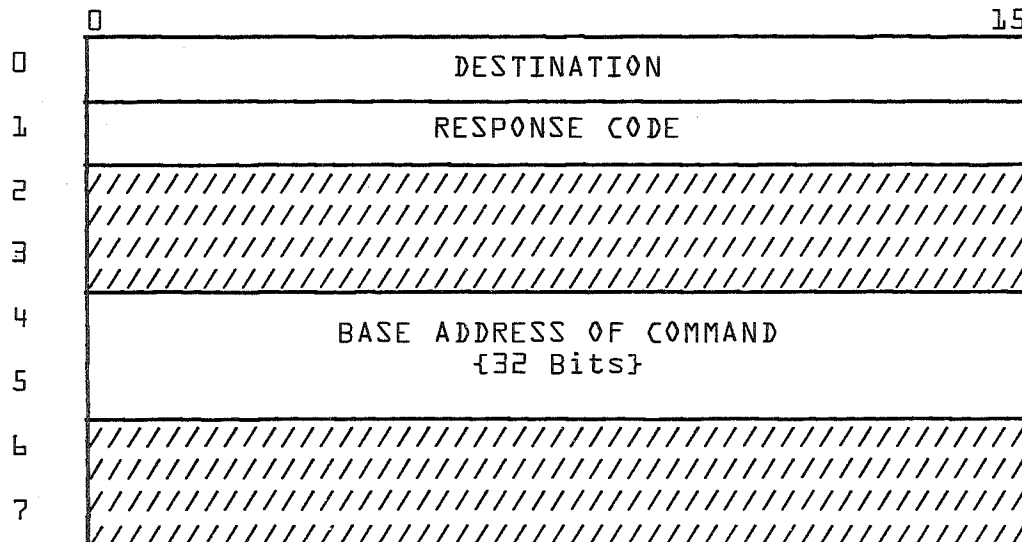
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6.1.4.5.2 Normal Solicited Response - Type 3

Type 3 sent in response to a stream request.

```
        0                       7 8                    15
        ┌───────────────────────────────────────────────┐
   0    │                 DESTINATION                    │
        ├────┬──────────────────────────────────────────┤
   1    │LOG │           RESPONSE CODE                   │
        ├────┴──────────────────────────────────────────┤
   2    │                                               │
        │                                               │
   3    │                                               │
        ├───────────────────────────────────────────────┤
   4    │            32 BIT BASE ADDRESS OF             │
        │                   COMMAND                      │
   5    │                                               │
        ├─────────────────────────┬─────────────────────┤
   6    │      REXMIT COUNT       │     LINK STATUS      │
        ├─────────────────────────┴─────────────────────┤
   7    │                 BYTE COUNT                     │
        └───────────────────────────────────────────────┘
```
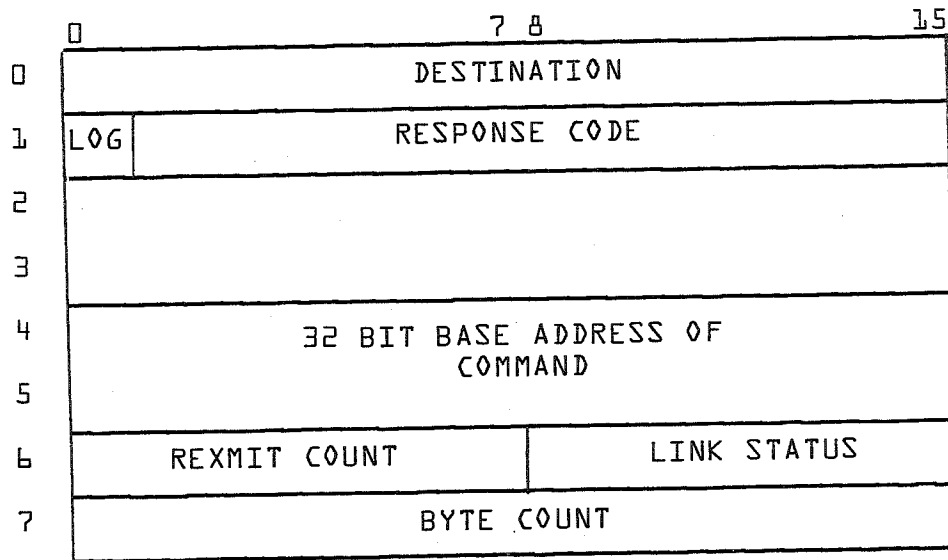
REXMIT = the number of error recovery attempts on the

last block.

BYTE COUNT = the number of 8 bit bytes of data transferred.

6.1.4.5.4 Abnormal Unsolicited Response - Type 4

```
        0                       7 8                    15
        ┌───────────────────────┬───────────────────────┐
   0    │                       │     LINE NUMBER        │
        ├────┬──────────────────┴───────────────────────┤
   1    │LOG │           RESPONSE CODE                   │
        ├────┴──────────────────────────────────────────┤
   2    │                                               │
        │                                               │
   3    │                                               │
        │                                               │
   4    │                                               │
        │                                               │
   5    │                                               │
        ├─────────────────────────┬─────────────────────┤
   6    │        FIELD A          │       FIELD B        │
        ├─────────────────────────┼─────────────────────┤
   7    │        FIELD C          │       FIELD D        │
        └─────────────────────────┴─────────────────────┘
```
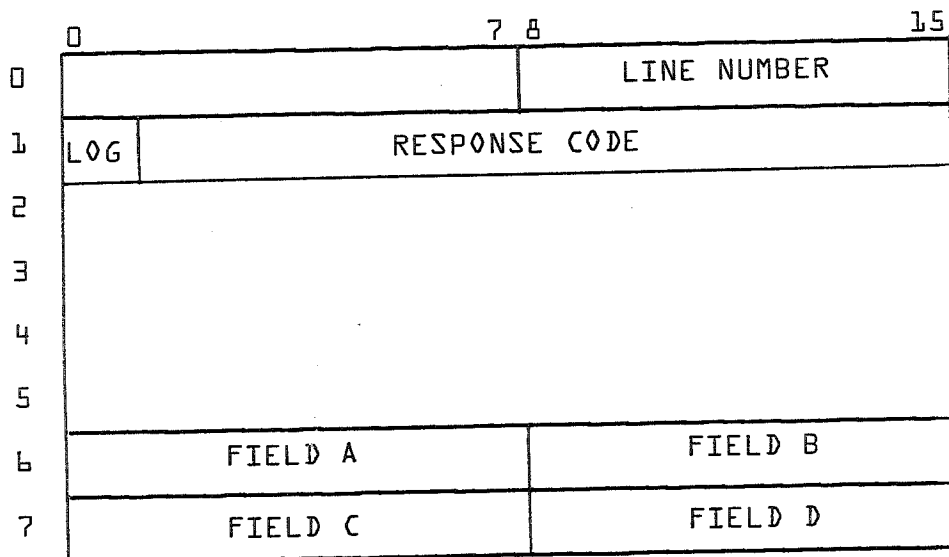
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There are two type 4 responses. They are response 44 {link

has errored out} and 45 {intermittent SAC problems}. Response

44 uses fields B, C, D.

Field B = Link status {8 bits}; B, S, C, NE, N, TO, SAC, NA

        B = illegal data SID, not used with mode 4

        S = out of sequence block, not used with mode 4

           terminals

        C = BPC or character parity error

      NE = no ending delimiter or E code

        N = NAK was received

      TO = link time out on output

    SAC = had intermittent SAC problem

     NA = ending delimiter, not used with mode 4 terminals

           0 - ETB

           1 - ETX

Field C = DSA error results from DSA loop exercise.

        = 0 all attempts were successful

        ≠ 0 number of unsuccessful attempts

Field D = Carrier on/off status

        = 00 carrier is on and data set is ready

        = 01 carrier was on but data set not ready

        = 02 carrier was not on, data set ready

        = 03 neither carrier on nor data set ready

The "intermittent SAC problems" response uses Field A to indi-

cate the number of intermittent SAC rejects in this pass.

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6.1.4.5.5 Solicited Response Codes

Code	Resp. Type	Associated Command	Description
00	2	any stream	HLP solicited response on initiation of a stream request.
20	3	00	A not ready condition is present on the card reader {an E2 code has been received}.
21	3	80-82	Data from the card reader has been received. A write to the printer request terminated normally with an E1 code detected. This means that the operator has depressed the "intervene" key and wishes to gain access to the system. The data has been printed.
22	3	00-02 80-86	Normal termination without irrecoverable errors for a stream request.
22	2	F4, F8	Normal termination without irrecoverable errors for an HLP to LCC request.
23	2	F5	The HLP request to change the TM selection mask {reconfigure line} is complete.
24	2	F2	The HLP request to terminate a stream has been initiated. Response code 27 or 28 will eventually be given for this stream.
25	2	F4	Request to transfer LCC memory into the HLP is complete.
26	2	F1	Close line request is initiated.

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Code	Resp. Type	Associated Command	Description
27	2	F2	Terminate stream request terminated normally. LCC did not find an outstanding stream request.
28	3	all streams	Stream request terminated abnormally.
29	2	all	Request rejected, illegal parameter.
2A	3	00-02 80-86	System is at buffer threshold, this request is rejected.
2B	4	F6	Request to initiate DSA loop is completed. The format of this response is the same as the abnormal unsolicited response number 44, except the base address of the command is in words 4 and 5.
2C	4	F7	Request to initiate Data Set loop is completed. The format of this response is the same as the abnormal unsolicited response number 44, except the base address of the command is in words 4 and 5.
2D	3		A write request sent to the printer has terminated abnormally. A not ready status has been detected on the line printer. The data sent in the request has not been printed.

Code	Resp. Type	Associated Command	Description
2E	2	F3	The HLP request to suspend the system has been initiated.
2F	3	00	A read request sent to the card reader has terminated abnormally with an E1 code detected. This means that the operator has depressed the "intervene" key and wishes to gain access to the system. No data has been read from the card reader.

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6.1.4.5.6 Unsolicited Response Codes

Code	Resp. Type	Associated Command	Description
40	1		This stream is becoming active for the first time since the line has been opened. It has data to send to the HLP. The HLP is requested to set up a read request on this stream.
44	1		Link has errored out, all outstanding requests are being terminated abnormally. If the line is point-to-point it is closing. A multi-drop line remains open.
45	1		System had intermittent SAC rejects, Field A contains the current count.
46	1		System buffers are saturated, this line is closing.
48	1		Had a disastrous DSA malfunction, this line is closing.
49	1		Channel flag is cleared.
4A	1		A terminal has dialed into the line which was previously opened. The TM ordinal is in word 2.
4B	1		An unauthorized terminal has dialed into the line. The line is closed. An attempt has been made to disconnect the terminal.
4D	1		Unsolicited response, the system is in a

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Code	Resp. Type	Associated Command	Description
			suspended state.
4E	1		Unsolicited response. The line is closed.
50	2		No terminal is dialed in {dialed lines only}. The line is open. The LCC will send an unsolicited response {4A or 4B} which will identify the terminal when a terminal dials in.
4F	1		Unsolicited response. The line is open.

6.1.4.6 Use of the Interface by the HLP

The mode 4 capability of the LCC software has been designed to
use the mode 4 terminals at a high level of performance, to take
advantage of some of the unique properties of mode 4 terminals
to attain this goal, and to provide a software base that will
not hinder future feature development and will make such
additions easier to implement. Those users who do not want
to use some of the features of this product are provided with
options whereby certain features can be bypassed.

Examples of this are:

1. Terminal Models and LCA parameters do not have to be passed
    to the system initializer at autoload time. These, and
    code conversion tables may be assembled into memory and
    portions of the SI routine assembled out.

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2. Request/commands that provide features not desired do not
    have to be issued. Examples are: sustend operation on the
    LCC {command function code F3}, transfer LCC memory to the
    HLP {F4}, configuration definition for a line {F5},
    data set loop request {F7}, data set adapter loop request
    {F6}, read code conversion table {F8}, either read normal
    {00} read all {02} or read wait {01} can be ignored,
    alert write {83}, diagnostic write {84}, graphic write {85}.

3. Responses from the LCC can be ignored such as those
    indicating initial activity on a station. This may result
    in decreased performance, however.

6.1.4.6.1 HLP's Role in Error Recovery

It is the responsibility of the LCC to detect and correct
transmission generated errors. This includes parity errors,
both character and message, handling of destroyed data and
responses and handling of error replies from the terminal.
There is another class of error from which the LCC cannot
properly recovery without the assistance of the HLP. The two
instances of this are:

1. Printer not ready

2. Card reader not ready.

The printer will become not ready for a variety of reasons
such as: out of paper, power off, gate open. When this
occurs, operator intervention is required to clear the error
condition. It will be the responsibility of the HLP to

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attempt to clear this condition or take other steps to continue

processing even though this may be accomplished simply by

not sending messages to the printer. The most common method

of clearing a printer not ready condition is for the HLP to

initiate the writing of a message to the operator informing

him of the printer not ready condition. Following this, the

HLP should set up a read of the CRT to receive notification

from the operator that the not ready condition has been cleared.

Normal printer operation can then continue.

The card reader not ready condition is detected by the LCC

while processing a "card read" request from the HLP. This

condition occurs for various reasons: some of which are:

1.   The last card has been read, hopper empty.

2.   Stacker full.

3.   Card jam in the transport.

4.   Power off.

5.   Card read error.

The condition that the last card has been read does not

necessarily mean that an error has occurred. If the last card

read indicates the end of file, there is no error. This

condition cannot be determined by the LCC since the card data

is essentially transparent to the LCC.

The HLP has the responsibility of determining whether an error

has actually occurred by determining whether an end of file

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condition exists or not. If an error has occurred, manual

intervention by the operator will be required to clear the

not ready condition. It will be the responsibility of the HLP

to initiate a dialogue with the operator to clear the card

reader in the manner discussed above for the line printer.

6.1.4.6.2 Intervene Key Processing

The "intervene" key is a key on the 200 UT keyboard which,

when depressed, unlocks the keyboard and allows the operator

to depress the "send" key. Depressing the "send" key will

cause a "read" message to be transmitted by the terminal

when the LCC polls the terminal. In this way the operator is

able to indicate to the HLP that he wishes to gain accesss to

the system during continuous card reading or while writing to

the line printer. The LCC will detect this condition while

processing a card read or write to the printer request. The

LCC will notify the HLP that the "intervene" key has been

depressed by sending a unique response code in reply to the

request for which the condition was noted. When this occurs,

the following is true:

1. If a read cards operation was requested it has not been

    performed and no card data has been transmitted to the

    HLP.

2. If a request to write data to the line printer was made

    the operation has been completed without error.

3. The "intervene" key has been depressed.

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4. If the operator has entered data before depressing the

    "send" key, this data has not been transmitted to the HLP.

If the next request processed by the LCC is a read request,

the message entered by the operator will be transmitted to

the HLP. This information will be lost to the HLP after the

LCC processes a write request. For this reason the LCC will

not process a write request after an E1 condition is detected

until it has processed a read request.

6.1.4.6.3 <u>Termination of Stream Commands by the HLP</u>

A command code {F2} has been provided to allow the HLP to

terminate an active stream request. In this way, the HLP will

be able to perform the following functions, if desired:

1. Set timeouts on requests and terminate those that are

    outstanding when a timeout occurs.

2. Terminate requests that are queued by the LCC such as

    the "read wait" or "read all" request.

The LCC will periodically read the HLP to LCC request slot

for each line for which any of the following is true:

1. A "read wait" or "read all" command is being processed

    but the LCC is receiving rejects from the terminal.

2. Infinite retries on an error condition has been specified

    and an error condition has occurred.

3. Before reading a stream request.

When a "terminate active stream request" request is found, the following action will be taken:

1. The LCC will issue a solicited response with response code 24 to the HLP to indicate that the LCC has begun to process the terminate request.

2. Any internally queued {to the LCC} requests having a DESTINATION field the same as the DESTINATION field contained in field A of the terminate request, will be abnormally terminated. The response sent will have a response code of 28.

3. Any stream request in the Request List with the specified DESTINATION field will be abnormally terminated and a response with response code 28 will be sent.

4. If no active stream request is present in the Request List or internally queued in the LCC, a response with a response code of 27 will be sent to the HLP.

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6.1.4.6.4 <u>Auto-disconnect Requiring Action by the HLP</u>

Because the LCC does not examine the data received or trans-

mitted between the HLP and the terminal, it cannot detect the

following conditions:

1. The terminal operator has logged out.

2. The last block of data has been transmitted in a data

    gathering operation.

3. The last block of data has been sent in the transmission

    of a file to an unattended terminal.

When conditions such as these occur, the HLP may want to

disconnect the terminal for which processing is complete from

the line and begin processing with another terminal. If this

is true, the HLP must inform the LCC that the terminal is to be

disconnected by closing the line. Processing will continue

when the line is again opened.

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6.1.5 Interface with the Terminal

6.1.5.1 Error Correction Procedure with Read Commands

The following procedures will be used when executing a ᵛreadᵛ or a ᵛread waitᵛ or "read all" request from the HLP.

CONDITION	PROCEDURE
1. The LCC receives a ᵛrejectᵛ response to a poll message while performing a ᵛreadᵛ request.	The ᵛreadᵛ request will be immediately terminated with an ᵛabnormal stream terminationᵛ response indicating that the terminal has no data to send.
2. The LCC is processing a ᵛreadᵛ request. An infinite number of retries is specified if an error occurs. An error message or a message with character or message parity errors is received in response to a poll message.	The terminal will be repolled until a ᵛterminate streamᵛ request is received or until a timeout occurs indicating the loss of carrier or a DSA failure. The DSA loop test will be performed and the request will be terminated with an abnormal termination response. The LCC will search for a ᵛterminate streamᵛ request after every 10 attempts to perform the operation requested. If data is received without error while attempting to recover from an error, the request will be completed with a normal termination response.

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CONDITION	PROCEDURE
3. The LCC is processing a ▽read▽ request. A finite number of retries is specified if an error occurs. An error message or a message with character or message parity errors is received in response to a poll message.	The poll message will be repeated the number of times specified if errors persist. The DSA loop test will then be performed and the request will be term- inated with an abnormal termination re- sponse.
4. The LCC is processing a ▽read wait▽ or "read all" request. An infinite number of retries is specified if an error occurs. A reject message or an error message or a message with character or or message parity errors is received in response to a poll message.	The poll message will be retried 10 times if data is not received without error. A ▽terminate stream▽ request will then be searched for. If not found, the poll message will be resent 10 times. If a ▽terminate stream▽ request is found or if a timeout occurs, the DSA loop test will be performed and the request will be terminated with an abnormal termination response.

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CONDITION	PROCEDURE
5. The LCC is processing a ▽read wait▽ or "read all" request. A finate number of retries is specified if an error occurs. A reject message or an error message or a message with character or message parity errors is received in response to a poll message.	The poll message will be repeated the number of times specified if a ▽read▽ message is not received without error. The DSA loop test will then be performed if an error condition exists. The request will then be completed with an abnormal termination response.

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6.1.6 <u>Overview</u>

This section presents a general description of how the system

operates.

Before any communications activity can begin, the LCC-11 must

be autoloaded with the LCC software. Autoloading is done at

the instigation of the HLP and is performed under its control.

The LCC resident software is loaded into LCC-11 memory through

the PL-SAC Coupler. A 64 word bootstrap program is first

transferred to the LCC and begins execution. The bootstrap

program reads in the LCC software and system initialization

routines.

The System Initialization routine {SI} processes records from

the HLP containing information about the number of lines in

the system, the assignment of lines to communication modes, a

description of the terminals in the network in the form of

Terminal Models {TM}, the assignment of terminals to the lines,

and data needed to establish the Line Control Area for each

line. When the table area and buffers have been established,

the SI will idle waiting for the HLP to set the channel flag

to indicate that it has placed entries in the Line List and

is ready to open lines. When this occurs, the SI routine

gives control to the LCC software which begins execution.

The LCC will read each entry in the Line List, clear the channel

flag indicator when the last Line List entry has been read,

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and send an unsolicited response to the HLP indicating that
this has been done. For each line for which a positive Line
List entry was found, the LCC will send an unsolicited response
indicating the line is open. If the line is a switched line,
the LCC will determine if a terminal has dialed in. If no
terminal has dialed into the line at this time, an unsolicited
response is sent to the HLP indicating that no terminal is
present. The line remains open and the LCC continues to
search for the presence of a terminal on the line. When a
terminal dials into the line, the LCC will attempt to
identify the terminal in the following manner.

The Terminal Model Selection Mask will be used to reference
each Terminal Model allowed on the line. One poll message
will be sent for each Terminal Model referenced using the
site code specified in the Terminal Model. If a reply was
received to one of these poll messages, the LCC will complete
the "open line" request with a solicited response identifying
the terminal. If no reply was received, the LCC will send
an unsolicited response indicating that an unauthorized
terminal is present. The line is closed and an attempt is
made to disconnect the terminal.

When the line is opened and the terminal on a switched line
has been identified, the LCC will do the following:
1. Read the Request List for the line and process any HLP
    to LCC and stream requests found.

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2. Determine when a terminal or station of a buffered terminal
    first becomes ready to transmit data to the HLP and notify
    the HLP with an unsolicited response.

The determination of initial activity response is sent only
once for each station each time the line is opened. If the
HLP ignores the response, the LCC will not repeat it. This
determination is made by the LCC sending either a poll
message {in the case of a terminal with 200 UT protocol} or a
station status request message {in the case of a terminal
using 216 protocol} to the terminal. The status of the
terminal or stations will be known from the reply received.
No data is transmitted to the HLP in this process and no data
will be lost. When the HLP issues a request to read, the
data from the terminal will be transmitted to the HLP. This
procedure will be applied to all mode 4 terminals on all lines
whether the lines are dedicated or switched, point-to-point
or multi-point.

At any time, when it is desirable to stop activity on a line, a
request to close a line may be sent from the HLP. Communication
activity will be stopped, the line will be set to closed status
and a response will be sent to the HLP. When reopened, the
terminals on the line will again be identified and have initial
activity determined as discussed above.

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APPENDIX A

GLOSSARY OF TERMS

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GLOSSARY OF TERMS

The following definitions, terms, and abbreviations are used in this

document:

ACTIVE LINE   - A communication line that has an area in the
                           HLP's memory dedicated for requests.

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

ALPHA {α}
Information Trade   - See Section 4.2.1 for a complete definition.

BC   - See Buffer Controller.

Beta {β}
Information Trade   - See Section 4.2.1 for a complete description.

Block   - A transmission block is a group of bits,
                           characters, or bytes that are transmitted on a
                           link as an entity by use of the appropriate link
                           control procedure.

BPS   - Bits Per Second.

Buffer Controller   - A 16-bit parallel digital computer with a 200
                           nsec or 1.1 usec memory cycle time.

Byte   - 8 bits.

CHANNEL FLAG   - Communication from the HLP to the LCC is
                           initiated by the HLP sending a pulse on the
                           trunk control strobe and by sending a channel
                           flag control code on the control lines.

Closing Delimiter   - A character sequence which defines the end of
                           a transmission block.

Correct Trans-
mission   - A transmission whose opening delimiter, closing
                           delimiter are recognizable {i.e., valid} and
                           cyclic redundancy check is not in error.

DATA   - Data is those characters which make up a message.

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Glossary Continued....

Data Framing
Characters   - ASCII control characters that delimit the data
                    and indicate its transmitted mode, SOH, STX,
                    TSTX.

Data Set   - A piece of hardware which modulates/demodulates
                    data signals in a link.

Data Set Adapter - A hardware module that acts as an interface
{DSA}   between a data set {modem} and normal channels.
                    During input operations, the DSA assembles
                    the serial bit stream furnished by the data
                    set into 8-bit characters. During the output
                    operation, the reverse disassembly occurs.

DOMINANT   - Stations on a link that initiate all activity.
                    The subordinate must always reply to the
                    dominant, the reverse is not always true.

DSA   - See Data Set Adapter.

EOM   - End of Message.

Full Duplex   - A hardware capability of transmitting and
                    receiving on a link simultaneously.

HLP   - Higher Level Processor.

Information {Status} - A transmission block which contains only
Block   stream identifiers and their status {i.e., SID}.

Interpretable
Response   - A response which has valid opening and closing
                    delimiters {i.e., can be interpreted}.

INPUT Stream   - Input streams are those simplex flow of data
                    which are received by the LCC {i.e., the LCC
                    inputs the data}.

LCC   - Local Communication Controller.

LINK   - A communication channel and communication
                    control logic in all directly connected stations.

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Glossary Continued....

Message	- A logically related group of data elements that must be switched or processed as an entity. In this application, a message is always ended by an ETX or TETX.
Modem	- See Data Set
Non-Continuous	- Every block transmitted must have a response before another block is transmitted in the same direction.
Non-Switched Line	- A communication channel which has both ends connected point-to-point. The line does not go through a telephone switch network.
Off-Line	- A remote station is off-line when it does not service the communication line, but does some outside utility.
Opening Delimiter	- A sequence of characters which define the beginning of a transmission block.
Output Stream	- Output streams are those simplex flow which are transmitted by the LCC (i.e., the LCC outputs the block).
Poll	- To quiz the remote for activity. A poll is a signal from the LCC to the remote, asking the remote if it has anything to send.
Point-To-Point	- Only two data sets are connected on a communication line.
Preemptive Priority	- A request which is to be processed before all others, even those which have been in the system longer.
SID	- Streams Identification with Status.
SINK	- The receiver of information.
SOURCE	- The sender of information.
Station Control Information	- Information about the status or activity condition of a stream.
Stream	- A simplex flow of data.

Glossary Continued....

Subordinate — A station on a link that responds to communications and does not initiate communications.

Text — That portion of a message that contains user data.

Transparent Data — 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 line is a requirement for two-way simultaneous operations.

Valid Transmission — A transmission whose opening delimiter and closing delimiter are recognizable.

WORD — 16-bits of information, two bytes.

XSN — Transmission sequence number. ASCII graphic character that forms part of the opening prelimier in Mode 2 procedure.