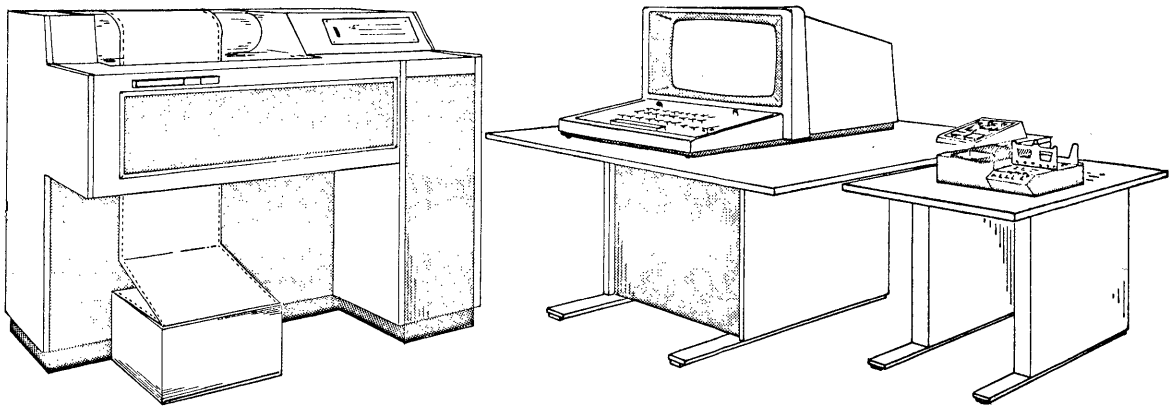
CONTROL DATA®

200 USER TERMINAL

This Publication Includes
Information on the Listed
Products:

217-2 EQUIPMENT CONTROLLER AND
DISPLAY STATION
218-1 TYPEWRITER PRINTER STATION
222-1 LINE PRINTER STATION
222-2 LINE PRINTER STATION
224-1 CARD READER STATION



- General Description
- Operation
- Programming

CONTROL DATA CORPORATION

HARDWARE REFERENCE MANUAL

200 USER TERMINAL
HARDWARE REFERENCE MANUAL

SECTIONS IN THIS MANUAL:

Section I —— General Description

Section II —— Operation

Section III —— Programming

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FOREWORD

This document is in no sense intended to be a complete examination of the 200 User Terminal. The purpose is to provide a systematic approach to the fundamental operation of the terminal from the user's point of view. A particular feature of this manual is its brief digest of the underlying principles for each of the various input and/or output stations. This serves to bridge the gap between the more detailed customer engineering publications for each device.

The discussion is arranged in three basic sections. The first explains the characteristics of the terminal from both operational and functional viewpoints. Controls available to the operator along with basic "turn-on" and "turn off" procedures are covered in the second section. In the third section, attention focuses on programming including flow charts and operating procedures. Sample displays are shown throughout the text to provide a better understanding of terminal operation.

The following publications should aid the reader whose interest is beyond the transient. These publications may be ordered through the Control Data Literature Distribution Center.

EQUIPMENT CONTROLLER

Documentation on this unit consists of a two-book Customer Engineering Manual and a Parts Data Book. The following list provides a description of each book.

- Book 1 (publication no. 82128100) — contains six sections; General Description, Operation and Programming, Installation and Checkout, Theory of Operation, Maintenance, and Maintenance Aids. The first two sections act as a supplement to the Hardware Reference Manual. Illustrated instructions for installing the equipment at the site as well as procedures for making it operational constitute the third section. The Theory of Operation is concerned with internal operations. A functional approach is used to eliminate the necessity of tracing through the logic diagrams. This approach links the various functional areas in the controller and provides insight into techniques used to perform various

FOREWORD (CONT)

operations. After absorbing this material, the reader should have little difficulty understanding the logic diagrams. Maintenance consists of preventive and corrective maintenance procedures while Maintenance Aids provides information which the customer engineer may find useful.

- Book 2 (publication no. 82128200) — this book contains logic diagrams, timing charts, block diagrams, card placement charts, schematic diagrams and interconnection diagrams. In many instances, the back of the preceding sheet is used to explain functions shown on the diagram. This serves as an additional "Theory of Operation", from a more analytical viewpoint.

- 217-2 Equipment Controller Parts Data Book (publication no. 82128400) — consists of replaceable parts information for the Equipment Controller. A provisioning parts list is interlaced with an illustrated parts breakdown, simplifying the identification procedure. A list of vendors is also supplied.

DISPLAY STATION

A single-volume Hardware Reference/Customer Engineering Manual (publication no. 82128500) is available which has its sections structured in a manner similar to that for the Equipment Controller. The theory of operation has been integrated with the various schematics and waveforms which have been added to interconnection diagrams. The approach taken in the area of maintenance represents a improvement over literature previously available. Parts information is supplied in a separate document (publication no. 82128800).

CARD READER

The card reader is an NCR Model EM-D2. Three manuals are available on this unit.

- Card Reader Station Hardware Reference/Customer Engineering Manual (publication no. 82128600) — which concerns itself mainly with the electronic assembly located within the reader unit. This manual is another eight-section effort, covering the areas mentioned for the previous two units.

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- NCR EM-D2 Punched Card Reader Technical Manual (publication no. MX-1027-22) — presents a detailed description of the mechanics involved in the reader. This manual is published by NCR and can be purchased through:

  Industrial Products Division
  National Cash Register Company
  Dayton, Ohio

- Card Reader Customer Engineering Manual (publication no. 60161300) — a Control Data reprint of the NCR manual.

TYPEWRITER

Documentation on the Typewriter Printer Station covers two major areas. The power supply and a general description of typewriter operation are included in the Typewriter Printer Station Hardware Reference/Customer Engineering Manual (publication no. 82128700), available from Control Data. Parts data (excluding the typewriter) is supplied in a separate document (publication no. 82128900).

The typewriter is an IBM Selectric *, Model 731. IBM documentation on this unit is divided into five sections and a parts catalog, as listed. These documents should be ordered from:

Office Products Division
Customer Engineering
International Business Machines Corp.
Lexington, Kentucky

- Section 1 — Scheduled Maintenance and Lubrication (F/N 241-5308-0).

- Section 2 — Adjustments (F/N 241-5309-0).

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* IBM trademark

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- Section 3 — Removal (F/N 241-5310-0).
- Section 4 — Specifications (F/N 241-5311-0).
- Section 5 — Diagnostic Aids (F/N 241-5302-0).
- Parts Catalog (F/N 241-5157-7).

Control Data Institute has a publication which also might prove to be a valuable aid. This is the Selectric Typewriter Training Manual (publication no. 080566A).

LINE PRINTER

There are three publications available on the line printer. The first two listed fully document the printhead and related hardware. The third publication is concerned with printer controller logic mounted on the printer main frame.

- Line Printer Equipment Customer Engineering Manual (publication no. 47967000) — five-section manual containing introduction, operation, principles of operation, maintenance, and diagrams for the printhead and related electrical and mechanical hardware.
- Line Printer Equipment Customer Engineering Manual (publication no. 47967100) — parts identification for the areas covered by the previously listed manual.
- Line Printer Controller Hardware Reference/Customer Engineering Manual (publication no. 47966700) — information pertaining to the logic assembly (including memory) which handles communications with other external devices.

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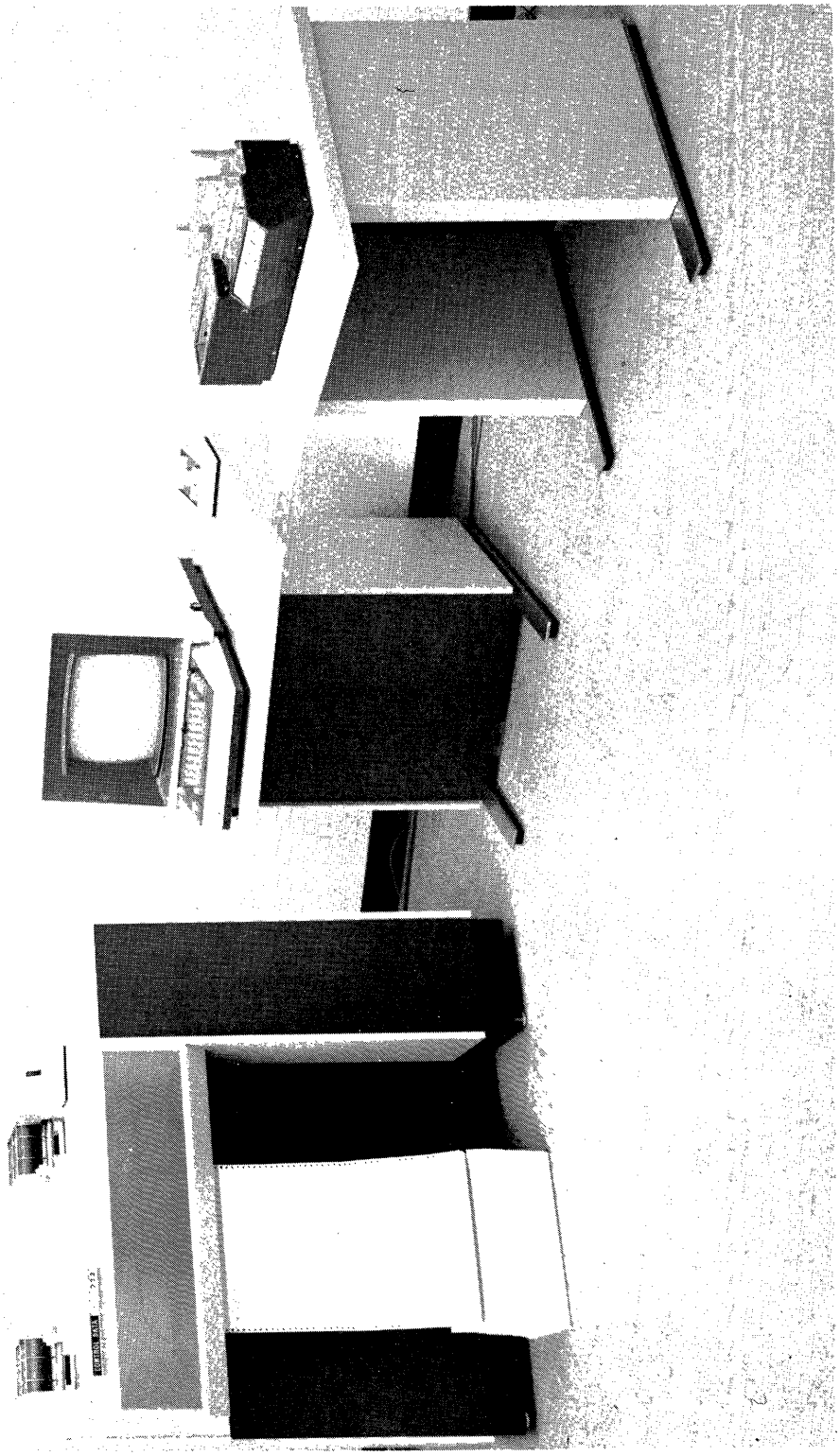


Figure 1-1. Typical Terminal

SECTION I

GENERAL DESCRIPTION

The 200 User Terminal offers a variety of data input/output features at a location remotely situated from the central processing site (data source). Some of these features are:

- punched card data entry
- keyboard data entry
- cathode ray tube display
- hardcopy output

An Equipment Controller controls and processes all remote site operations. This unit, combined with a Display Station (entry keyboard and crt display), forms the basic terminal. The characteristic feature of this terminal is its modular design which allows the user to configure his site by adding other input/output devices. Figure 1-1 illustrates the maximum configuration including a Card Reader station and Line Printer station. A typewriter may be used in lieu of the line printer.

As a remote site network, the terminal has been designed to communicate with the data source via serial synchronous modems with baud rates up to 2400. These modems must conform to EIA Standard RS 232B, which provides a telephone channel type data link. All communications are processed by the Equipment Controller which governs their ultimate destination. Figure 1-2 illustrates the communications network.

OPERATIONAL DESCRIPTION.

In typical operation, the Display Station operator composes an inquiry message using the alphanumeric entry keyboard. As the message is composed, it is displayed on the crt. A chain of markers (underlines of symbol positions) indicate to the operator where the next symbol will be displayed. Initially, the markers extend from the left to right edge in the top line of the raster. In this case, the marker in the upper left corner is called the entry marker. Depressing a symbol

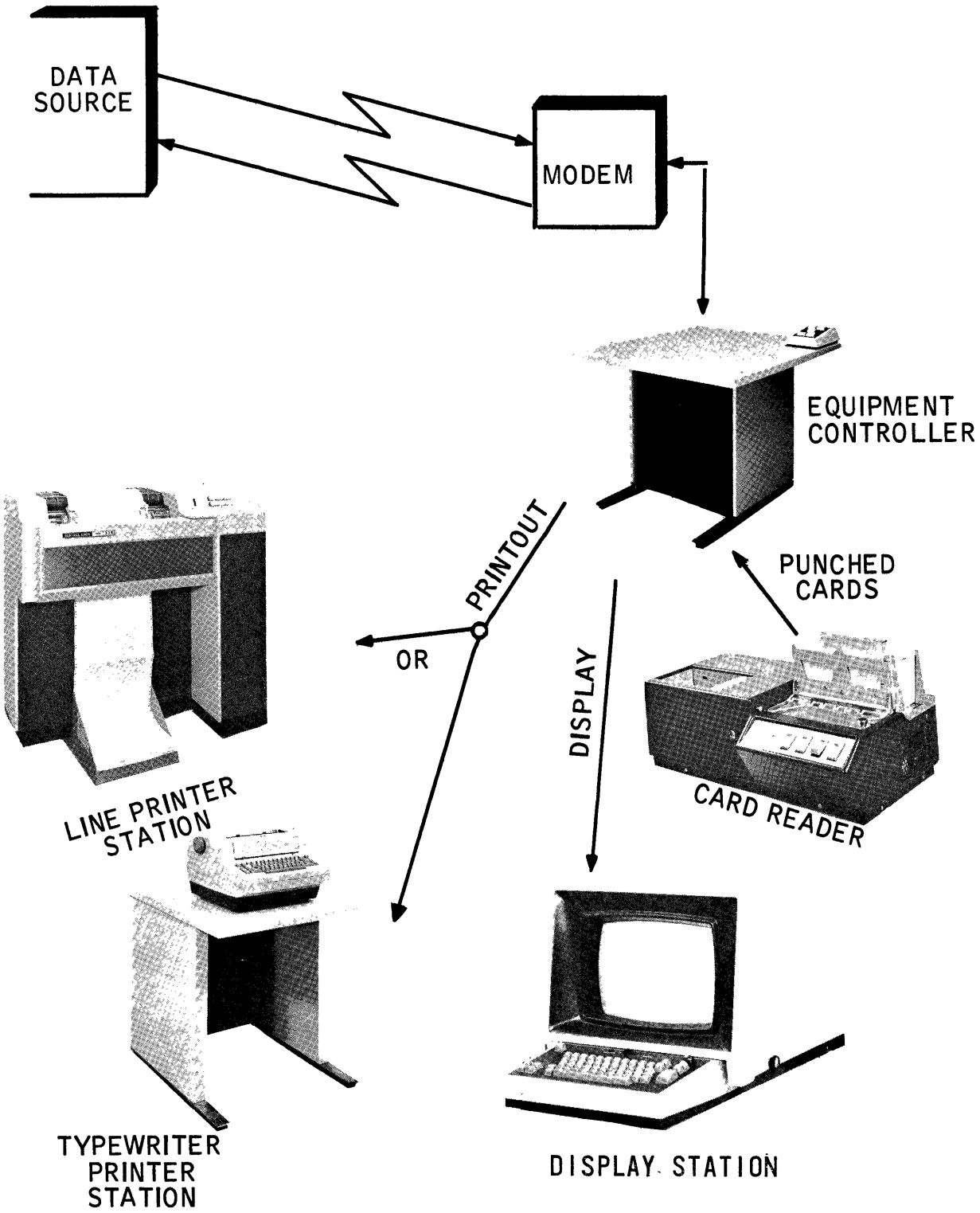


Figure 1-2. Communications Network

key enters a symbol at this position and erases the marker. The next marker to the right now becomes the entry marker. After reaching the end of the line, the marker chain is automatically displayed in the next lower line. When the end of the last line has been reached, the chain is displayed in the first line, with the marker in the upper left corner becoming the entry marker again. Various editing keys allow the operator to position the entry marker anywhere on the page without affecting data already displayed. This marker chain feature is useful for determining the amount of symbol positions left on a line during message composition. The display format may be either 20 lines of 50 symbols or 13 lines of 80 symbols. Symbol intensity is adjustable, and the P4 phosphor crt makes the display clearly legible in normal office lighting. Data presented on the 6- by 8-inch viewing raster is refreshed at a flicker-free rate of 50 cycles per second. Figure 1-3 shows a typical display in an 80 by 13 display format.

Either complete or partial message transmission is possible at the discretion of the operator. A line indicator is used (line mode) to enable partial transmission. This indicator (■) is located to the left of the first symbol position in a

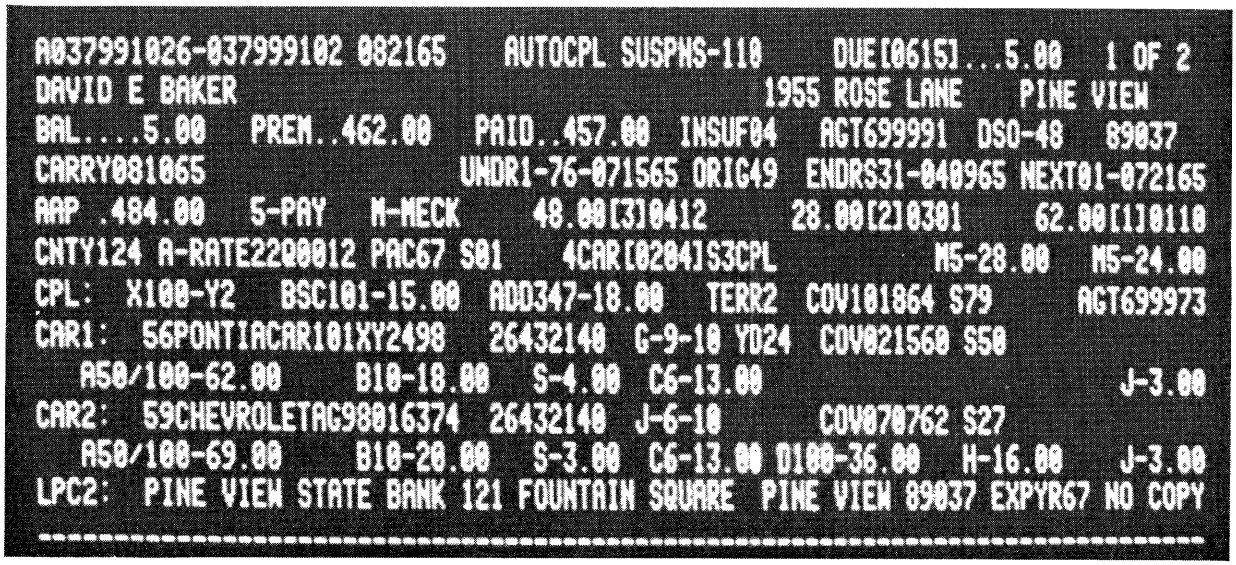


Figure 1-3. Typical Display

line, and can be relocated to precede any line through the use of the SEND INDEX key. In either case, the operator depresses the SEND key to enable message transmission to the data source. This action enters an E1 symbol (Δ) at the current entry marker position and repositions the marker chain to the top line if the line indicator is not used (block mode). Otherwise, the entry marker is repositioned to the beginning of the line preceded by the line indicator. The read message begins with the symbol indicated by the entry marker in either case, and terminates with transmission of the E1 code. Actual data transfer begins when the equipment is successfully polled by the data source. As each word is read, the entry marker continually advances (original entry markers erased) until the E1 word is read. At this point, the entry marker resides one symbol position beyond the E1 symbol.

The data source normally replies to the read message with a write message which is also displayed. The data source may clear the crt and/or reset the entry marker. Otherwise, the write message begins at the entry marker which remains one position to the right of the E1 symbol. In the line mode, the line indicator and marker chain are repositioned to the next lower line after completion of a write message terminated by E1. The E1 code frees the Display Station keyboard allowing the operator to compose another message.

If either a line printer or typewriter is included in the equipment configuration, hard copy of a displayed message may be obtained. Printout can be initiated by either the data source or the Display Station operator. For example, the Display Station operator may depress the AUX SEND key instead of SEND after composing a message. This inserts an E2 symbol (') at the current entry marker position, and resets the marker chain to the top line in the display page (line indicator is not functional in this case). Consequently, printout occurs from the upper left corner of the display page to the E2 code.

The data source may also initiate printout. Normally, the Display Station operator composes a print request message and transmits it to the data source which responds with a write message containing an E2 code. This message is displayed and all data up to the E2 code is transferred to the printer. Completion of transfer to the printer memory enables transmission of a read message to the data source upon a successful poll operation. The read message may contain either an E2 or E3 code depending upon the status of the equipment. An E2 message termination indicates transfer between display and printer is not possible. Normally, the read message contains an E3 code which informs the data source of a successful transfer. If this is the case, another message containing an E2 code may be sent for printout, or the data source may end the operation by transmitting a write message ending with E1. This code frees the keyboard for operator use.

Hollerith-coded punched cards may be used in lieu of the Display Station keyboard facility. The card reader operator loads the hopper with a message constructed of punched cards. By depressing the Equipment Controller LOAD switch, a batch of cards is transferred to a reader buffer memory in the Equipment Controller. A maximum of 12 cards constitutes a batch. The Display Station operator composes a message requesting the data source to read cards. Detection of an E3 code (⁘) in a write message response from the data source enables the data in the reader buffer memory to be displayed and transmitted. Another batch is then loaded into the reader buffer memory. Display and transmission occur when the data source responds to the preceding transmission with another write message ending with an E3 code. The end of the card message is marked by the presence of an E2 code (error or no cards left in hopper). The data source then unlocks the Display Station keyboard with a write message ending in E1.

FUNCTIONAL DESCRIPTION.

The remainder of Section I describes, in more detail, the primary functions performed by the Equipment Controller and various attached stations. A simplified block diagram is shown in figure 1-4; major assemblies within the Equipment Controller are called out.

Video formations can best be explained by visualizing each symbol position on the crt raster as a 5 by 7 dot matrix. The electron beam traverses this matrix and energizes phosphor to create a meaningful image. If the phosphor at a particular position is to be energized, the symbol generator outputs a pulse to unblank the beam. Since each symbol requires unblanking at different positions in the matrix, separate trains of pulses are required from the symbol generator. Figure 1-5 shows a typical formation using the letter A.

The entire display message is stored in the display buffer memory which is a 10-millisecond magnetostrictive delay line. Each word is read out of the delay line, assembled, and decoded by the main control network. If the word is to be changed (such as keyboard "editing"), the new word is entered. If no change is pending, the decoded word enables the symbol generator to transmit the associated pulse train to the crt. The word is then rewritten into the delay line. This process of data recirculation enables the display to be continually refreshed. Two passes through the delay line are required to retrieve a data word for display purposes. Since each pass requires approximately 10 milliseconds, data is refreshed at a rate of about 50 times per second to ensure flicker-free viewing.

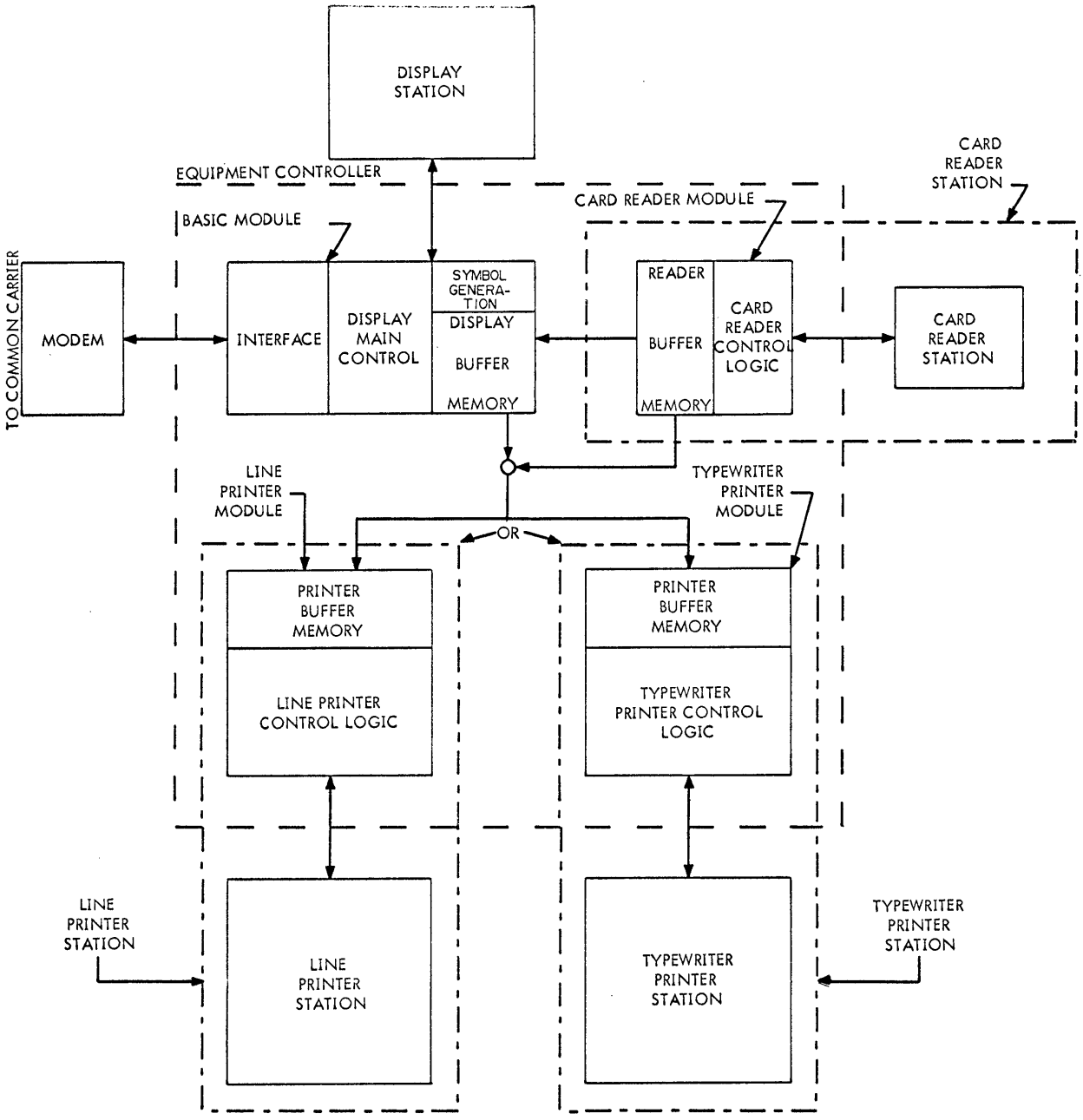


Figure 1-4. Simplified Block Diagram

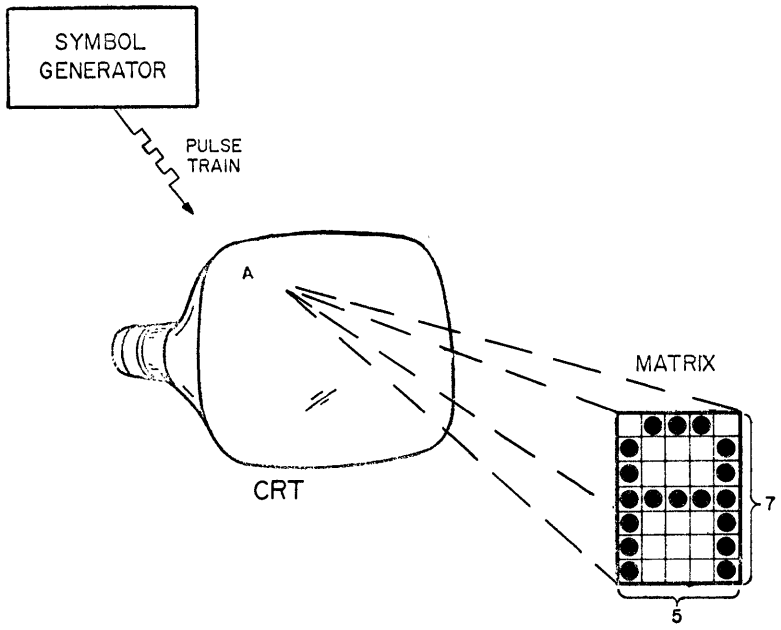


Figure 1-5. Typical Symbol Formation

Table 1-1 shows the rate at which the display occurs. Timing shown is for the format of 20 lines of 50 symbols or 13 lines of 80 symbols.

TABLE 1-1. DISPLAY STATION TIMING

FUNCTION	TIMING
Display 1 symbol	16.8 microseconds
Display 1 line (50 symbols)	840 microseconds
Display 1 line (80 symbols)	1.344 milliseconds
Carriage Return (after 50 symbols)	151.2 microseconds *
Carriage Return (after 80 symbols)	168 microseconds **
Display entire page (50 by 20 format)	19.8408 milliseconds
Display entire page (80 by 13 format)	19.6728 milliseconds

* 168 microseconds for last line.
** 184.8 microseconds for last line.

The link between the modem and the display main control assembly is provided by the interface. As each word is read out of memory and assembled, it is transferred to the interface (assuming a read message). Data assembled in the interface is transmitted to the data source in serial, bit by bit, least significant bit first. Received data is also in serial, at a rate of transfer determined by the modem. To eliminate timing differences between the modem and the terminal, the interface contains synchronization logic.

Messages intended for the data source may have their origins at either the Display Station keyboard or the card reader. Each time a key is depressed, the corresponding code is stored in the display memory and the associated symbol is displayed. The message is not transferred until the SEND key is depressed.

Messages originating at the card reader are composed via 80-column, Hollerith-coded, punched cards (figure 1-6). The station has a capacity for up to 380 cards which it can read at a rate of 100 cards per minute. Data from the punched cards is fed to the reader buffer memory, governed by the card reader control logic. This memory is also a 10-millisecond delay line. Data is entered into the delay line in 12-card batches. Once a batch has been stored, it is transferred to the display buffer memory upon receipt of a write message containing an E3 code. Another batch is then stored in the reader memory. This process continues until the entire message has been transmitted.

The reader features a changeable program disc. This disc institutes automatic control of field selection allowing operator selection of particular fields of information on each card. Fields may be varied from program to program by simply changing the disc.

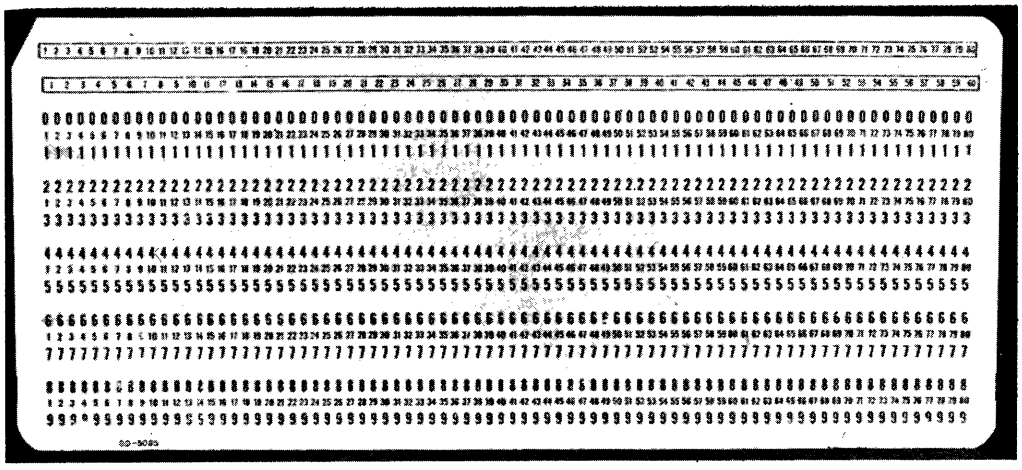


Figure 1-6. Punched Card

Performance of the solar cells used to read the cards is checked before and after each card is read. A "light" check precedes the card while a "dark" check follows. Should any cell fail this test, the data source is informed of the error, and the read operation terminates. This check ensures proper transmission of data.

Either a typewriter or line printer may be used to obtain hard copy of a message. Displayed messages are transferred from the display buffer memory to the printer buffer memory, another 10-millisecond delay line. During a list operation, 12-card batches of data are transferred from the reader buffer memory to the printer buffer memory; hence, a crt display does not occur. Display Station or data source-initiated printout has precedence over the list operation. However, the displayed message must wait until the current 12-card batch has been printed.

The typewriter printer consists of a Selectric * typewriter mounted on a stand containing the power supply. Basic operations are performed by a moving typeball, containing the symbol repertoire, while the carriage remains motionless. Various other features common to most typewriters are included. Type set is designated "Data No. 1" ** and type spacing is 10 symbols per inch in a line with 6 lines per inch. The printer uses a black fabric ribbon to type symbols on a continuous strip paper.

Printout is accomplished by the typewriter as shown in table 1-2.

TABLE 1-2. TYPEWRITER SPEEDS

FUNCTION	TIMING
Carriage Return	129.0 milliseconds (minimum)
Print 1 symbol	64.5 milliseconds
Shift	64.5 milliseconds
Space	64.5 milliseconds

* IBM Trademark
** IBM Classification

The line printer utilizes the hammer and rotating drum principle. The drumhead may be 80 column or 136 column. Type style is modified open Gothic while symbol and line spacing are the same as for the typewriter.

In a continuous mode of operation, the line printer operates at a nominal speed of 300 lines per minute.

SECTION II

OPERATION

Operator action governs most of the communications network. This section describes the operations necessary to begin communications. The descriptions provided are of a general nature. For more detail, reference the applicable Customer Engineering Manuals.

EQUIPMENT CONTROLLER AND DISPLAY STATION.

Since all communications must be processed by the Equipment Controller, the following steps should be followed. Figures 2-1 and 2-2 provide a visual aid.

(a) Depress Equipment Controller POWER ON switch.

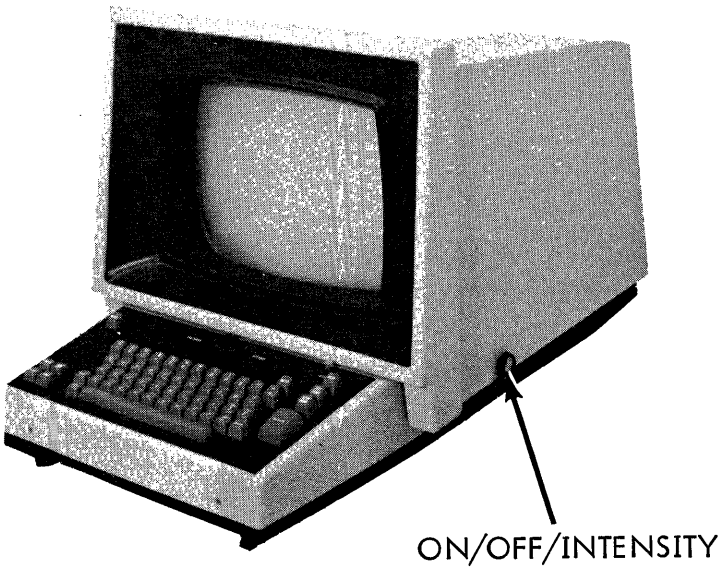
(b) Rotate Display Station ON/OFF/INTENSITY control to the ON position (toward the rear of the cabinet).

(c) After a 30-second warmup period, begin further rotation of the ON/OFF/INTENSITY control until the marker chain is visible in the uppermost line in the viewing raster.

(d) A message may be composed by activating the various keys on the Display Station keyboard.

There are 44 alphanumeric symbol keys on the Display Station keyboard. Depression of any one of the keys enables the corresponding symbol to be displayed at the current entry marker position and the associated code to be entered into the display memory. The entry marker is then advanced one symbol position. The keyboard is electrically interlocked so the depression of two or more keys, simultaneously, results in display and entry into memory of only one of the selected symbols.

The remaining keys on the Display Station keyboard are used in message composition. They affect the presentation on the crt and enable outputting to the



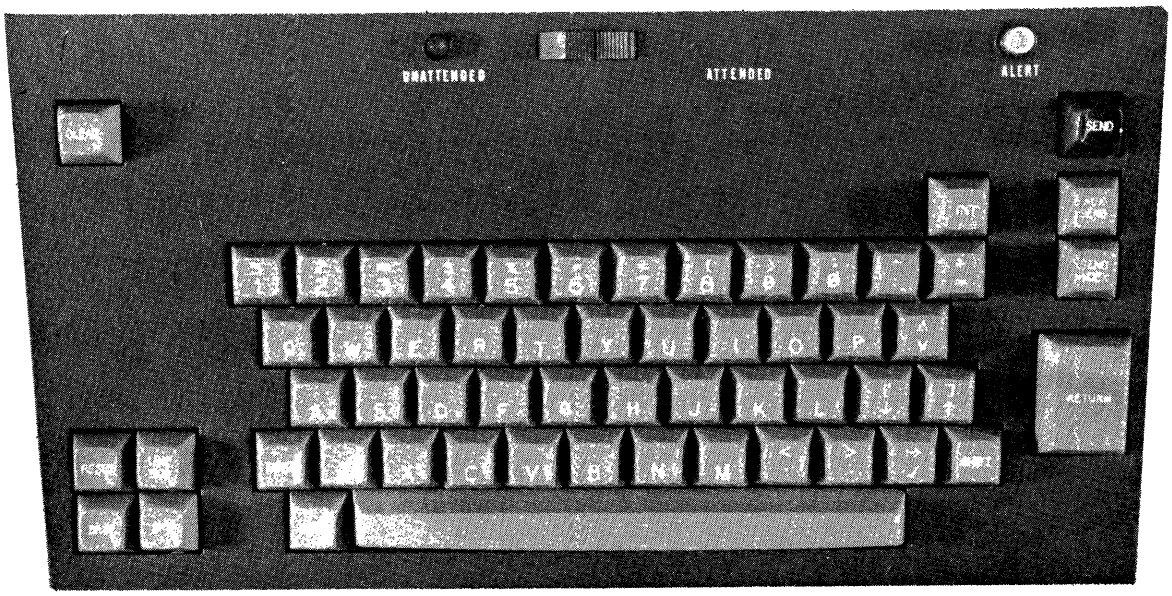


Figure 2-1. Display Station and Keyboard

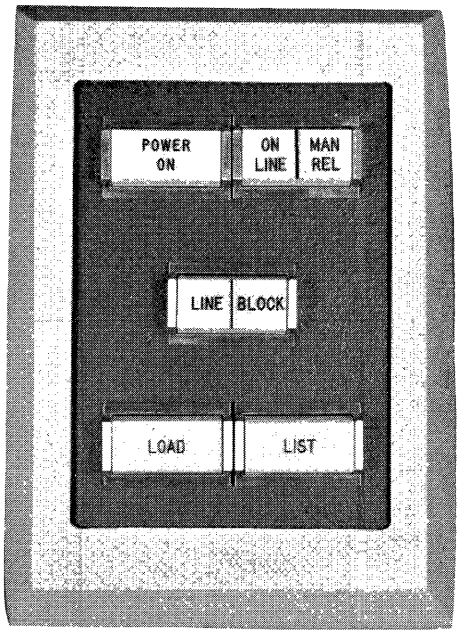


Figure 2-2. Switch Indicator Panel

printer or data source. Figure 2-3 illustrates the operations performed by some of the keys. A sample display is shown accompanied by the subsequent displays resulting from depression of the keys. The first symbol in the first line is assumed to be the upper left corner position of the viewing raster.

Message composition does not necessarily have to occur at this time. Instead, the card reader may be used for data entry.

CARD READER STATION.

Power on and loading procedures are described in the following list. There is a more detailed description of card reader operation in the associated Reference/ Customer Engineering Manual. Figure 2-4 shows areas involved in the operation.

(a) Punch program disc for columns to be read on the punched cards.

(b) Load up to 380 punched cards in the card hopper and insert the card feed plate.

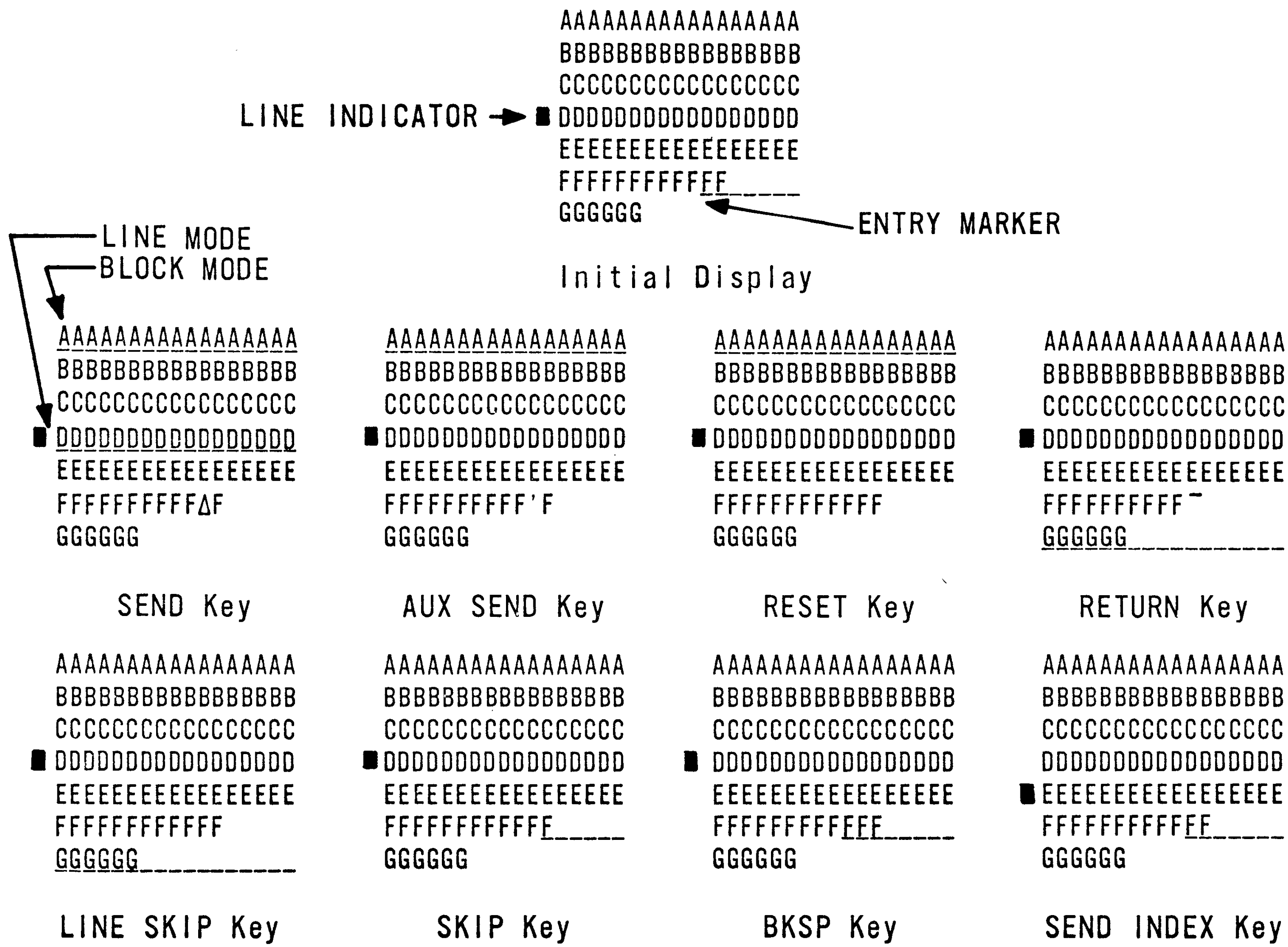


Figure 2-3. Keyboard Functions

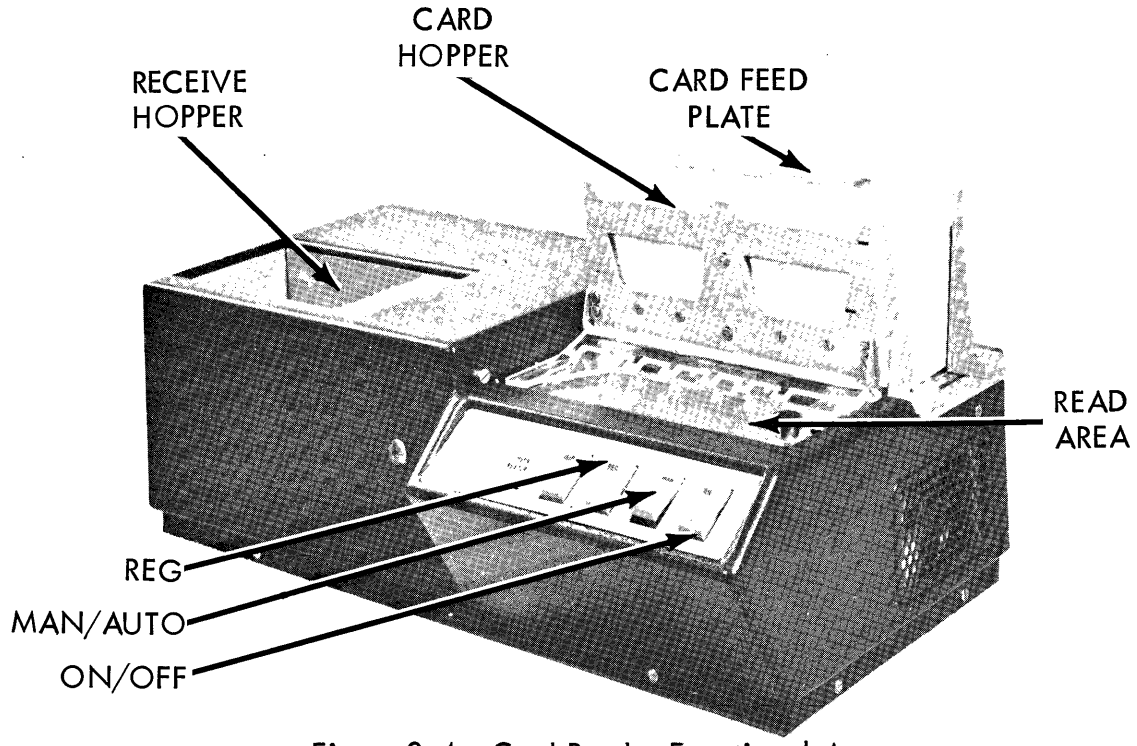


Figure 2-4. Card Reader Functional Areas

(c) Place the ON/OFF switch on the reader in the ON position.

(d) Depress reader MAN/AUTO switch to AUTO position.

(e) Activate the reader REG switch.

At this point, there should be one card in the read area. The first request for data from the Equipment Controller enables the first card to be read and ejected into the receive hopper. In addition, a second card is entered into the read area from the card hopper. Each subsequent request from the Equipment Controller enables the card in the read area to be scanned and ejected to the receive hopper before the next card arrives from the card hopper.

A-c power to the motor in the card reader is controlled by one other switch in addition to the ON/OFF switch. The second switch is located in the hopper. This switch activates when the card feed plate is put in place. Depress the ON switch and insert the card feed plate for application of power.

The program disc (figure 2-5), located in the rear of the assembly, allows the operator to specify columns to be read. There are two rows of numbers on the disc. The outer row is numbered from 1 to 80 and is used in conjunction with a

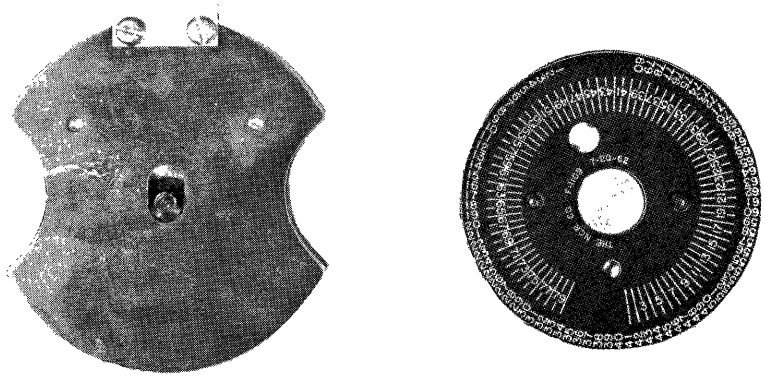


Figure 2-5. Program Punch and Disc

scribe mark on the reader cabinet to denote which column is being read. The inner row (numbered 1 through 79) acts as a guide for punching holes in the disc. The columns where the holes appear determine which portions of each card are to be read. Assume, for example, that holes are punched in disc positions 10, 27, 45, and 71. When a "read card" signal is given, the card advances and the information in columns 10 through 27 is the first to be read. Information in columns 28 through 44 is skipped and columns 45 through 71 are read next. The remaining columns on the card are not read. This process repeats for each card.

LINE PRINTER STATION.

Operator controls for the line printer are located on the upper right portion of the cabinet. The control panel is shown in figure 2-6. There are other controls for positioning and handling the paper as well as maintaining the printer. These are covered in a separate Reference/Customer Engineering Manual for the line printer.

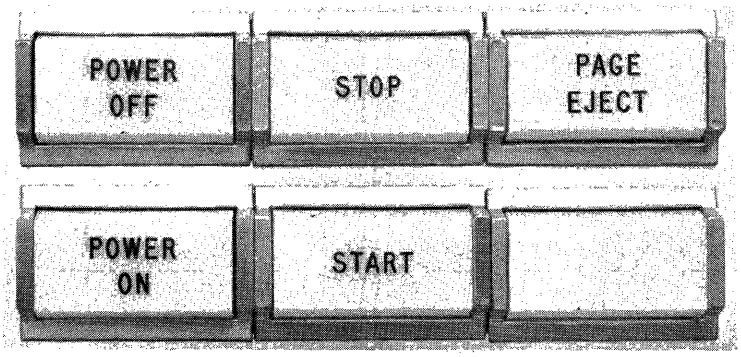


Figure 2-6. Line Printer Control Panel

A paper loading and adjusting procedure must be followed in order to obtain accurate printout on the line printer. This procedure is described in detail, in the line printer Reference/Customer Engineering Manual. The following list provides a brief summarization of that procedure.

(a) Install the control tape. This tape governs the vertical size of the form (page).

(b) Depress POWER ON switch on printer.

(c) Depress printer PAGE EJECT button to advance the tape to the beginning of form position.

(d) Insert paper in the tractor assembly.

(e) Activate the printer START button.

The line printer should now be in a ready condition and printout is accomplished when data is transmitted by the Equipment Controller.

TYPEWRITER PRINTER STATION.

Figure 2-7 shows the typewriter controls. Note the location of the ON/OFF rocker switch to the right of the keyboard. A multipaper adjustment (top left)

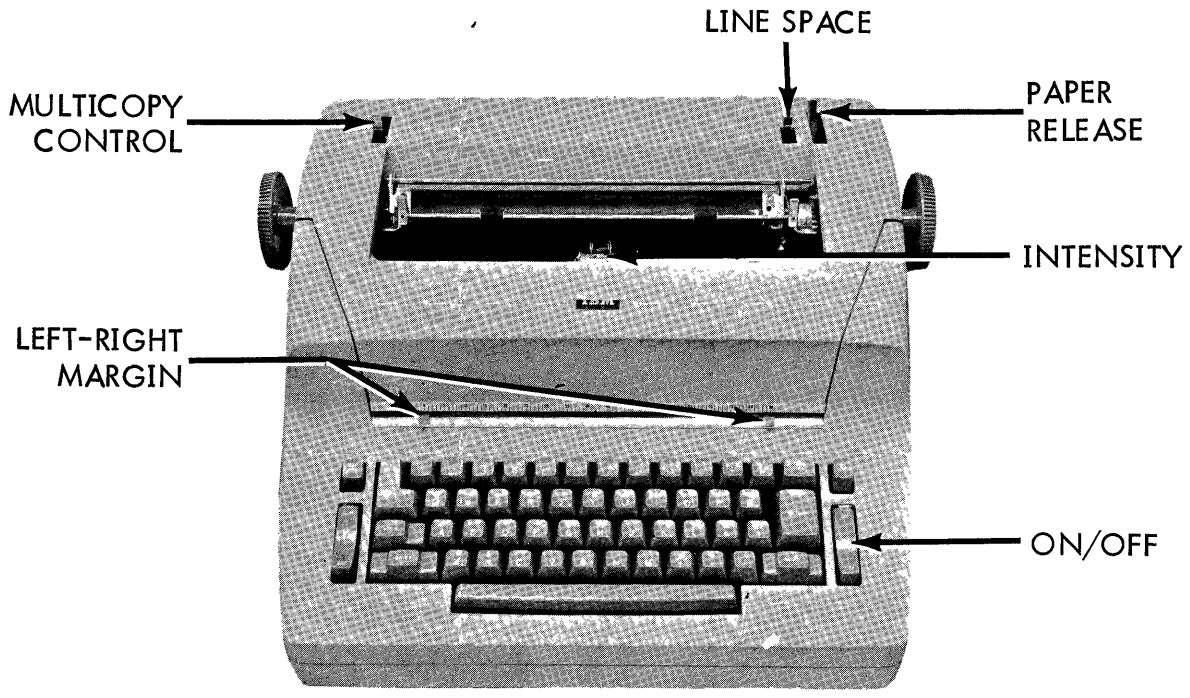


Figure 2-7. Typewriter Controls

provides even printing for carbon copies. Remaining controls are common to an electric typewriter and include the following: platen knobs for manually advancing the paper, a line-space lever for single or double spacing, a paper release lever, left and right visible margin stops, an impression selector lever which adjusts the striking force of the typing element, a tab set and clear control, tab key, index key, shift keys, margin release, space bar, etc.

For more detailed information about the typewriter, reference the IBM Selectric manuals mentioned in the foreword of this publication.

A paper handler is provided to perform the stacking and storing chores required with the use of continuous-strip paper. The paper is stored in the bottom tray and is threaded through the slot to feed the tractor assembly in the typewriter. The typewriter processes the paper and stacks it in the upper tray. The paper passes over a pressure-type switch, located on the handler, which halts printout when the paper has run out. Figure 2-8 shows the paper handler.

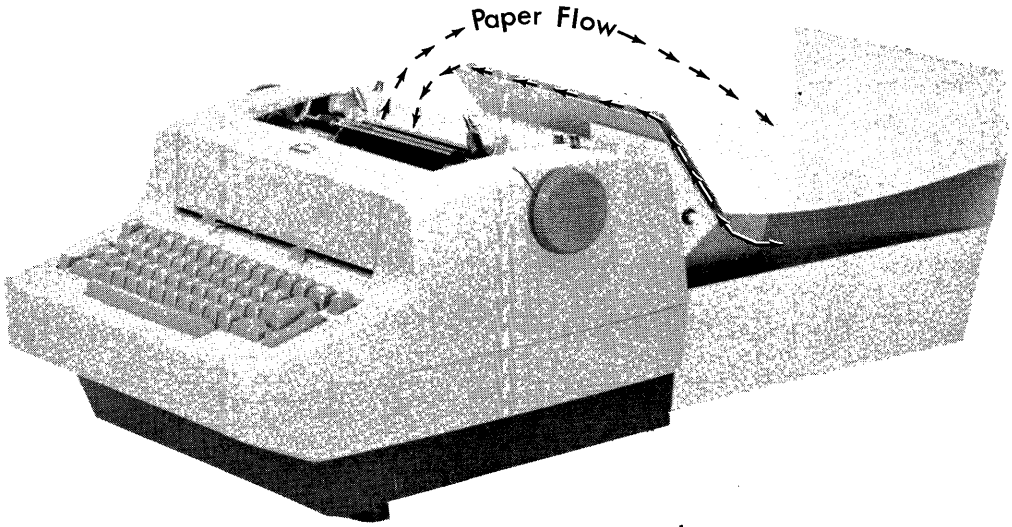


Figure 2-8. Paper Handler

TYPICAL OPERATION SEQUENCE.

A flow diagram depicting typical operation sequence is shown in figure 2-9. The operator may compose a message with punched cards or via the Display Station

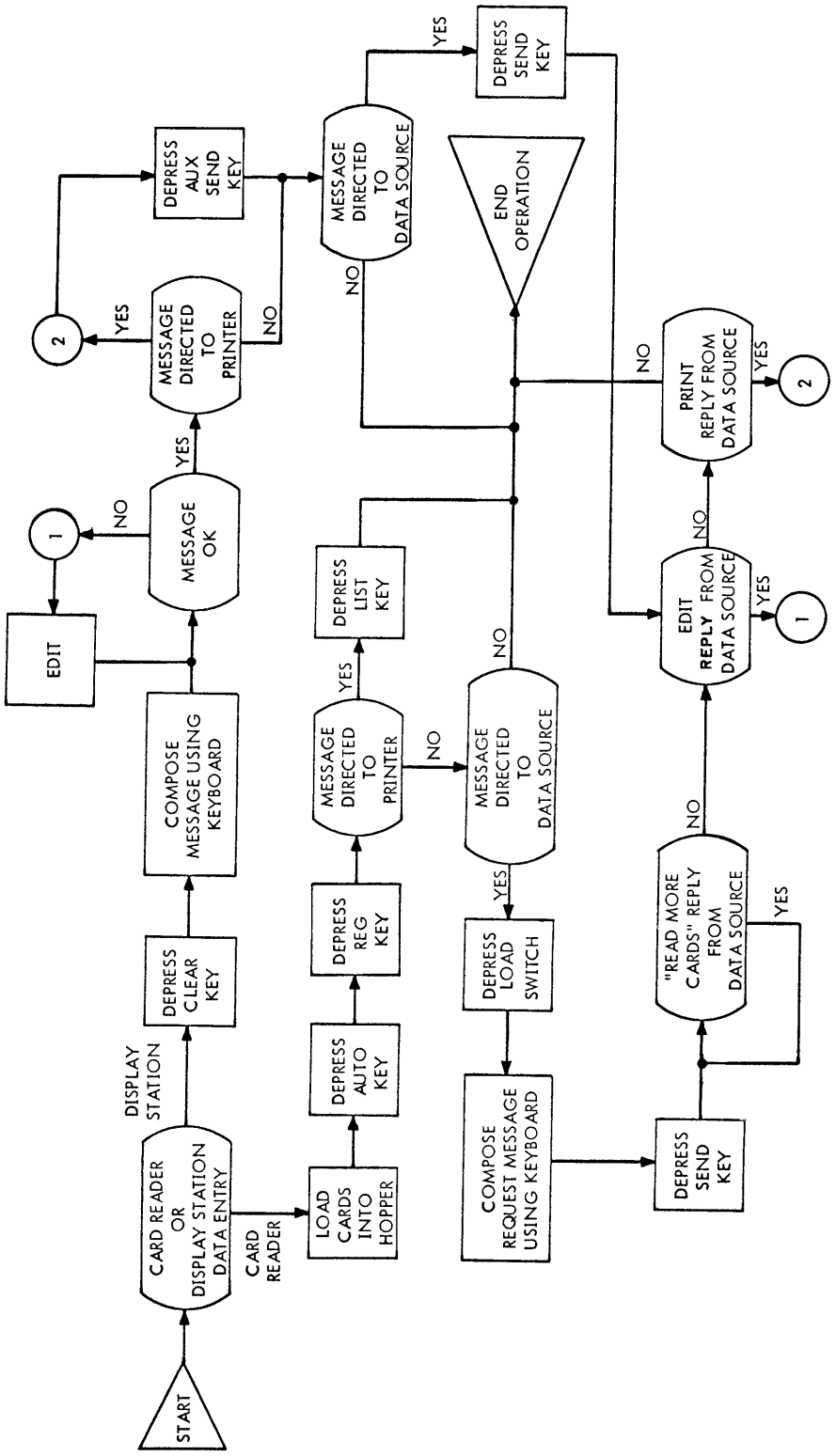


Figure 2-9. Typical Operation Sequence

keyboard. When data is properly composed, it may be sent to the data source by actuation of the SEND (for Display Station data) or LOAD (for punched card data) keys. Data may also be sent to a printer by depressing the AUX SEND (Display Station data) or LIST (punched card data) keys.

The data source responds to properly transmitted data by sending the requested data or a message acknowledging receipt of transmitted data. The operator may then print the reply data if printout is not indicated, or edit it (eg, filling in information on a blank form, or updating stored data), and transmit the edited data back to the data source. Printout also may be accomplished by data source initiation.

SECTION III

PROGRAMMING

The equipment communicates with a centrally located data source via a modem. Signals transmitted between the equipment and the modem meet or exceed the minimum of EIA Standard RS 232B. A negative voltage exceeding 3 volts represents an inactive state while a positive voltage greater than 3 volts represents an active condition. The communication system incorporating the equipment can operate the modem in half duplex, 2- or 4-wire mode. The advantage of 4-wire mode being a reduction in communication turnaround time.

Information received from the modem is processed by the Equipment Controller in an effort to determine which, if any, output station is to receive the data. After selecting the proper station, the data is converted to a compatible form and transferred to the selected device. Messages from the input stations follow the reverse path. Figure 3-1 provides an indication of interface signal capabilities. The arrows show signal direction.

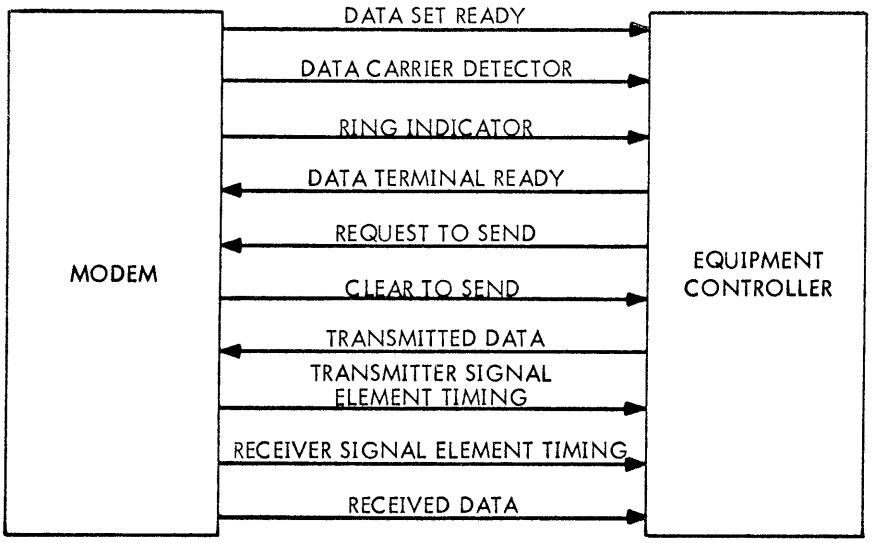


Figure 3-1. Interface Signals

INTERFACE SIGNALS.

Data transmissions between the modem and the interface are in serial and grouped into 8-bit words. Figure 3-2 shows the word format. Bit 0 is transmitted and received first while the parity bit marks the end of a word transfer. Parity is odd so the total number of 1's in an 8-bit word must be odd. These serial transmissions are received by the interface on the Received Data line and transmitted on the Transmitted Data line. The rate at which bits are placed on the lines is governed by the Transmitter and Receiver Signal Element Timing lines. Consequently, the rate varies (2400 baud maximum) according to the type of modem chosen.

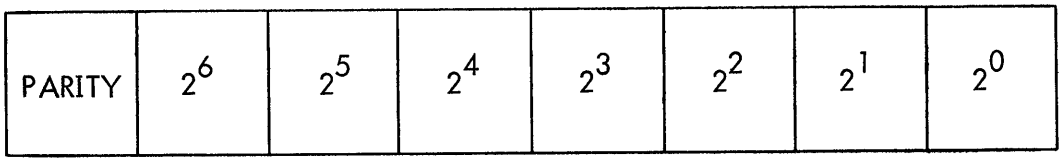


Figure 3-2. Interface Word Format

The Equipment Controller is normally in the receive mode. A synchronization sequence ensures that the first data bit received for a word is in the correct bit position. After receipt of a message, the Equipment Controller switches to the transmit mode and indicates its intention to transmit by enabling the Request to Send line. The modem automatically responds with a Clear to Send signal 8 or 210 milliseconds later depending upon which modem wiring option is employed. Serial binary data is then transmitted on the Transmitted Data line at the rate of one bit every cycle of the Transmitter Signal Element Timing signal. After completing the message, the Equipment Controller switches back to the receive mode.

The Ring Indicator line is used when the data source wishes to establish contact with the remote site. If automatic answering is incorporated, the Equipment Controller responds to this signal by activating the Data Terminal Ready line. At this time, the communication channel is established. The channel is broken if the Data Carrier Detector signal, along with Data Set Ready, does not appear at the interface within 30 seconds after the modem sends the Ring Indicator signal. The Data Terminal Ready signal drops to perform the disconnect.

STATION OPERATIONAL SIGNALS.

Messages arriving at the interface from the modem may contain data to be displayed on the crt. If so, the data is written into the display memory and display is initiated. There are 4 coaxial lines used in forming the display. The Horizontal line controls horizontal movement of the electron beam in the crt while the Vertical line controls the vertical page position. Diddle pulses cause the beam to move up and down as it travels across the raster creating a sawtooth path in each horizontal line. Beam unblanking occurs during the upswing, under control of the video pulse train. Both crt and keyboard signals are shown in figure 3-3.

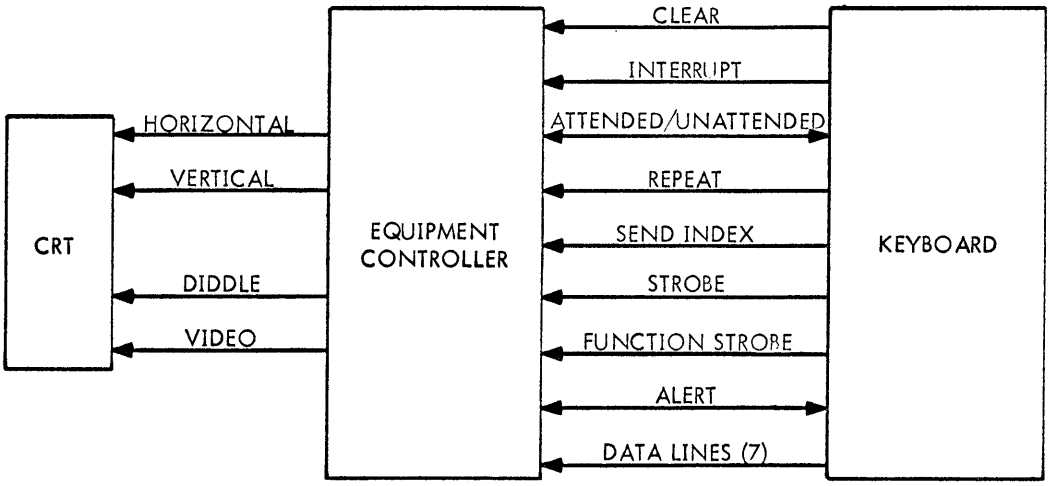


Figure 3-3. Display Station Signals

The displayed message from the data source may also require printout. If this is the case, data fed to the display memory is loaded into the memory associated with the printer module when the E2 code is detected. This module converts the data into a printer compatible form. Actual transfer begins when the line printer is in a ready state. Assuming a Ready signal from the line printer, the Equipment Controller raises the Information Ready line to the printer and places a 7-bit data word on the Data lines. Transfer, in this case, is word serial. After interpreting the data byte, the line printer raises the Output Resume line. This informs the

Equipment Controller that the line printer is ready for another word. Transfer continues as a series of data words accompanied by Information Ready signals. Each Information Ready signal solicits a response on the Output Resume line. Figure 3-4 shows signals used between the line printer module in the Equipment Controller and the Line Printer Station.

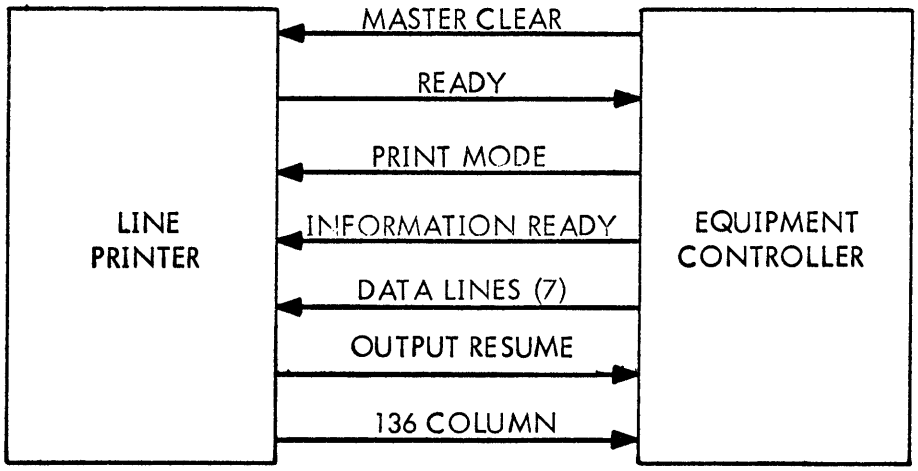


Figure 3-4. Line Printer Station Signals

Operation of the Typewriter Printer Station requires a different signal sequence. When not busy, the typewriter maintains an active condition on the Normally Closed line. Data transfer can be accomplished at this time by placing a 6-bit data byte on the Data lines. During the time it takes the typewriter to print the required symbol and advance one space, the Normally Closed line is disabled and the Normally Open line is active. Upon completion of printout, Normally Open drops and Normally Closed rises again. Hence, the typewriter is ready for transfer of another word. Functions such as carriage return, space, case shift, etc, are initiated via a signal on an associated line. The Normally Open/Normally Closed sequence is also used when functions are being performed. During the Normally Open interval, no data transfer may be performed. Figure 3-5 lists signals used in operating the typewriter.

Data entry facilities for the equipment feature the Display Station keyboard and the card reader. Keyboard signals, shown in figure 3-3, consist mainly of function and symbol key signals. Each depression of a symbol key enters a 7-bit code,

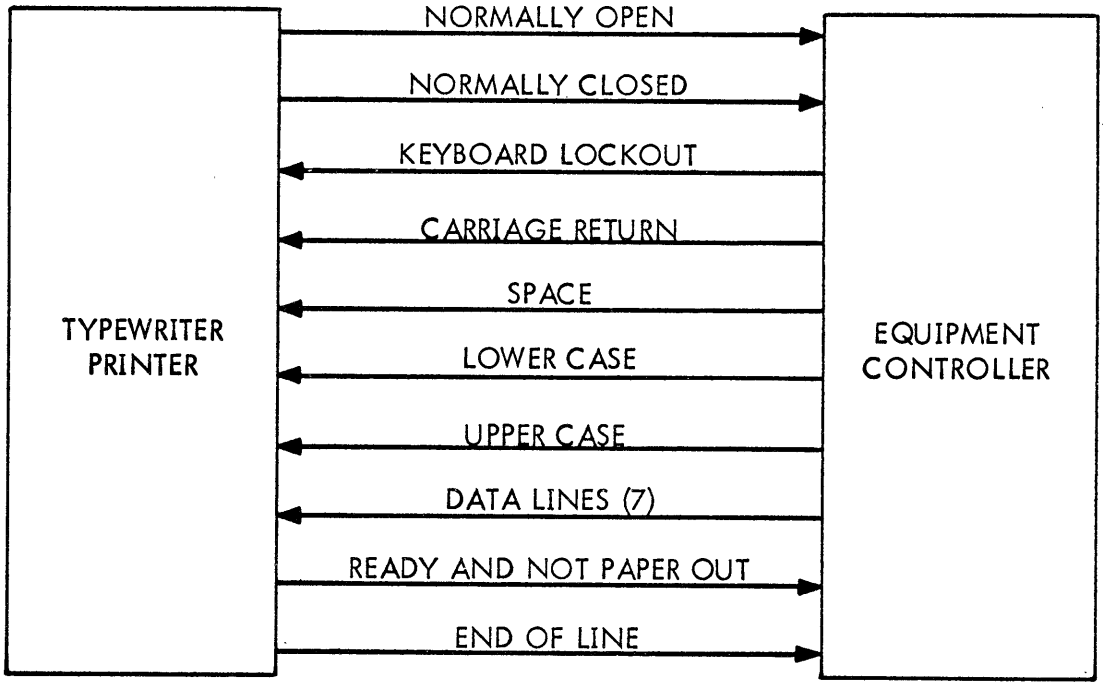


Figure 3-5. Typewriter Signals

representing the symbol, on the keyboard Data lines. These codes are accompanied by signals on the Strobe line and initiate display of the symbols on the crt by enabling the Equipment Controller to transmit associated video pulse trains to the crt. Some function keys also encode data on the lines. In this case, the data is accompanied by a Function Strobe signal to identify the word as a function.

The remaining method of data entry is via punched cards read at the Card Reader Station. Assuming power is applied and the hopper is loaded, depression of the REG switch enters a card on the read table if the reader is in the AUTO MODE. In addition to inserting a card, the REG switch enables the card reader to generate Ready and Card Present signals while illuminating the READY indicator. The Display Station operator initiates the read operation by depressing the LOAD switch for data entry or the LIST switch for printout. This action transmits an Escapement Drive signal to the reader. Consequently, information on the card is fed to the Data lines for transmission to the Equipment Controller. Synchronization between the controller and the reader is accomplished by a Clock signal generated by the card reader. The Field line indicates which columns are being read and is under control of the program disc. A batch of cards (12-card maximum) is read in this

manner and stored in the reader buffer memory. Another batch is not read until the memory has been emptied (subsequent read or print operation). Figure 3-6 lists the signals used between the Card Reader Station and the card reader module in the Equipment Controller.

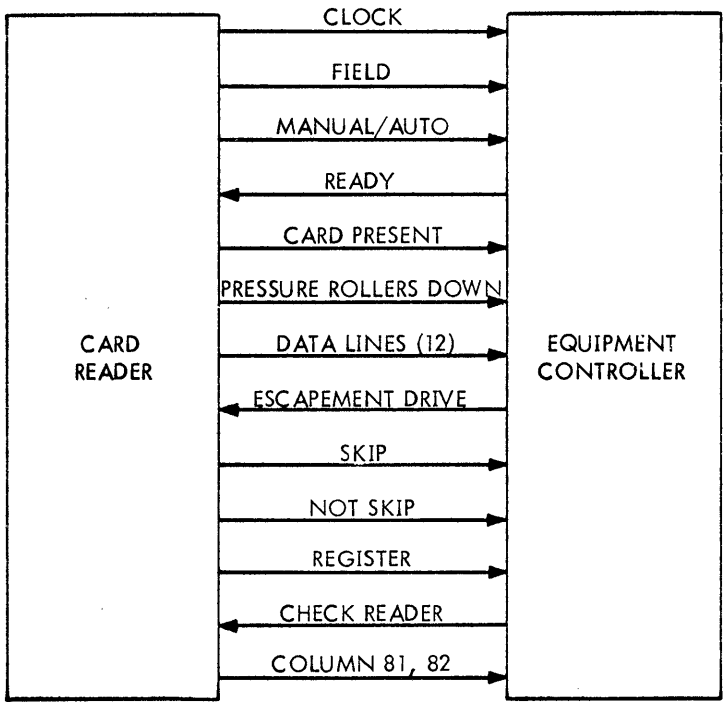


Figure 3-6. Card Reader Signals

MESSAGE FORMAT.

Messages received and sent by the Equipment Controller consist of several codes. The general message format is shown in figure 3-7. All messages transmitted are preceded by four sync codes to assure synchronization recovery on the receiving end. The start of header code informs the receiving device that the following two codes are addresses. Site and station addresses follow in that order. The site address designates the remote site to which the message is addressed or from

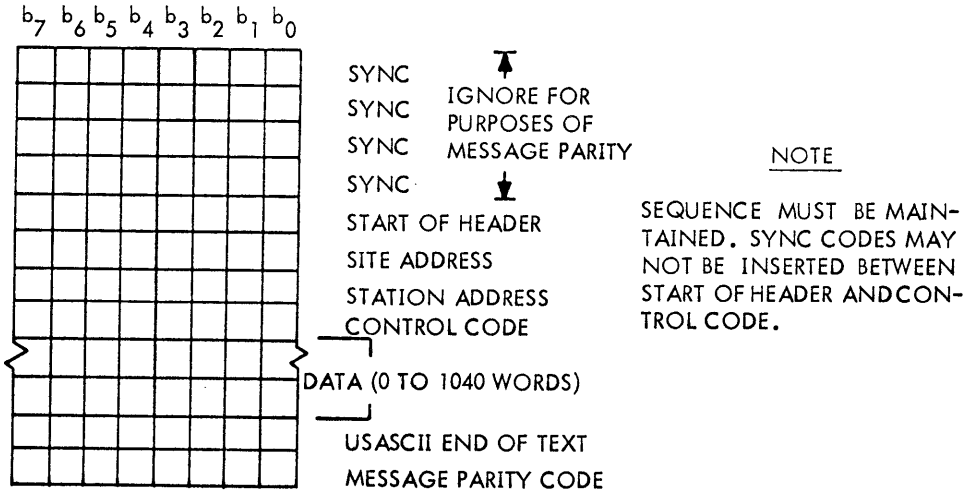


Figure 3-7. General Message Format

which a message is received. Since the terminal is a single-station device, the station address has little meaning and is defined mainly for purposes of program compatibility with multistation devices. The address is normally 141 or 161 octal for this terminal and has special applications in the realm of write messages and responses.

The control code defines the purpose of the message. In the case of messages for printout and display, the control code specifies conditions under which the write is to be performed. Read messages originating at the Display Station keyboard or card reader are indicated as such by the control code. All other messages are used in the selection-response realm.

The USASCII end of text code designates the previous word as the last word of the message. A message parity word follows. Message parity is applicable from the start of header code through the USASCII end of text. With odd parity on each word and a final message parity word, vertical and longitudinal redundancy checking is provided.

Specific messages sent and received by the remote terminal are shown in tables 3-1 and 3-2, respectively. The 7-bit octal translations are also listed.

TABLE 3-1. MESSAGES SENT BY TERMINAL

MESSAGE	7-BIT CODE	FORMAT
Acknowledge	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	006	Acknowledge
	003	USASCII End of Text
	XXX	Message Parity
Reject	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161 *	Station Address
	030	Reject
	003	USASCII End of Text
	XXX	Message Parity
Error	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	025	Error
	003	USASCII End of Text
	XXX	Message Parity

TABLE 3-1. MESSAGES SENT BY TERMINAL (CONT)

MESSAGE	7-BIT CODE	FORMAT
Read	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	023	Read
	XXX	Data (0 to 999 symbols with
	↕	50 by 20 format — 0 to 1039
	XXX	with 80 by 13 format)
	076 **	Escape
	102, 040, or 041	E1, E2, or E3
	003	USASCII End of Text
	XXX	Message Parity

*140 or 160 in response to a poll.
**External BCD (136 Internal BCD).

TABLE 3-2. MESSAGES RECEIVED BY TERMINAL

MESSAGE	7-BIT CODE	FORMAT
Poll	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	140 or 160	Station Address
	005	Poll
	003	USASCII End of Text
	XXX	Message Parity

TABLE 3-2. MESSAGES RECEIVED BY TERMINAL (CONT)

MESSAGE	7-BIT CODE	FORMAT
Alert	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	007	Alert
	003	USASCII End of Text
	XXX	Message Parity
Write	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	021	Write
	XXX	Data (0 to 999 symbols with
	↕	50 by 20 format — 0 to 1039
	XXX	with 80 by 13 format)
	076 *	Escape
	102, 040, or 041	E1, E2, or E3
	003	USASCII End of Text
	XXX	Message Parity
Reset-Write	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	014	Reset-Write

TABLE 3-2. MESSAGES RECEIVED BY TERMINAL (CONT)

MESSAGE	7-BIT CODE	FORMAT
	026	Sync
	↕	↕ 7 total
	026	Sync
	XXX	Data (0 to 999 symbols with
	↕	50 by 20 format — 0 to 1039
	XXX	with 80 by 13 format)
	076 *	Escape
	102, 040, or 041	E1, E2, or E3
	003	USASCII End of Text
	XXX	Message Parity
Clear-Write	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	141 or 161	Station Address
	022	Clear-Write
	026	Sync
	↕	↕ 7 total
	026	Sync
	XXX	Data (0 to 999 symbols with
	↕	50 by 20 format — 0 to 1039
	XXX	with 80 by 13 format)
	076 *	Escape
	102, 040, or 041	E1, E2, or E3
	003	USASCII End of Text
	XXX	Message Parity

TABLE 3-2. MESSAGES RECEIVED BY TERMINAL (CONT)

MESSAGE	7-BIT CODE	FORMAT
Diagnostic Write	026	Sync
	↕	↕ 4 total
	026	Sync
	001	Start of Header
	16X	Site Address
	140, 141, 160, or 161	Station Address
	020	Diagnostic Write
	026	Sync
	↕	↕ 7 total
	026	Sync
	XXX	Data (0 to 999 symbols with 50 by 20 format — 0 to 1039 with 80 by 13 format)
	↕	
	XXX	
	076 *	Escape
	102, 040, or 041	E1, E2, or E3
	003	USASCII End of Text
	XXX	Message Parity

* External BCD (136 Internal BCD).

MESSAGE PROCESSING.

Messages are processed by the equipment as shown in figure 3-8. The flow charts show the communications sequence between the remote site and the data source.

The equipment is normally in the receive mode. Data input is fed to a buffer register to undergo a synchronization sequence. After each word is received, buffer register contents are examined. At least two consecutive sync codes followed by the start of header code and correct site address must be observed to allow further progress. If this does not occur, the Equipment Controller again searches for the

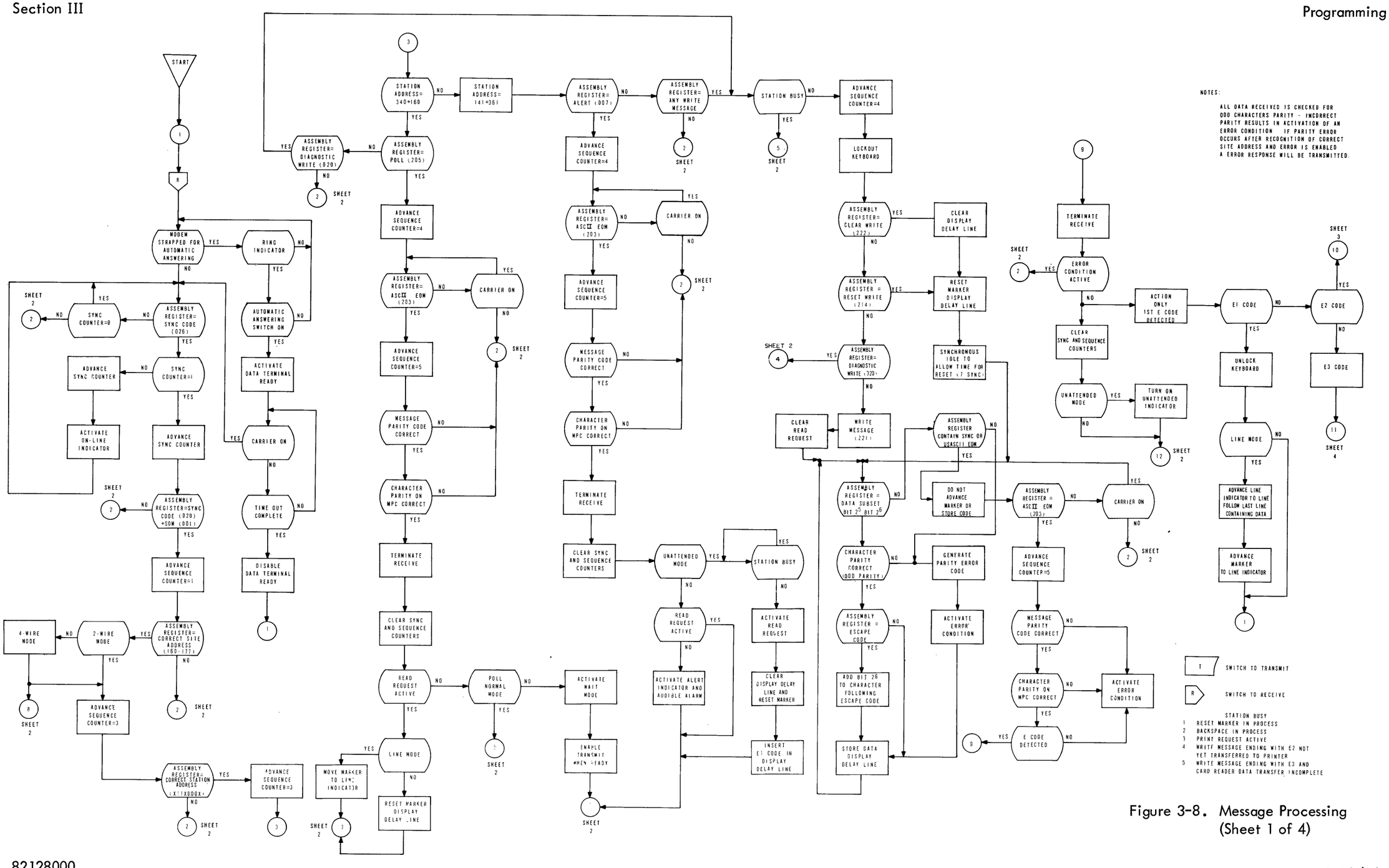


Figure 3-8. Message Processing (Sheet 1 of 4)

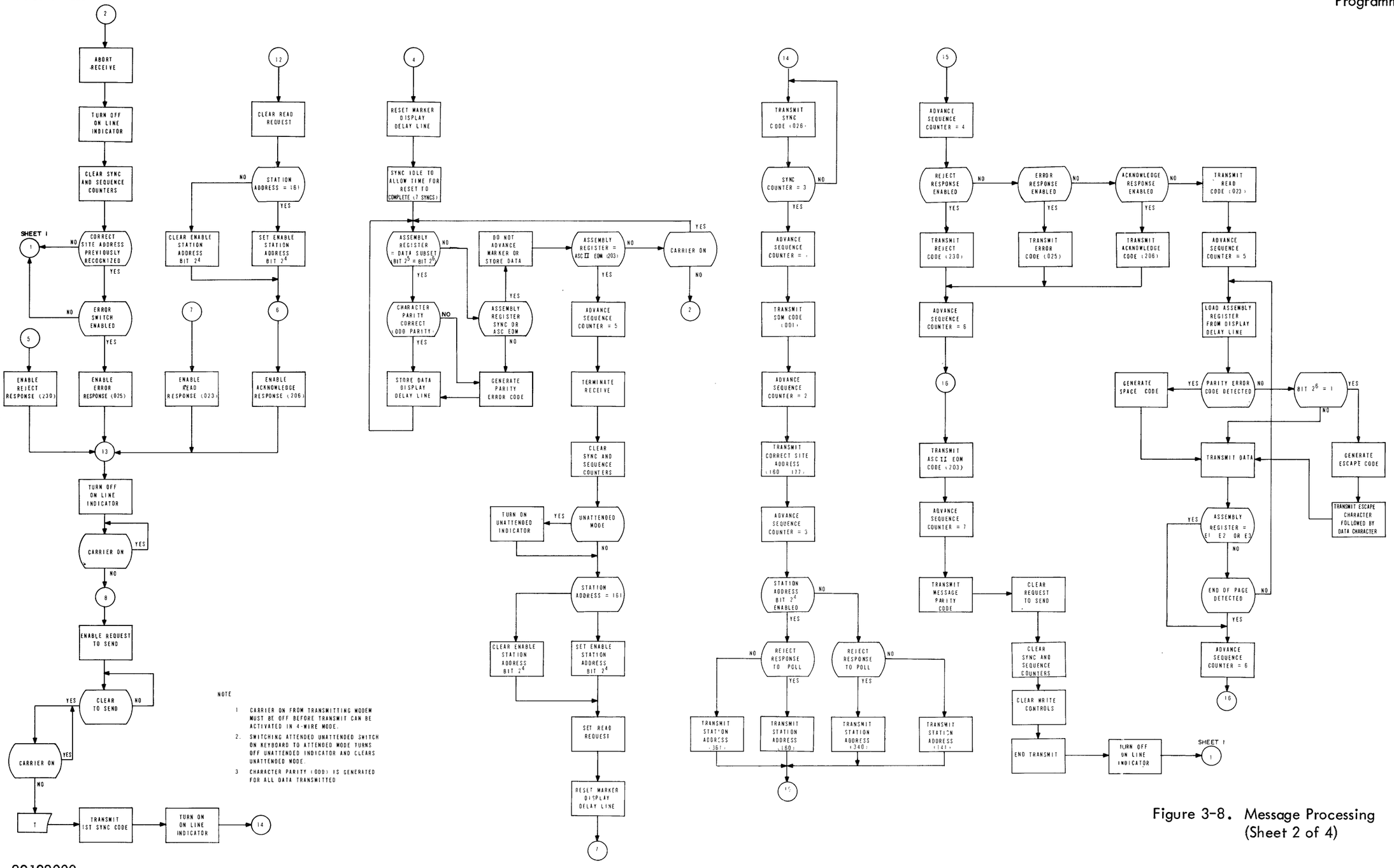
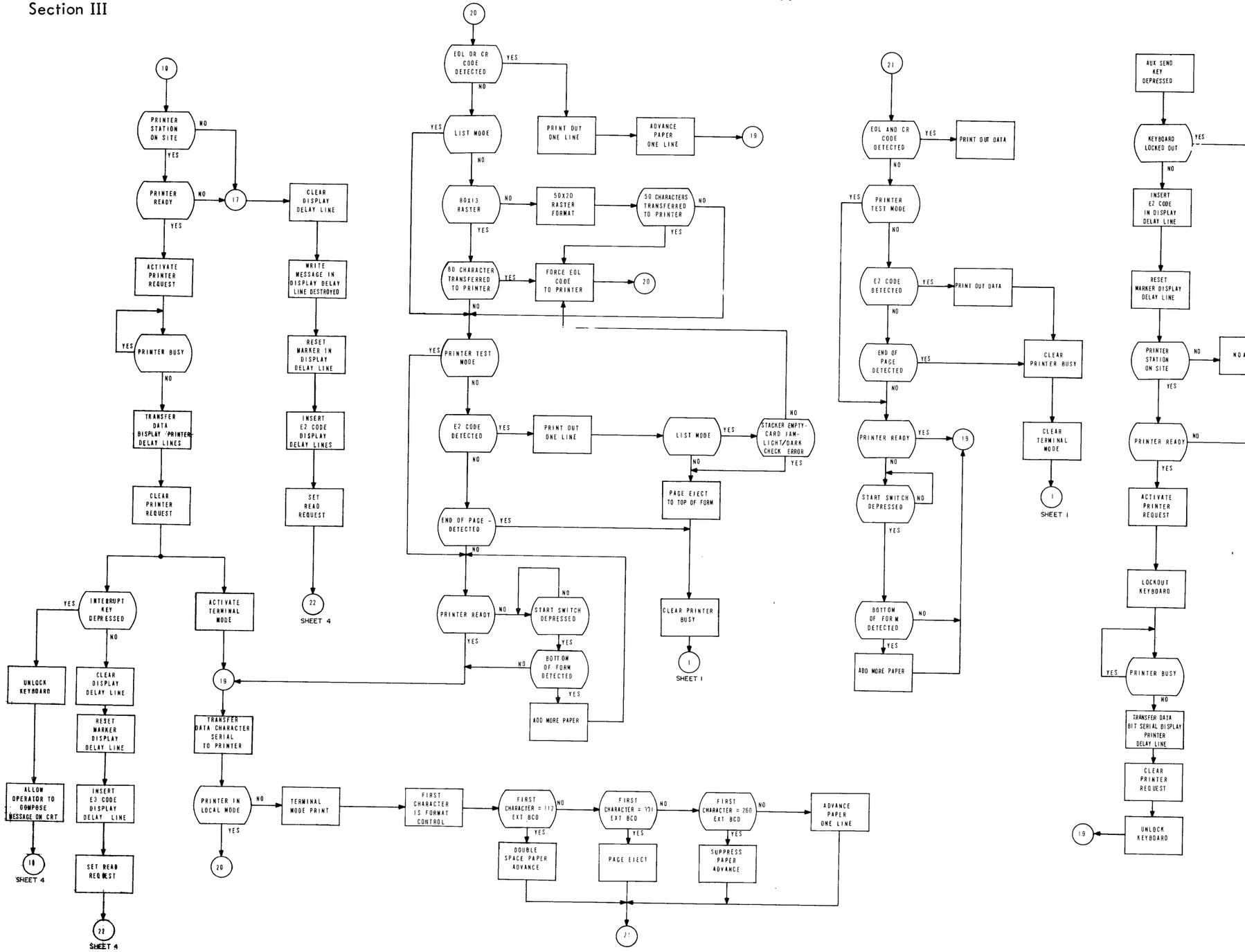


Figure 3-8. Message Processing (Sheet 2 of 4)



NOTE:

SWITCHING FROM TERMINAL TO LOCAL MODE ON PRINTER - OVERPRINTING CAN OCCUR SINCE IN TERMINAL MODE WE ADVANCE PAPER FIRST AND THEN PRINT AND IN LOCAL MODE WE PRINT FIRST AND THEN ADVANCE PAPER

PRINTER AND CARD READER ARE INDEPENDENT OF LINE INDICATOR AND ATTENDED UNATTENDED MODE.

Figure 3-8. Message Processing (Sheet 3 of 4)

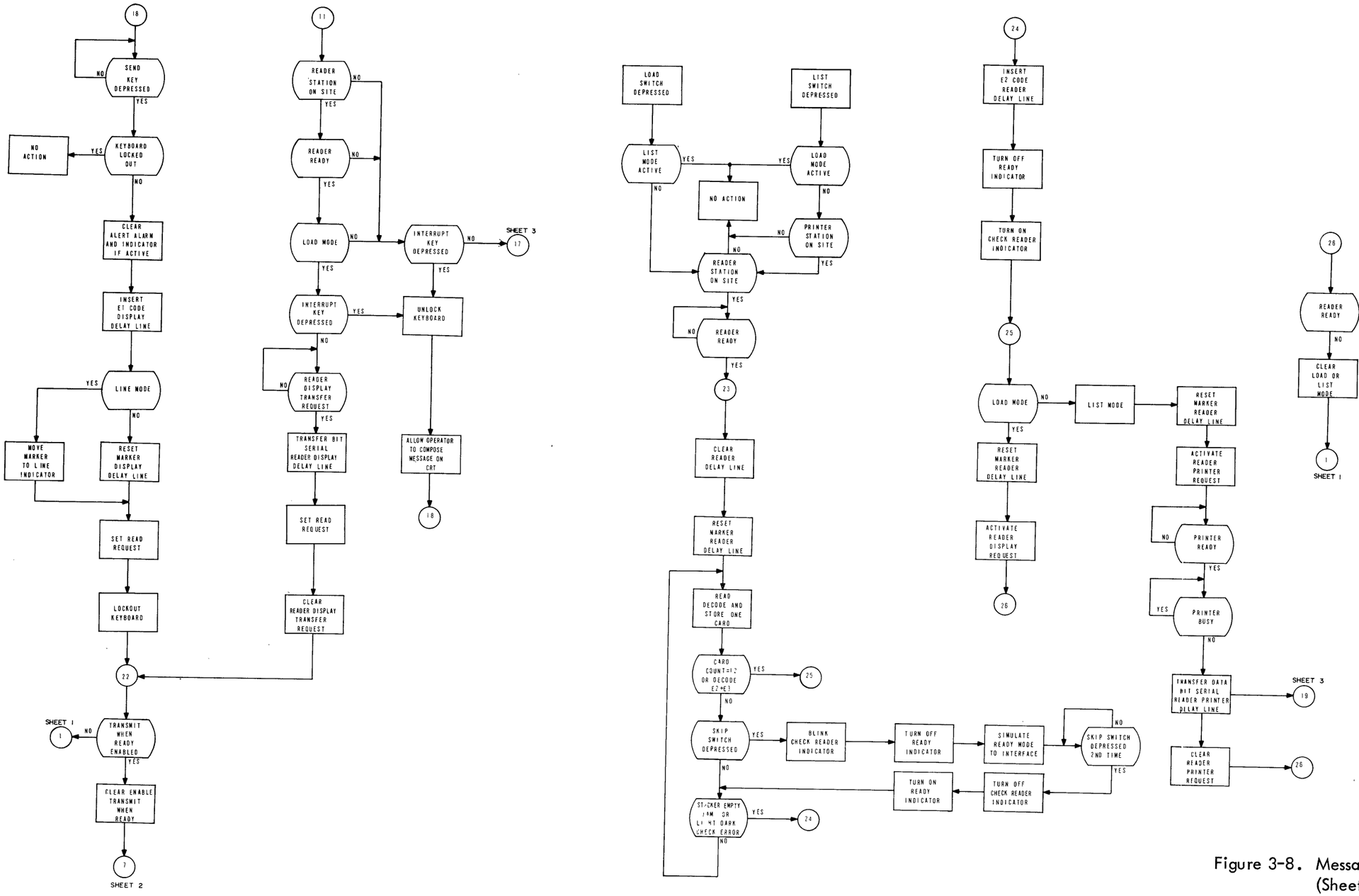


Figure 3-8. Message Processing (Sheet 4 of 4)

same pattern. Once synchronization has occurred, the message sequence continues. An incorrect station results in a message aborting error sequence (explained later in this section). A correct station address allows interpretation of the subsequent control code.

POLL MESSAGE.

Since the equipment generally makes up one of many remote sites on line to the modem, each site is scanned in a search for read messages. The poll message provides the scanning means. Each remote site in the sequence receives a poll message containing a station address of 140 octal. If no read message is available, and the POLL NORMAL/WAIT switch in the Equipment Controller is in the NORMAL position, a reject message containing a station address of 140 octal is transmitted. In the WAIT position, the Equipment Controller transmits an acknowledge message response to the poll if no read message is available. If a read message becomes available at some later time, it is transmitted without waiting for a poll. Regardless of the switch position, if a read message is available, it is transmitted as a reply to the poll message.

NOTE

For equipment sharing common carrier lines, the poll switch on all equipments on line must be in the NORMAL position.

Availability of a read message is indicated by a "read request" condition which remains active until a write, reset-write, or clear-write message is received. A read request condition may be initiated by:

(a) Depression of the Display Station SEND key.

(b) Transmission request from card reader after display buffer memory has been filled.

(c) Termination of data transfer from display module to printer module during a data source controlled print operation.

(d) Receipt of an alert message when the equipment is ready, not busy, and in the unattended mode.

(e) Receipt of a diagnostic write message.

ALERT MESSAGE.

The purpose of the alert message is to provide a means of informing the equipment that the data source has a write message ready for transmission.

When the Equipment Controller receives a correct alert message, an acknowledge message is sent, and the ALERT light and audible alarm at the Display Station are activated, provided the ATTENDED/UNATTENDED switch is in the ATTENDED position. To deactivate the light and alarm, the operator depresses the SEND key. This action inserts an E1 (Δ) code at the current entry marker position and resets the marker chain to the upper line (block mode) or to the line preceded by the line indicator (line mode). Consequently, a read message is generated. In the unattended mode the light and alarm are not activated but the action just described is automatically performed. Hence, by sending an alert message, the data source can inform the remote site of a pending write operation and either directly or indirectly force generation of a read message. This read message is not transmitted, however, until the site is polled. Upon receipt of the read message, the data source then performs a write.

ACKNOWLEDGE MESSAGE.

The Equipment Controller automatically transmits an acknowledge message upon correct receipt of a write, reset-write, clear-write, or alert message. An acknowledge is also sent in response to a poll when the POLL NORMAL/WAIT switch is in the WAIT position and there is no "read request" pending.

REJECT MESSAGE.

A reject message is transmitted by the Equipment Controller to indicate rejection of a previously received message on the following grounds.

(a) The Equipment Controller is polled but there are no pending "read requests" (POLL NORMAL/WAIT switch in NORMAL position).

(b) The Equipment Controller is busy (reset, clear, or backspace function in process) at the time of receipt of a write, reset-write, clear-write, or diagnostic write message. In addition, a busy condition exists when:

(1) The Equipment Controller display buffer memory is being transferred to the printer buffer memory or the display buffer memory is queued for a print operation.

(2) The Equipment Controller display buffer memory is being loaded from the reader memory during the process of reading punched cards.

READ MESSAGE.

The read message consists of data from the Display Station keyboard, punched cards read by the card reader, or data from a previous diagnostic write operation. Read messages may be terminated by a hardware-generated escape code followed by either an E1, E2, or E3 code. A message ending with E1 indicates the source as the Display Station keyboard. The other two endings occur in read responses to write messages requesting a printout or "read more cards" operation. If the write message requests a printout (ends in E2), the response is shown in figure 3-9. An automatic read message contains one word ("E" code) and is hardware generated.

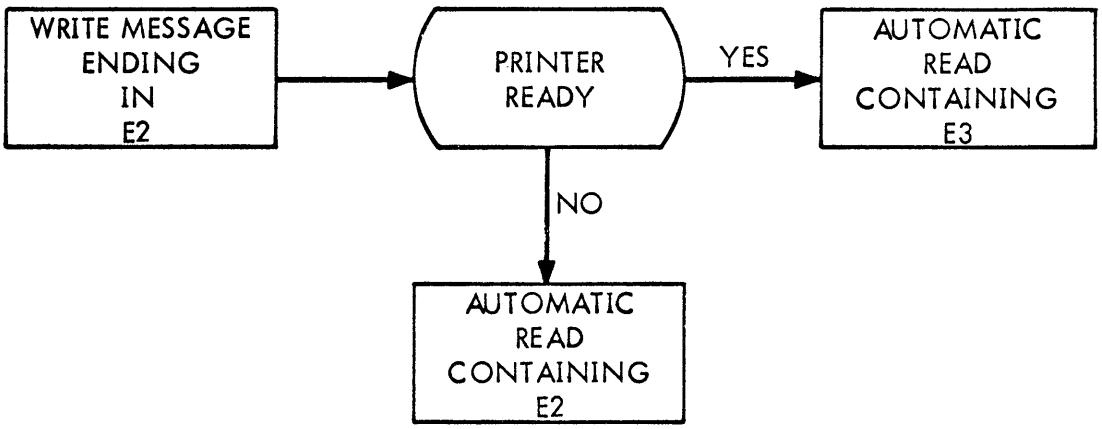


Figure 3-9. Read Responses to a Print Message

Read messages are also generated in response to a request to "read more cards" from the data source. Figure 3-10 points out the type of responses that might be expected.

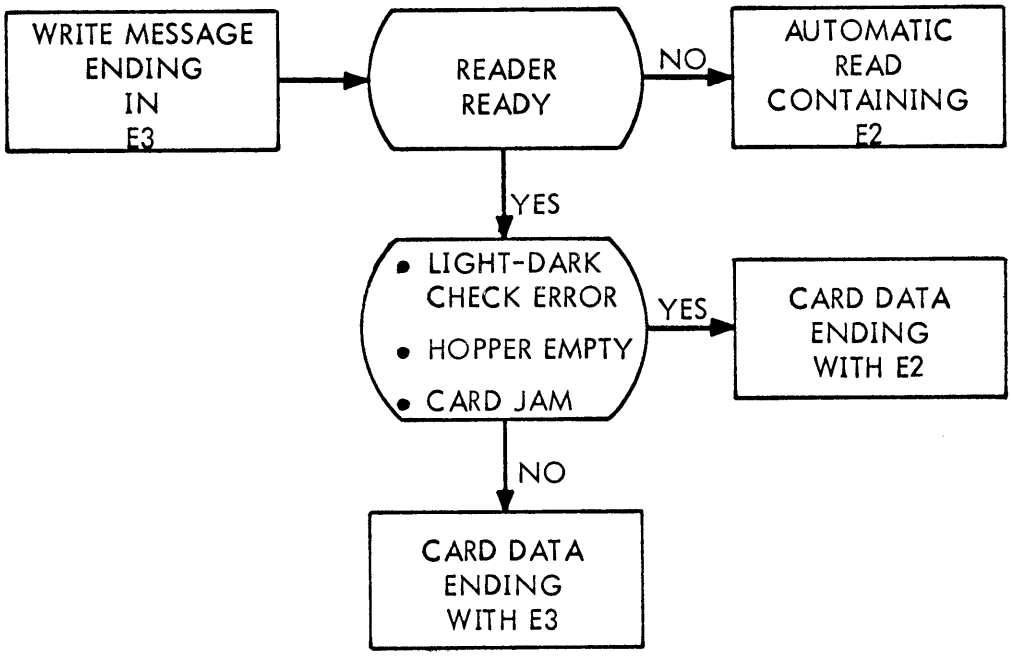


Figure 3-10. Read Responses to a "Request to Read More Cards"

If the read message is in response to a diagnostic write, the "E" codes are meaningless since their source was the preceding diagnostic write message. However, they are used to terminate the message.

The "E" codes as well as the carriage return code are preceded in the read message format by an escape code. The escape code is a flag code used to indicate that the following word has some controlling function. Escape codes are never stored in memory but are added or deleted in messages by the interface. An example of a read message termination might be:

Data
Escape
E1
USASCII End of Message
Message Parity Character

WRITE MESSAGES.

Information from the data source to be displayed or printed is sent in the form of write, reset-write, clear-write, or diagnostic write messages. The write

message designates that the display message must begin at the current position of the entry marker. A reset-write message enables resetting the entry marker to the upper left corner of the display (without clearing data already displayed) and the write message begins at that point. In addition to resetting the entry marker, the clear-write message also clears the display memory and viewing raster. The diagnostic write message resets the entry marker but does not clear the crt and memory. It has the additional feature of enabling a read message response containing the same data received. Data from the beginning of the diagnostic write message up to the first "E" code is returned in the read response. If no "E" code exists, the read response continues to the end of the page and terminates. Seven sync codes follow the reset-write, clear-write, and diagnostic write control codes in the message format, to allow time for the reset operation.

Station addresses used in write messages to a particular site should alternate between 141 and 161 octal. For example, if the first write message to the site contained a station address of 141 octal, the next write message to that site should contain a station address of 161. This restriction enables the Equipment Controller to remember and report the accuracy of the preceding write message (see Programming Aids).

Escape codes followed by "E" codes also serve controlling functions in write, reset-write, and clear-write messages. However, only the first of any "E" codes is treated as normal data and stored in the display memory. If an E1 code is detected first, the message is designated as for display only, and the keyboard is unlocked.

If an E2 preceded by an escape code is encountered first in a message, it is also treated as normal data and stored in memory. When a write, reset-write, or clear-write operation is complete, the presence of the E2 code initiates transfer of the contents of the display buffer memory into the printer buffer memory. A printout results and terminates at the E2 code. The E2 code is not printed. If the Display Station keyboard is not locked out by a previous read, it is locked by the write with an E2 code. The diagnostic write message cannot be used for printout. Display, only, results from the presence of the E2 code and the keyboard remains locked.

Completion of a write, reset-write, or clear-write where an E3 code acts as message designator, enables a "read more cards" command to be sent to the card reader. The E3 code is treated as normal data and stored in display buffer memory. In addition, the E3 locks the Display Station keyboard. A diagnostic write message containing an E3 code initiates display only and the keyboard remains locked.

Three other control code types may be present in any write message preceded by an escape code. These are end of line, carriage return, and compression codes.

Only carriage return performs an operation on the display page. The other two have meaning to the line printer only and are functional in all write messages with the exception of the diagnostic write. The carriage return code inserts the associated symbol at the current entry marker position, erases remaining data to the right of the present entry marker, and advances the marker chain to the next line.

The write message normally solicits a response from the equipment in the form of an acknowledge message. However, should the equipment be busy at the time, a reject message is transmitted instead. Any error conditions result in an error sequence described later. As stated before, a diagnostic write message obtains a read message response.

MESSAGES FOR PRINTOUT.

Messages processed by the line printer differ somewhat from other messages. Any write, reset-write, or clear-write message containing an escape code, followed by an E2 code, allows transfer of the message to the printer. The line printer has line truncation, format control, and character compression features which are governed by control codes in the message.

Line Truncation.

Print lines can be truncated through the use of an escape code followed by an end of line or carriage return code. These two codes enable the rest of the current print line to be filled with blanks. Truncation, such as this, can only occur in the line printer. The typewriter performs a carriage return operation under these conditions.

Since the line printer does not perform truncation automatically at the end of a line, it must be programmed to accomplish this purpose.

Format Control.

When the line printer is under data source control (terminal mode), the first data subset code of a line is recognized as a format control code and is not printed. The first code following an end of line or carriage return control code is also interpreted as a format control code. There is no format control when the

line printer is operating in local mode (AUX SEND or LIST key operation). This is because an automatic end of line condition is created within the adaptor, and single spacing occurs. The four format control codes are shown in table 3-3.

TABLE 3-3. FORMAT CONTROL

EXT BCD	INT BCD	SYMBOL	OCTAL CODE	FUNCTION
120	060	Blank	00	Single space (vertical)
112	100	0	12	Double space (vertical)
101	101	1	01	Page eject — advance to beginning of next form
060	120	+	60	Suppress space — maintain current line (do not space)

Any 6-bit codes, other than those shown, are interpreted as blanks, ie, the single-space operation is performed. In terminal mode, all operations are performed before subsequent printout of data (pre-print).

Proper use of the format control code prevents the possibility of "overprint". In this situation, the first line of one message is printed over the last line of the preceding message. For example, if the format control code beginning the first line is a suppress space, overprint is possible. The use of the suppress-space code also makes overprint possible within a message. Operation of the terminal in local mode cites another example. In this instance, the first code in a line is interpreted as data so no initial spacing operation is performed, and overprint could result. To prevent these situations, refer to the procedures listed in Programming Aids at the end of this section.

Character Compression.

The line printer allows data source compression of strings of zeros or spaces. This means that the data source need only send an escape code followed by one other code to enable printout of a specified number of zeros or spaces in succession. This character compression operation cannot take place simultaneously with format

control. Consequently, in terminal mode the first code for a line cannot be used for character compression in an effort to space and print out a string of zeros or spaces. The data compression code is interpreted as shown in figure 3-11.

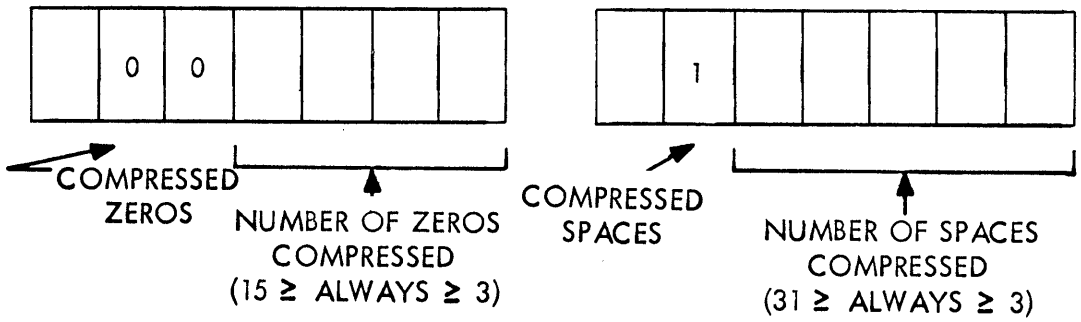


Figure 3-11. Compression Codes

ERROR MESSAGE.

The error message is generated by the terminal and is transmitted only if the ERROR MESSAGE ENABLE/DISABLE switch is in the ENABLE position in the Equipment Controller. Error conditions for all messages except diagnostic write are listed in table 3-4 which also lists the operations performed for both switch positions.

TABLE 3-4. ERROR CONDITIONS

ERROR CONDITION	ERROR MESSAGE SWITCH	
	ENABLE	DISABLE
Word Parity Error	Store message in memory. Insert parity error symbol for symbol in error. Transmit error message instead of acknowledge message. No data transfer to the printer or from the card reader.	Store message in memory. Insert parity error symbol for symbol in error. No data transfer to the printer or from the card reader.
Message Parity Error	Store message in memory. Transmit error message instead of acknowledge message. No data transfer to the printer or from the card reader.	Store message in memory. Receive sequence aborts on end of message. No data transfer to the printer or from the card reader.

TABLE 3-4. ERROR CONDITIONS (CONT)

ERROR CONDITION	ERROR MESSAGE SWITCH	
	ENABLE	DISABLE
Unrecognized Control Code	Transmit error message on end of message. Receive sequence aborts on end of message. No data transfer to the printer or from the card reader.	Receive sequence aborts on end of message. No data transfer to the printer or from the card reader.
Nonexistent Station Address	Transmit error message instead of acknowledge message. No data transfer to the printer or from the card reader.	Receive sequence aborts on end of message. No data transfer to the printer or from the card reader.
Write Message not ending with escape code and E1, E2, or E3	Store message in memory. Transmit error message instead of acknowledge message. No data transfer to the printer or from the card reader.	Store message in memory. Receive sequence aborts on end of message. Store message in memory. No data transfer to the printer or from the card reader.
Carrier On Signal drops before USASCII End of Text Recognized	Allow receive sequence to complete. Transmit error message instead of acknowledge message. No data transfer to the printer or from the card reader.	Receive sequence aborts on end of message. Store message in memory. No data transfer to the printer or from the card reader.

Error conditions arising in diagnostic write messages are treated the same as those listed in table 3-4 with the following exceptions:

(a) A word parity error does not enable transmission of an error message. Instead, a parity error code is stored in memory and a space code is substituted in the subsequent read message.

(b) Missing "E" codes or incorrect message parity do not result in error message transmission. Instead, data is transmitted in the read message exactly as it is received from the data source, up to end of page if there is no "E" code.

SYMBOL AND FUNCTION REPERTOIRE.

The symbol repertoire includes the alphabet in uppercase, Arabic numerals (0 through 9), punctuation marks, and special symbols. Table 3-5 presents the symbols in alphabetic and numerical order. The representations shown do not necessarily reflect actual images reproduced in the equipment. A parity error code in memory (076 octal) is transmitted as 120 external BCD or 060 external BCD.

Internal and external BCD codes shown are the 7-bit codes on line between the modem and the interface. The delay-line codes are the actual codes entered into memory, and on line from the Display Station keyboard.

The array of holes on punched cards is interpreted as Hollerith coding. An example of a punched card is given in figure 1-6. Each column represents one word or character. There are twelve rows and each character has twelve hole positions. The numbers given in the Hollerith code have a corresponding row number on the punched card with the exception of rows 11 and 12. Row 12 is the uppermost row while row 11 is the next lower row.

The typewriter receives data in the form of solenoid-pulsing signals. These signals are represented in table 3-6 by R1, R2, R2A, R5, T1, T2, and CK. The CK line contains the odd parity bit. In addition, a separate solenoid is used for upper and lowercase shift. Case position is also listed.

Table 3-6 lists the function codes and their associated images, if any, on the crt. In order for the function to be performed, it must be preceded by the escape code. The function codes have no print images. A listing is not made for the typewriter and some Display Station functions because the operations are initiated by various signal lines rather than an encoding and decoding network. Some of the keyboard functions listed are not available for data source programming, hence there are no codes listed under BCD headings. These functions are on line from the Display Station keyboard only. Delay-line codes 120 through 132 in the table are available from the Display Station keyboard only.

TABLE 3-5. SYMBOL REPERTOIRE

BCD INT	BCD EXT	DELAY-LINE CODE	DISPLAY SYMBOL	TYPEWRITER SYMBOL	TYPEWRITER CODE	LINE PRINTER SYMBOL	LINE PRINTER CODE	HOLLERITH CODE
121	061	61	A	A	R1, R2, R2A, R5, CK (LC)	A	61	12, 1
122	062	62	B	B	R2, R2A, CK (LC)	B	62	12, 2
123	063	63	C	C	R5, R2, R2A (LC)	C	63	12, 3
124	064	64	D	D	R1, R2A, CK (LC)	D	64	12, 4
125	065	65	E	E	R1, R2A, R5 (LC)	E	65	12, 5
126	066	66	F	F	R2A (LC)	F	66	12, 6
127	067	67	G	G	R2A, R5, CK (LC)	G	67	12, 7
130	070	70	H	H	R1, R5, CK, (LC)	H	70	12, 8
131	071	71	I	I	R1 (LC)	I	71	12, 9
041	041	41	J	J	R1, R2, R2A, R5, T1 (LC)	J	41	11, 1
042	042	42	K	K	R2, R2A, T1 (LC)	K	42	11, 2
043	043	43	L	L	R2, R2A, R5, T1, CK (LC)	L	43	11, 3
044	044	44	M	M	R1, R2A, T1 (LC)	M	44	11, 4
045	045	45	N	N	R1, R2A, R5, T1, CK (LC)	N	45	11, 5
046	046	46	O	O	R2A, T1, CK (LC)	O	46	11, 6
047	047	47	P	P	R2A, R5, T1 (LC)	P	47	11, 7
050	050	50	Q	Q	R1, R5, T1 (LC)	Q	50	11, 8
051	051	51	R	R	R1, T1, CK (LC)	R	51	11, 9
062	122	22	S	S	R2, R2A, T2 (LC)	S	22	0, 2
063	123	23	T	T	R2, R2A, R5, T2, CK (LC)	T	23	0, 3
064	124	24	U	U	R1, R2A, T2 (LC)	U	24	0, 4
065	125	25	V	V	R1, R2A, R5, T2, CK (LC)	V	25	0, 5
066	126	26	W	W	R2A, T2, CK (LC)	W	26	0, 6
067	127	27	X	X	R2A, R5, T2 (LC)	X	27	0, 7
070	130	30	Y	Y	R1, R5, T2 (LC)	Y	30	0, 8
071	131	31	Z	Z	R1, T2, CK (LC)	Z	31	0, 9
101	101	01	1	1	R1, R2, R2A, R5, T1, T2, CK (LC)	1	01	1
102	102	02	2	2	R2, R2A, T1, T2, CK (LC)	2	02	2
103	103	03	3	3	R2, R2A, R5, T1, T2 (LC)	3	03	3
104	104	04	4	4	R1, R2A, T1, T2, CK (LC)	4	04	4
105	105	05	5	5	R1, R2A, R5, T1, T2 (LC)	5	05	5
106	106	06	6	6	R2A, T1, T2 (LC)	6	06	6
107	107	07	7	7	R2A, R5, T1, T2, CK (LC)	7	07	7
110	110	10	8	8	R1, R5, T1, T2, CK (LC)	8	10	8
111	111	11	9	9	R1, T1, T2 (LC)	9	11	9
100	112	12	Ø zero	0	R1, R2, R2A, T1, T2 (LC)	0	12	0
113	113	13	=	=	T1, T2, CK (LC)	=	13	8, 3
114	114	14	≠	≠	R1, R5, T1, T2, CK (UC)	≠	14	8, 4
115	115	15	≤	≤	R1, T1, T2 (UC)	≤	15	8, 5
116	116	16	%	%	R1, R2, R2A, T1, T2 (UC)	%	16	8, 6
117	117	17	[	[	T1, T2, CK (UC)	[	17	8, 7
060	120	00	BLANK	SPACE	None	SPACE	00	BLANK
061	121	21	/	/	R1, R2, R2A, R5, T2 (LC)	/	21	0, 1
072	132	32	]	]	R2A, R5, T2 (UC)	]	32	0, 8, 2
073	133	33	, comma	,	T2 (LC)	,	33	0, 8, 3
074	134	34	(	(	R1, R5, T2 (UC)	(	34	0, 8, 4
075	135	35	⌐	⌐	R1, T2, CK (UC)	⌐	35	0, 8, 5
076	136	36	≡	≡	R1, R2, R2A, T2, CK (UC)	≡	36	0, 8, 6
040	040	40	- minus	-	R1, R2, R2A, T1, CK (LC)	-	40	11
077	137	37	^	^	T2 (UC)	^	37	0, 8, 7
052	052	52	v	v	R2A, R5, T1 (UC)	v	52	11, 0
053	053	53	$	$	T1 (LC)	$	53	11, 8, 3
054	054	54	*	*	R1, R5, T1 (UC)	*	54	11, 8, 4
055	055	55	↑	↑	R1, T1, CK (UC)	↑	55	11, 8, 5
056	056	56	↓	↓	R1, R2, R2A, T1, CK (UC)	↓	56	11, 8, 6
057	057	57	>	>	T1 (UC)	>	57	11, 8, 7
120	060	60	+	+	R1, R2, R2A (LC)	+	60	12
132	072	72	<	<	R2A, R5, CK (UC)	<	72	12, 0
133	073	73	. period	.	CK (LC)	.	73	12, 8, 3
134	074	74	)	)	R1, R5, CK (UC)	)	74	12, 8, 4
135	075	75	≥	≥	R1 (UC)	≥	75	12, 8, 5
None	None	76	■ parity error	■	R1, R2, R2A (UC)	⌊	76	None
137	077	77	;	;	CK (UC)	;	77	12, 8, 7
112	100	20	:	:	R1, R2, R2A, T2, CK (LC)	:	20	8, 2

TABLE 3-6. FUNCTION REPERTOIRE

FUNCTION CODE	DISPLAY SYMBOL*	DELAY-LINE CODE	BCD		HOLLERITH CODE	LINE PRINTER CODE
			INT	EXT		
End of Line	None	100	060	120	None	100
Carriage Return	-	101	101	101	None	101
E1	Δ	102	102	102	None	102
Escape	None	None	136	076	None	None
E2	'	140	040	040	None	140
E3	⁘	141	041	041	None	141
End of Record	None	127	067	127	7, 8, 9	None
End of File	None	126	066	126	6, 7, 8, 9	None
Compress 3 Zeros	None	103	103	103	None	103
Compress 4 Zeros	None	104	104	104	None	104
Compress 5 Zeros	None	105	105	105	None	105
Compress 6 Zeros	None	106	106	106	None	106
Compress 7 Zeros	None	107	107	107	None	107
Compress 8 Zeros	None	110	110	110	None	110
Compress 9 Zeros	None	111	111	111	None	111
Compress 10 Zeros	None	112	100	112	None	112
Compress 11 Zeros	None	113	113	113	None	113
Compress 12 Zeros	None	114	114	114	None	114
Compress 13 Zeros	None	115	115	115	None	115
Compress 14 Zeros	None	116	116	116	None	116
Compress 15 Zeros	None	117	117	117	None	117
Compress 3 Spaces	None	143	043	043	None	143
Compress 4 Spaces	None	144	044	044	None	144
Compress 5 Spaces	None	145	045	045	None	145
Compress 6 Spaces	None	146	046	046	None	146
Compress 7 Spaces	None	147	047	047	None	147
Compress 8 Spaces	None	150	050	050	None	150
Compress 9 Spaces	None	151	051	051	None	151
Compress 10 Spaces	None	152	052	052	None	152
Compress 11 Spaces	None	153	053	053	None	153
Compress 12 Spaces	None	154	054	054	None	154
Compress 13 Spaces	None	155	055	055	None	155
Compress 14 Spaces	None	156	056	056	None	156
Compress 15 Spaces	None	157	057	057	None	157
Compress 16 Spaces	None	160	120	060	None	160
Compress 17 Spaces	None	161	121	061	None	161
Compress 18 Spaces	None	162	122	062	None	162
Compress 19 Spaces	None	163	123	063	None	163
Compress 20 Spaces	None	164	124	064	None	164
Compress 21 Spaces	None	165	125	065	None	165
Compress 22 Spaces	None	166	126	066	None	166
Compress 23 Spaces	None	167	127	067	None	167
Compress 24 Spaces	None	170	130	070	None	170
Compress 25 Spaces	None	171	131	071	None	171
Compress 26 Spaces	None	172	132	072	None	172
Compress 27 Spaces	None	173	133	073	None	173
Compress 28 Spaces	None	174	134	074	None	174
Compress 29 Spaces	None	175	135	075	None	175
Compress 30 Spaces	None	176	136	076	None	176
Compress 31 Spaces	None	177	137	077	None	177
Backspace	None	120	None		None	None
Line Skip	None	122	None		None	None
Skip	None	131	None		None	None
Reset	None	132	None		None	None

* In the case of "None", a meaningless image may be present.

PROGRAMMING AIDS.

The following paragraphs summarize the discussions presented throughout this manual. They are intended to aid the operator in the programming and operation of the equipment.

PUNCHED CARD DATA ENTRY.

Hollerith-coded cards, only, are read by the card reader. Binary-coded cards are interpreted as Hollerith coding. Operation of the card reader requires the following steps.

(a) Apply power to the Equipment Controller via the POWER ON switch.

(b) Load reader hopper and insert card feed plate.

(c) Depress ON switch and AUTO switch. This action applies power to the reader and places it in the automatic mode.

(d) Activate REG switch. At this point, the first card is registered on the read table and the READY indicator should be illuminated.

(e) To locally print card data:

(1) Verify printer is ready for use.

(2) Depress LIST switch on Equipment Controller.

(3) Cards are read and contents printed in blocks of 12, until the reader hopper empties or reader jams.

OR

(e) To transmit card data to data source:

(1) Depress LOAD switch on Equipment Controller. First 12 cards are loaded into reader buffer memory.

(2) Operator composes message on crt requesting data source to read cards and depresses SEND key. Keyboard is locked out.

(3) Read message is transmitted to data source upon receipt of poll message.

(4) Data source transmits write message to remote site ending with E3. This initiates card data transfer from reader buffer memory to display buffer memory.

(5) Card data is sent to data source in read message ending with E3 indicating "more cards to come." Cards are read in blocks of 12.

(6) Steps (4) and (5) are repeated until all cards are read. A read message containing the last of the card data ends with an E2 code in place of the E3.

(7) Depression of the Display Station INT key causes step (4) to abort and the keyboard is released for operator intervention.

(8) Data source must transmit a write message ending with E1 to unlock the keyboard (INT key may be used to provide the release).

OPERATOR-INITIATED PRINTOUT.

Printout may be initiated by the operator either directly (LIST or AUX SEND key) or indirectly (print request message). A printout, directly initiated, follows these steps.

(a) Apply power to printer.

(b) Depress PAGE EJECT (list mode). This advances the paper to the top of the next form preventing overprint in the event the previous message did not advance the paper before terminating. Depression of AUX SEND performs this operation automatically.

(c) Compose or otherwise generate within the display buffer memory the data to be printed. This can be accomplished using the keyboard or the card reader (in list mode of operation).

(d) Depress AUX SEND key if data was generated via the keyboard. Data generated via the card reader in the list mode does not require depression of AUX SEND. The operator keyboard is locked out (load mode only) until data transfer from the display buffer memory to the printer buffer memory is complete.

(e) Completion of the data transfer initiates the printer mechanism and frees the display buffer memory for generation of another print message.

(f) The printer proceeds with the print operation until an E2 code is encountered. The print operation is terminated at the E2 code and the associated symbol is not printed.

Messages indirectly generated by the operator are initiated by print request messages to the data source. The data source responds to the print request with a write message ending with an E2 code and composed in compliance with the print message structure shown in table 3-7. For print messages from the data source initiated by the operator:

(a) Verify printer is ready for operation.

(b) Compose a print request message via the keyboard and transmit to the data source by operating the SEND key. Keyboard is disabled when the SEND key is depressed.

(c) Data to be printed is transmitted to the display buffer memory from the data source in a write message. The write message must end with an escape and an E2 code to initiate the print operation (reference table 3-7).

(d) Upon recognition of the E2 code, the print message is transferred to the printer buffer memory and the print operation begins.

(e) Completion of data transfer to the printer buffer memory results in an "automatic" read message to the data source on subsequent receipt of a poll. This read message contains an escape code and either an E2 or E3 code, depending on printer conditions.

(f) A second print message can be transmitted to the equipment before the preceding message printout is complete. The second message is queued in the display buffer memory for subsequent printout. An automatic read message is not generated until the queued print message is transferred to the printer buffer memory.

(g) Individual print messages are printed until an E2 code is encountered (E2 code is not printed).

TABLE 3-7. DATA SOURCE PRINT MESSAGE FORMAT

	EXT BCD	INT BCD	FORMAT	DESCRIPTION
First Line	XXX	XXX	FMT	Any format control code in table 3-3 except suppress space.
	XXX ↕ XXX	XXX ↕ XXX	Data ↕ Data	Data compression codes restricted to this area.
	076	136	ESCAPE	
	120	060	EOL	Carriage return (101 EXT and INT BCD) may also be used.
Succeeding Lines	XXX	XXX	FMT	Any format control code in table 3-3. Suppress space may be used to maintain same line.
	XXX ↕ XXX	XXX ↕ XXX	Data ↕ Data	Data compression codes restricted to this area.
	076	136	ESCAPE	
	120	060	EOL	Carriage return may also be used.
Last Line	XXX	XXX	FMT	Any format control code in table 3-3. Suppress space may be used to maintain same line.
	XXX ↕ XXX	XXX ↕ XXX	Data ↕ Data	Data compression codes restricted to this area.
	076	136	ESCAPE	
	120	060	EOL	Carriage return may also be used.
	101	101	FMT	Page eject used to advance paper to beginning of next form for next message.
	076	136	ESCAPE	
	040	040	E2	End of print message.

Notes — FMT is format control code: EOL is end of line code.

(h) The operator keyboard remains locked out until a write message ending with an escape code and an E1 is received from the data source.

(i) Operator depression of the INT key aborts step 5 and releases the keyboard for operator action.

DATA SOURCE-INITIATED PRINTOUT.

The data source can initiate a print operation by either an alert sequence or by transmitting a "print" write message to the equipment. The latter method overrides any operation by the operator and erases any message in the display buffer memory. Unsolicited transmission of a write message can be executed by the data source only at the risk of losing at least one operator-generated message. The recommended procedure for data-source initiation of an unsolicited print operation is:

(a) The data source transmits an alert message to the remote site. Proper receipt of this message lights the ALERT indicator and sounds the alarm.

(b) The operator is now aware that the data source desires control of the equipment. However, the operator can depress the SEND key at his option.

(c) Subsequently, the SEND key is operated and a read message transmitted to the data source.

(d) The data source transmits the print message to the remote site without the possibility of destroying any operator message.

(e) The operator keyboard remains locked from the time the SEND key is operated until receipt of a write message ending with an escape and an E1 code.

The equipment can be used for unattended or nonoperator influenced print operations through the use of the ATTENDED/UNATTENDED switch on the keyboard. The steps involved are as follows:

(a) Operator verifies that printer is ready and ATTENDED/UNATTENDED switch is in the UNATTENDED position.

(b) Operator composes an unattended message and transmits it to the data source by operating the SEND key. The keyboard is locked out at this time.

(c) Data to be printed immediately is transmitted to the display buffer memory in a write message responding to the read message. This write message must end with an escape code and an E2 code to initiate printout. The write message places the equipment in the unattended mode of operation and illuminates the UNATTENDED indicator.

(d) Upon recognition of the write message E2 code, the print message is transferred to the printer buffer memory and printout is initiated.

(e) Completion of data transfer from the display buffer memory to the printer buffer memory causes an "automatic" read message to be transmitted to the data source on a subsequent poll.

(f) If the display buffer memory contains data for a print operation, write messages are rejected.

(g) To reestablish the automatic print sequence, when the equipment is in the unattended mode, an alert message may be transmitted. A successful poll, if the equipment is ready and not busy, causes an automatic read message ending with an escape and E1 code to be transmitted to the data source. The print operation proceeds as in steps 4 through 6.

TYPICAL READ/WRITE OPERATION.

The following discussion centers on a read/write (display only) operation in the line mode (LINE/BLOCK switch in the LINE position). A 10 by 10 format is assumed.

Suppose the operator clears the crt and composes the following message:

■ AAAAAAAAAA
BBBBBBBBBB
CCCCCCCCCC
DDDDD_____

By depressing the SEND INDEX key, the crt display changes to:

AAAAAAAAAA
■ BBBBBBBBBB
CCCCCCCCCC
DDDDD_____

Depressing the SEND key creates a read request condition and the display experiences the following change:

```
  AAAAAAAAAA
■ BBBBBBBBBB
  CCCCCCCCCC
  DDDDDΔ
```

Upon receipt of a subsequent poll, a read message is transmitted from the first symbol to the right of the line indicator up to and including the E1 symbol (Δ). After completion of the read message, the crt display appears as follows:

```
  AAAAAAAAAA
■ BBBBBBBBBB
  CCCCCCCCCC
  DDDDDΔ____
```

The next write message begins writing at the position of the entry marker (not reset-write or clear-write message). Assuming the write message is four E's followed by five F's and an escape and E1 code, the crt presentation becomes:

```
  AAAAAAAAAA
  BBBBBBBBBB
  CCCCCCCCCC
  DDDDDΔEEEE
  FFFFFΔ
■ ----------
```

Hence, the line indicator and markers are in position to allow easy composition of the next message. The line indicator is not functional in diagnostic write messages.

REDUNDANT RESPONSES.

Normally, the terminal responds to each write message from the data source with either an acknowledge, reject, or error message. The type of response issued tells the data source that:

(1) either the write message was correctly or incorrectly received.

(2) if correctly received, the terminal was either busy at the time and could not process the write, or not busy, and the write message was processed.

Telephone channel errors normally occur in bursts which result in unintelligible communications. A situation such as this could leave the data source in doubt as to the status of the write message. With proper programming, the terminal is capable of providing this status and alleviating the consequences of telephone channel error bursts.

A restriction should be placed on the use of station addresses when programming write messages. This address should alternate between 141 and 161 octal for each successive write message to a particular site. If the write message is correctly received, the terminal returns the same station address in its response. Incorrect receipt results in a response with the alternate address. The following list shows the station address situation for both incorrect and correct receipt of write messages. Normally, the data source retransmits a write message if it is incorrectly received. Message 5 indicates this procedure.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write	161	Acknowledge	161
Message 4	Write	141	Error	161
Message 5	Write	141	Acknowledge	141

If the data source failed to receive a response correctly, another message (poll or alert) may be transmitted in an effort to determine the status of the preceding write message. This new message may use either of the station addresses. If the original write message had been correctly received, the response to this second transmission supplies the original station address.

In the following list, the acknowledge message response to the write message marked with an asterisk (*) is assumed to have been destroyed by a telephone channel error burst. By transmitting a poll message, the data source receives a reject message response (assuming no read requests) containing the station address used by the preceding write (however, 160 is used instead of 161 in reject response to a poll). This station address tells the data source that the previous write message was received and processed correctly and retransmission is not necessary.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write *	161	Acknowledge	161
Message 4	Poll	140 or 160	Reject	160
Message 5	Write	141	Acknowledge	141

If the write message had been incorrectly received, the error message response (ERROR MESSAGE ENABLE/DISABLE switch is in ENABLE position) contains the alternate station address as shown by the following list. Assuming a telephone channel error burst destroys this error response, the data source transmits a poll message to determine the status. An alternate station address in the reject message response informs the data source of the error condition in the previous write. Retransmission of the write message is the normal procedure.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write	161	Error	141
Message 4	Poll	140 or 160	Reject	140
Message 5	Write	161	Acknowledge	161