CONTROL DATA®

MODEL 3290-D
DISPLAY EQUIPMENT

- General Description
- Operation
- Programming

CONTROL DATA **HARDWARE REFERENCE MANUAL**

MODEL 3290-D
DISPLAY EQUIPMENT
HARDWARE REFERENCE MANUAL

SECTIONS IN THIS MANUAL:

Section I —— General Description

Section II —— Operation

Section III —— Programming

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Publication No. 82122900
April 1968
Changed October 1968

Model 3290-D Display Equipment
HARDWARE REFERENCE MANUAL
Revised Edition

REVISION RECORD	
REVISION	DESCRIPTION
A-0-0	Released
(3-8-68)	
A-1-0	Revised - to incorporate Option 10033-C (80 by 13 display
(8-13-68)	format) which is used in the Display Controller. Affected pages
	are: cover, title, copyright, A, i, 1-1, 1-3, 1-4, 3-14, 3-30,
	3-31, 3-32, 3-33.

FOREWORD

This manual contains information to guide personnel in operating the CONTROL DATA Model 3290-D Display Equipment. This manual explains the operation of the display equipment from a user's point of view and bridges the gap between the more detailed customer engineering publications for each device.

Discussion in this manual is arranged in three basic sections. A brief outline of each section follows:

Section I, General Description — contains functional, operational, physical descriptions, and electrical data.

Section II, Operation — lists controls and their functions and explains operating procedures through use of the controls.

Section III, Programming — gives programming aspects of the display equipment. Information is provided on function codes, status codes, interface signals, word formats, etc.

For a more detailed description of the equipment described herein, reference the Model 211-G, H, J, K, L, P Display Station Reference/Customer Engineering Manual (publication number 82117800), Model 218-F, G Printer Station Reference/Customer Engineering Manual (publication number 82132900), and Model 3290-D (with 215-B Poller and including Option 10033-C) Customer Engineering Manual, Books 1 through 4 (publication numbers 82123000, 82123100, 82135600, 82123200, and 82123300, respectively).

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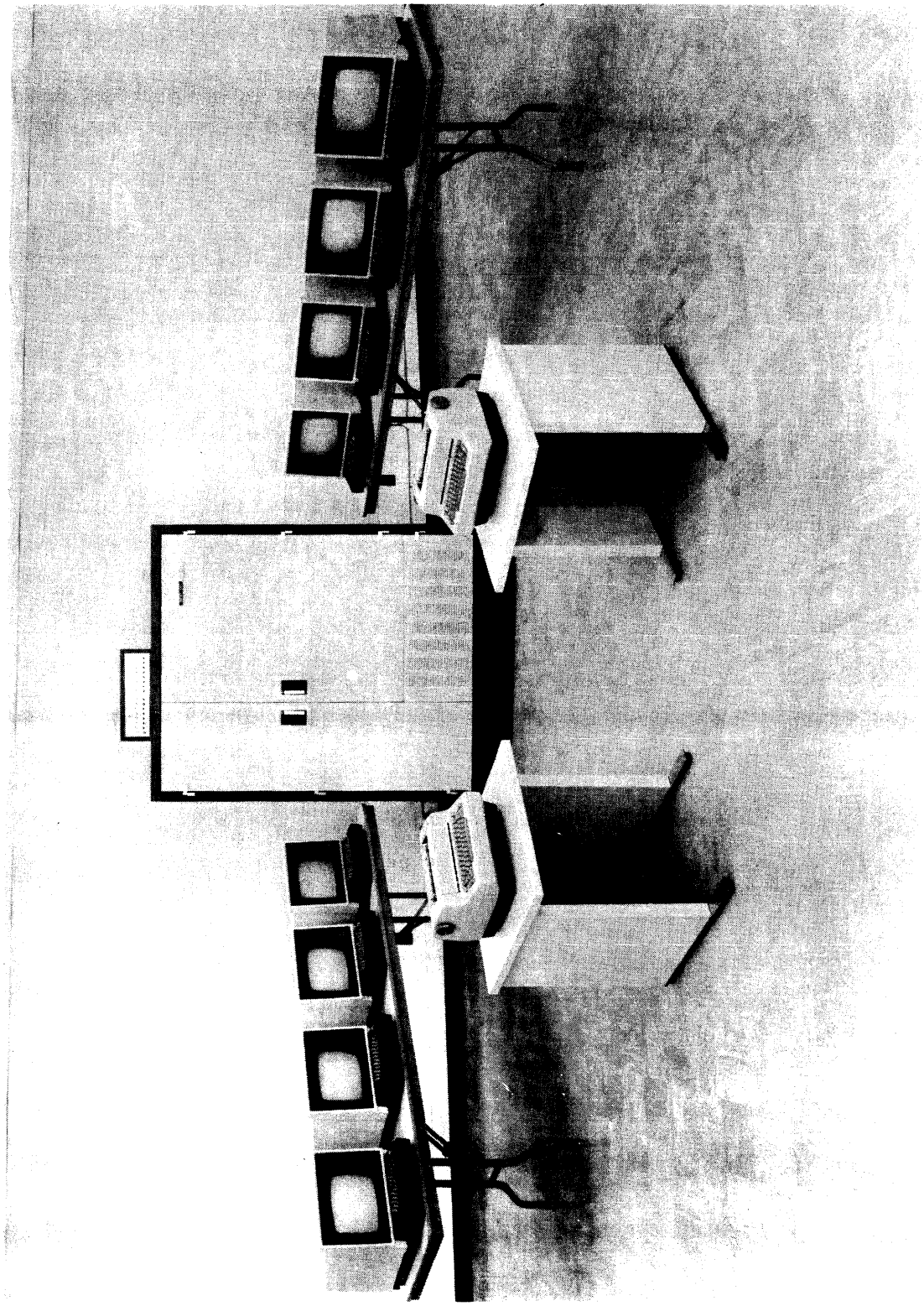

Figure 1-1. Typical Set of Display Equipment

SECTION I

GENERAL DESCRIPTION

The display equipment, designed for use with a CONTROL DATA 3000 Series computer, consists of a Display Controller and a combination (not to exceed 12) of Display Stations, Printer Stations, and pollers.

A typical set of display equipment is shown in figure 1-1. The display equipment provides access to data storage and computational capabilities of a central computer complex by means of inquiry and retrieval Display Stations. To obtain hardcopy records of displayed messages, transfer data to an associated off-line Printer Station. The poller allows communications between the computer and remote sites.

The Display Stations and/or Printer Stations may be located as far as 1000 feet from the Display Controller. A Display Station and its associated logic circuitry must be employed for every Printer Station used; however, one Printer Station may serve more than one Display Station. The poller assembly controls communications between the 3000 Series computer and a remote terminal Display Controller. Communications between the poller assembly and the remote Display Controller take place over conventional phone lines utilizing a DATA-PHONE * Data Set 201A or 201B.

OPERATIONAL DESCRIPTION.

Data is entered on the Display Station 14-inch (diagonal measurement) cathode ray tube (crt) screen from the computer at an approximate rate of 50,000 symbols per second and from the Display Station keyboard at operator typing speeds. Standard display format is 20 lines of 50 symbols per line within a nominal 8-inch-wide by 6-inch-high raster area. An optional display format is available with 13 lines of 80 symbols per line.

Symbol intensity is adjustable and the P4 phosphor-coated crt makes displays clearly legible in normal office lighting. Data presented on the display screen is refreshed at a flicker-free rate of 50 cycles per second. Symbol dimensions are nominally 1/8-inch wide by 1/4-inch high.

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* Trademark of AT&T

An entry marker, displayed as an underline, conveniently indicates to the operator where the next symbol will appear. The entry marker can be positioned anywhere within the 8 by 6 inch viewing area and moves automatically across the page as each symbol is typed, or inserted by the computer. At the end of a line, the entry marker automatically moves to the first symbol position in the next line down. When it reaches the end of the last line on the page, it automatically moves to the first symbol position in the upper left corner of the screen.

Positioning the entry marker at the end of the print message and depressing the keyboard PRINT key transmits displayed messages to an associated Printer Station. Data from the top of the screen to the entry marker position is transmitted to the Printer Station and typed out at the rate of 15.5 symbols per second on continuous strip paper 9-7/8 inches wide and perforated for folding and tearing at 11-inch intervals.

FUNCTIONAL DESCRIPTION.

The remainder of Section I describes in more detail primary Display Controller, Display Station, and Printer Station functions.

The Display Controller consists of an interface, central control and symbol generator assembly, station driver assemblies, printer driver assemblies, and may contain up to two poller assemblies. On diagrams and some figures the central control and symbol generator assembly is referred to as CBU, station drivers as SDU's and printer drivers as PCU's.

The interface enables Display Controller communications with a 3000 Series computer. Two cables (up to 200 feet long), identified as "A" and "B", provide the data link between the computer and Display Controller. Twisted-pair signal lines, contained in cables A and B, are described under interface signals in Section III.

Symbol generation, timing, and data flow gating logic are contained in the central control and symbol generator assembly. Video pulse trains, representing symbols, are developed in the symbol generator. These pulse trains are made available to each station driver. The station driver selects the proper pulse train and transmits it to the crt where it is displayed by unblanking the beam in a 5 by 7 dot matrix. Symbol dimensions are, nominally, 1/8-inch wide by 1/4-inch high. Each station driver contains logic circuitry controlling the operation of a Display Station. It receives data from the Display Station keyboard and the central control symbol generator assembly. All data sent to the station driver is stored in an associated

10-millisecond magnetostrictive delay-line memory. All stored data is assembled and decoded in each station driver, fed to the Display Station, and displayed on the crt. The display remains visible as long as stored data is continually refreshed on the crt. Figure 1-2 is a functional diagram of the Display Station.

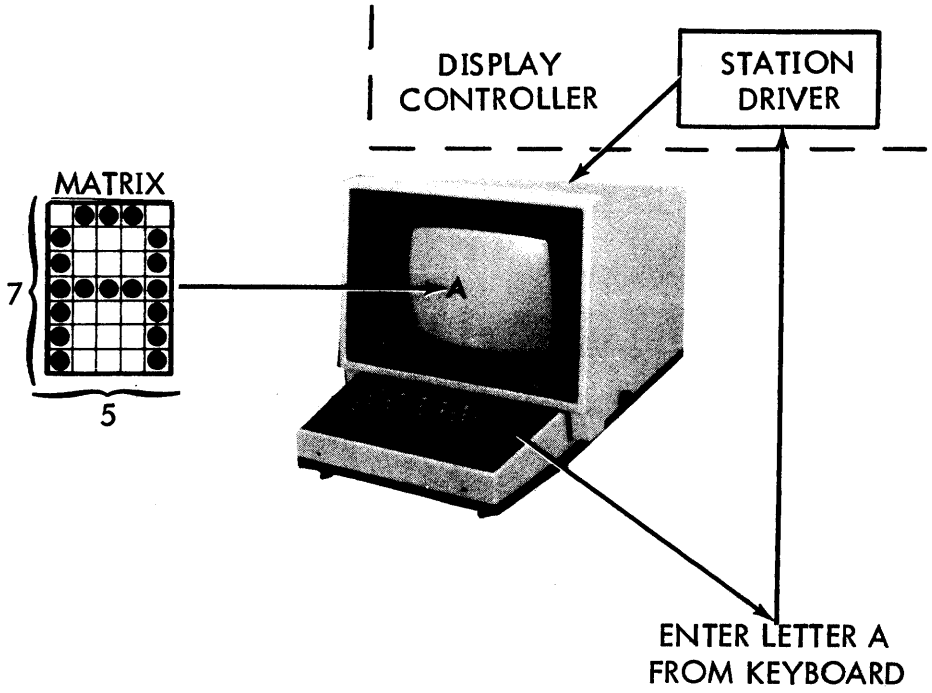

Figure 1-2. Display Station Functional Diagram

One symbol requires 16.8 microseconds to display while one line is displayed in 991.2 microseconds. Twenty lines of 50 symbols, therefore, require 19.824 milliseconds allowing 9 symbol times for horizontal retrace. Thirteen lines of 80 symbols require 19.437 milliseconds.

A printer driver contains the Printer Station control logic. Data from the station driver assembly register is translated and sent to the printer driver. Printer control and priority control logic are in the printer driver. One Printer Station can serve as an output device for up to 10 Display Stations if one poller is used or it can be used for an output device for up to 9 Display Stations if two pollers are used.

Each Printer Station contains a Selectric * typewriter; depressing the PRINT key at a Display Station activates the typewriter. If the PRINT keys at several Display Stations associated with a Printer Station are depressed while the Printer Station is busy printing, the requests are processed in order of lowest Display Station number. 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 9-7/8-inch-wide continuous strip paper. The paper is perforated for folding and tearing at 11-inch intervals. Feed holes are 9-3/8 inches apart and spaced 1/2 inch in the longitudinal direction.

Printout is accomplished at the following speeds: print one symbol, 64.5 milliseconds; carriage return, 129.0 milliseconds; shift, 64.5 milliseconds; and space, 64.5 milliseconds.

The Display Controller may contain a maximum of two pollers. Data is sent to or from the remote stations via the poller in 8-bit serial codes. The Data Set synchronizes all received or transmitted data. A poller controls the remote site's requests to transfer data by periodically polling (scanning) them in sequential order.

ENVIRONMENTAL CONDITIONS.

The Display Controller operates at normal room temperature but has a blower assembly housing located beneath the logic chassis assemblies for specific cooling of the logic chassis. The Display Stations and Printer Stations also operate at normal room temperature but are cooled by radiation and convection. Tables 1-1 through 1-3 list specific environmental limitations for all three units.

PHYSICAL DATA.

The display equipment configuration may consist of no more than 12 Display Stations, Printer Stations, and pollers. No more than two pollers may be employed, so the maximum display equipment configuration that would be possible locally would be a combination of ten Display Stations and/or Printer Stations with two pollers. The pollers are capable of communicating with up to 16 remote Display Controllers. Refer to figure 1-3.

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* IBM Trademark.
** IBM Classification.

TABLE 1-1. DISPLAY CONTROLLER ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)
Temperature	+65 F to +85 F	-30 F to +150 F
Relative Humidity	10 to 90%	0 to 100% (Note 2)
Altitude	-1000 to +10,000 feet	-1000 to +15,000 feet

Note 1 — packed for shipment.

Note 2 — includes condensation in the form of moisture or frost.

TABLE 1-2. DISPLAY STATION ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)
Temperature	+65 F to +100 F	-65 F to +160 F
Relative Humidity	40 to 60%	10 to 90% (Note 2)
Altitude	8,000 feet	12,000 feet

Note 1 — packed for shipment.

Note 2 — includes condensation in the form of moisture or frost.

TABLE 1-3. PRINTER STATION ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)
Temperature	+60 F to +100 F	-30 F to +150 F
Relative Humidity	10 to 90%	5 to 100% (Note 2)
Altitude	-1000 to +10,000 feet	-1000 to +15,000 feet

Note 1 — packed for shipment.

Note 2 — includes condensation in the form of moisture or frost.

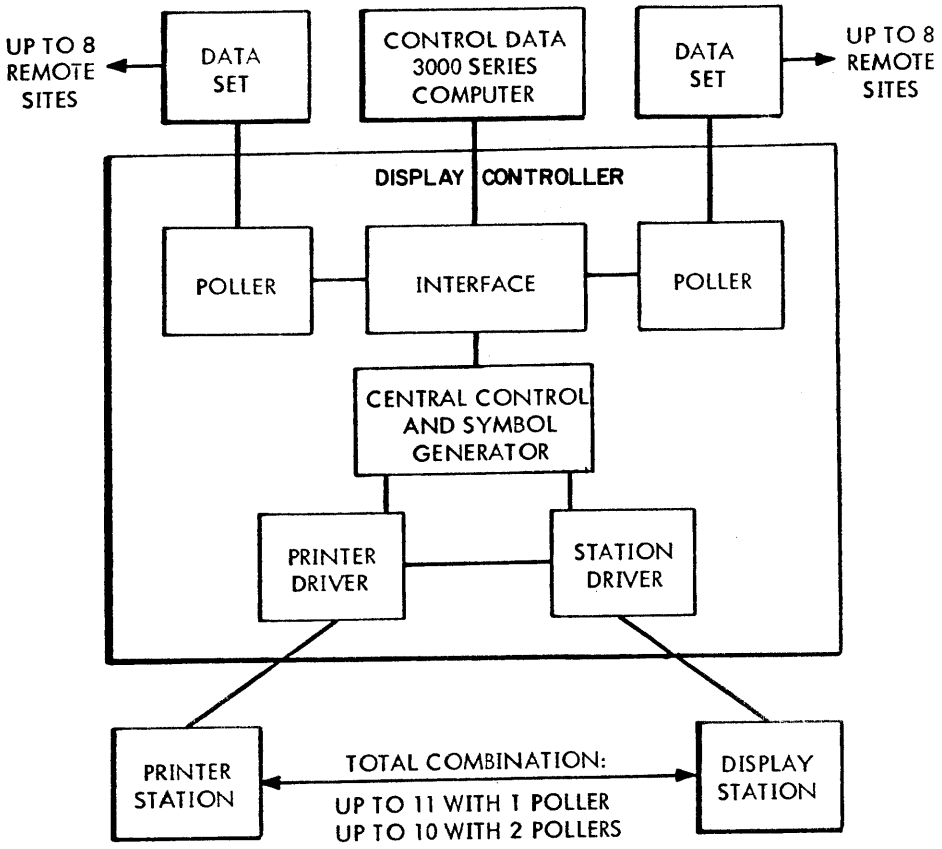


Figure 1-3. Display Equipment Block Diagram

Physical construction of the display equipment incorporates latest recognized factors in engineering, convenience, and safety to operating personnel. Figures 1-4 through 1-6 show the dimensions and approximate weight of the Display Controller, Display Station, and Printer Station respectively.

DISPLAY CONTROLLER ELECTRICAL DATA.

The Display Controller requires 57 to 63 Hz, 187 to 216 volts, 3-phase alternating current of 8 amperes. Each station driver or printer driver requires 0.4 ampere in addition to that required for the Display Controller.

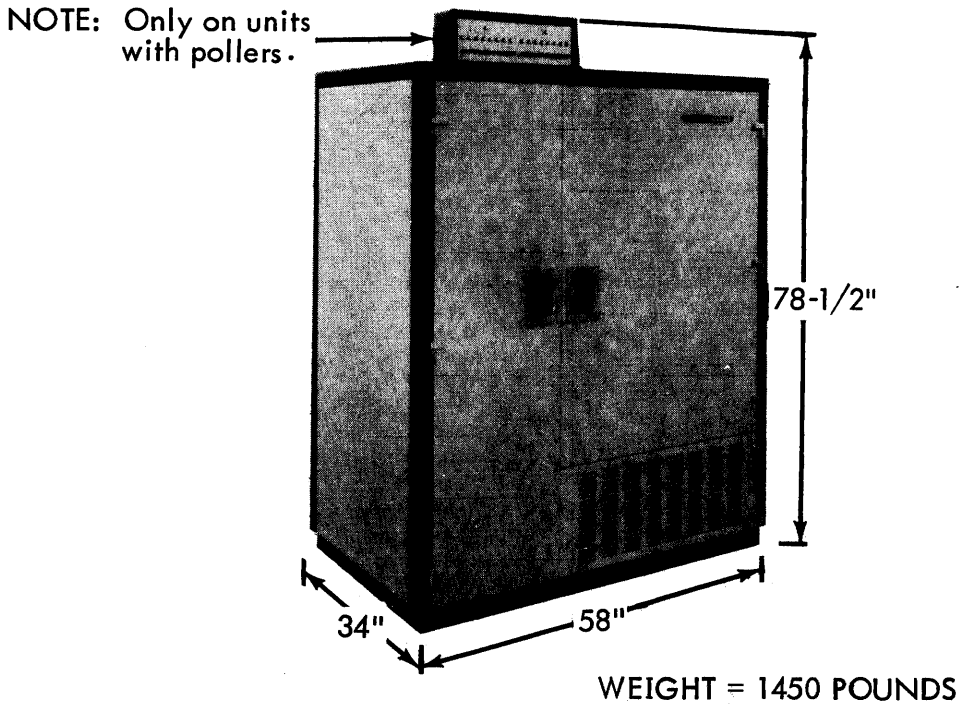


Figure 1-4. Display Controller Physical Data

DISPLAY STATION ELECTRICAL DATA.

The Display Station requires 115/230-volt, 50/60-Hz, 3-wire, single-phase power. Power expended is 130 watts with heat dissipation of 465 Btu per hour. Voltage potentials in the Display Station range from - 16 volts dc to 10 kilovolts.

PRINTER STATION ELECTRICAL DATA.

The Printer Station requires 120-volt, single-phase, 60-Hz power. It has a maximum current rating of 1.0 ampere, dissipates 400 Btu per hour, and is cooled by radiation and convection.

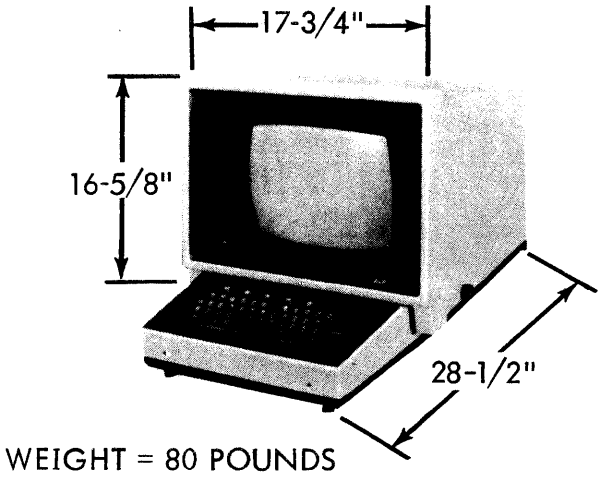


Figure 1-5. Display Station Physical Data

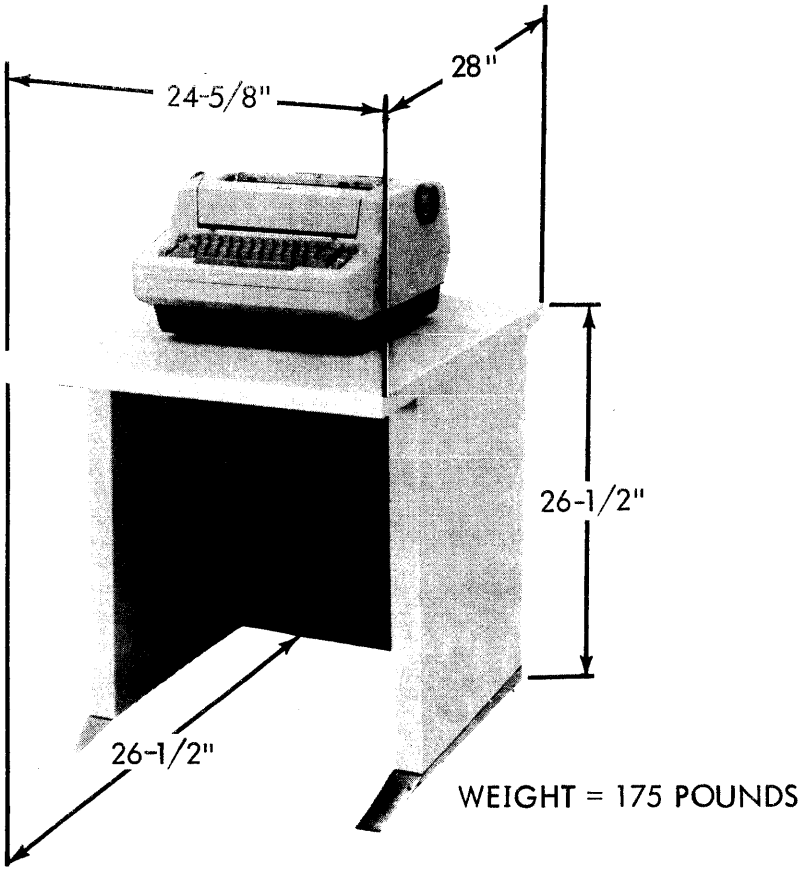


Figure 1-6. Printer Station Physical Data

CONVENIENCE OUTLETS.

To facilitate the use of test equipment during periods of maintenance, Control Data requires that a convenience outlet be available within 15 feet of each system component cabinet. The outlets may be located in the walls or raised floor panels and must not be obstructed by storage racks or other furniture. The receptacles shall be of the single-phase grounded type, installed according to local electrical codes. For 60-hertz installations, the nominal voltage shall be 120 volts. For 50-hertz installations, the nominal voltage shall be 220, 230, or 240 volts, as dictated by the single-phase power available at the site.

SECTION II

OPERATION

This section contains a list of controls for operation and maintenance of the display equipment and also contains information on data inquiry, and turn on/turn off procedures.

CONTROLS.

Display Equipment controls are divided into three groups: Display Controller, Display Station, and Printer Station. Following paragraphs explain control usage within each group.

The Display Controller maintenance panel controls apply power and enable checking the display equipment operational sequence. Display Station controls apply power and adjust crt intensity. The Display Station keyboard enters data into the display equipment and controls its destination. Printer Station controls apply power to the hardcopy printer.

DISPLAY CONTROLLER.

Figure 2-1 shows the Display Controller maintenance panel. Table 2-1 explains the callouts.

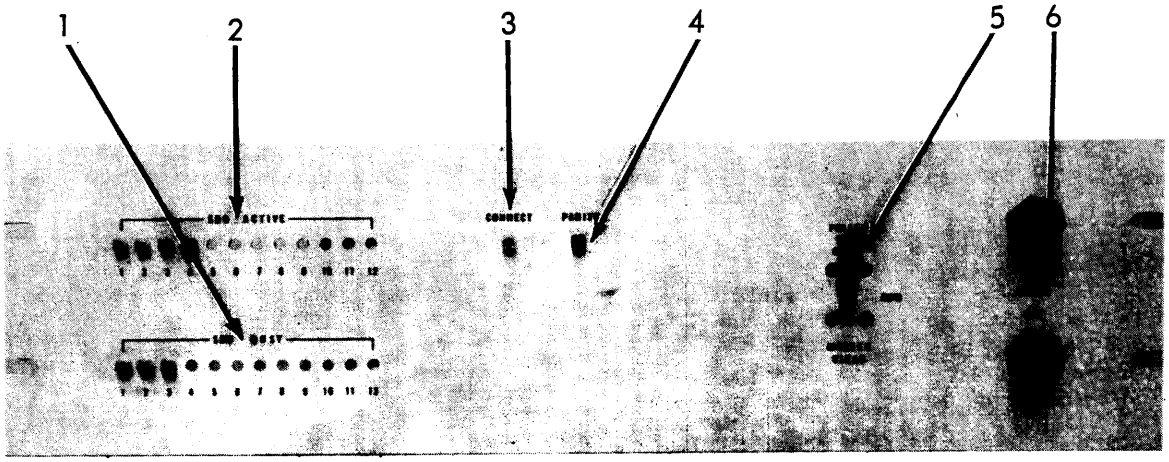


Figure 2-1. Display Controller Maintenance Panel

TABLE 2-1. MAINTENANCE PANEL CONTROLS AND INDICATORS

CALLOUT	CONTROL NAME	CONTROL TYPE	FUNCTION
1	SDU BUSY 1 through 12	Indicators white	Indicates the print busy status of each Display Station.
2	SDU ACTIVE 1 through 12	Indicators white	Indicates the input/output status of each Display Station.
3	CONNECT	Indicator white	Indicates the Display Controller is connected to the computer by a computer connect code.
4	PARITY	Indicator red	Indicates the Display Controller has detected a transmission parity error.
5	POLLER TEST/ RUN/MASTER CLEAR	Lever switch 3-position	POLLER TEST — allows communications between remote site and poller. RUN — enables normal Display Controller operation. MASTER CLEAR — clears Display Controller logic and all data from the delay-line memory within each station driver.
6	POWER ON/OFF	Two push-buttons	Turns Display Controller cabinet power on and off.

The auxiliary maintenance panel (figure 2-2) contains a toggle switch and a light for each of the sixteen possible remote sites (8 for each poller). The corresponding site address for each switch is labeled directly below the switch. If a switch is in the down position, the corresponding remote site receives a poll message from the poller. If it is in the up position, its site address is not polled in the poller sequence.

The indicator for each site, located directly above the switch, illuminates when a poll message is initiated to its corresponding remote site. The indicator extinguishes when the poller receives an errorless message from that site. If a particular indicator remains illuminated indefinitely, there is a communications

problem between that site and the poller. The switch corresponding to this indicator should then be placed in the up position. This will extinguish the light and remove the site from the system.

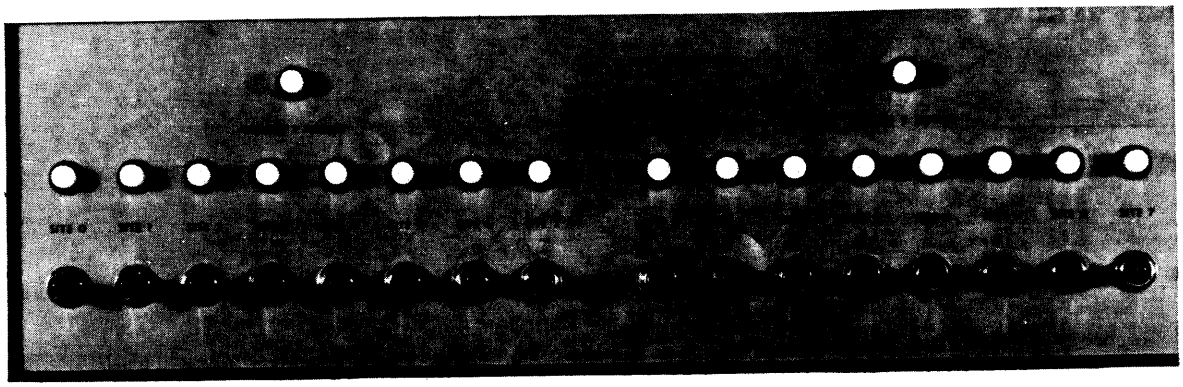


Figure 2-2. Auxiliary Maintenance Panel

Circuit breaker CB1 on the a-c control panel (figure 2-3) applies primary 208-volt, 3-phase power to the Display Controller. Also on this panel are two 120-volt ac convenience outlets and a meter, M1, which indicates the total number of hours power has been applied to the Display Controller. The six fuses located on the panel provide circuit protection for the power supplies, blower assembly, and convenience outlets.

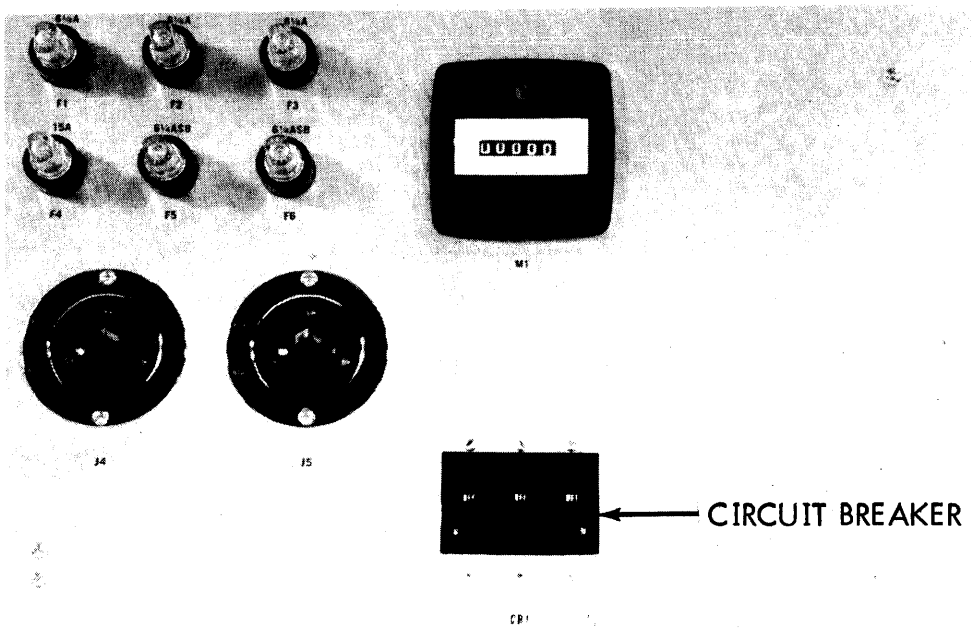


Figure 2-3. A-C Control Panel

The interface panel contains the EQUIPMENT SELECTOR rotary switch (figure 2-4) for selecting a specific external equipment address 0 through 7 for the Display Controller. The switch setting also determines which interrupt line to the computer is used. Four receptacles are provided for connecting the Display Controller to the computer; only two are used at one time. The other two should be terminated if not in use.

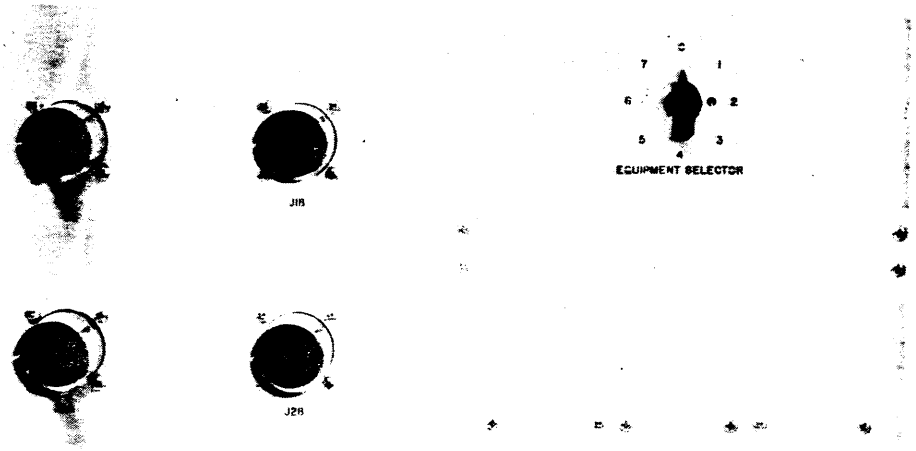


Figure 2-4. Display Controller Interface Panel

Figure 2-5 shows the Data Set interface panel. This panel provides the power and data outlets for two pollers. J1 and J2 are the data cable receptables while J3 and J4 provide 120-volt ac, 60 Hz power to the Data Set.

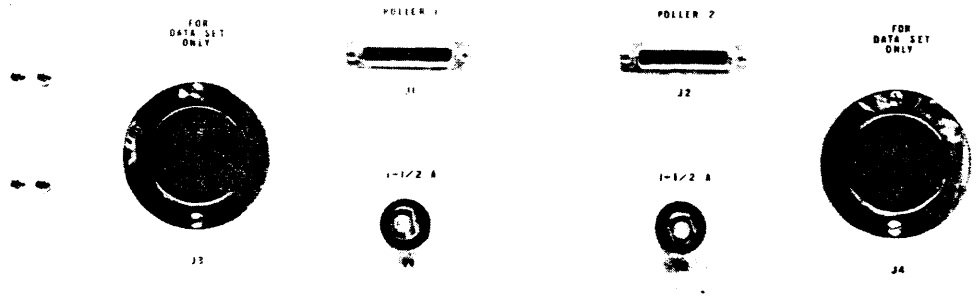


Figure 2-5. Data Set Interface Panel

DISPLAY STATION.

Rotating the ON/OFF/INTENSITY control, located on the right side of the Display Station, toward the rear of the cabinet turns the Display Station on; further rotation increases the intensity of the displayed symbols. The ON/OFF/INTENSITY control being off does not prevent communication on the interface between the computer and the delay-line memory and does not disable keys on the keyboard, except the SHIFT key. Figure 2-6 shows the Display Station and figure 2-7 shows the Display Station keyboard.

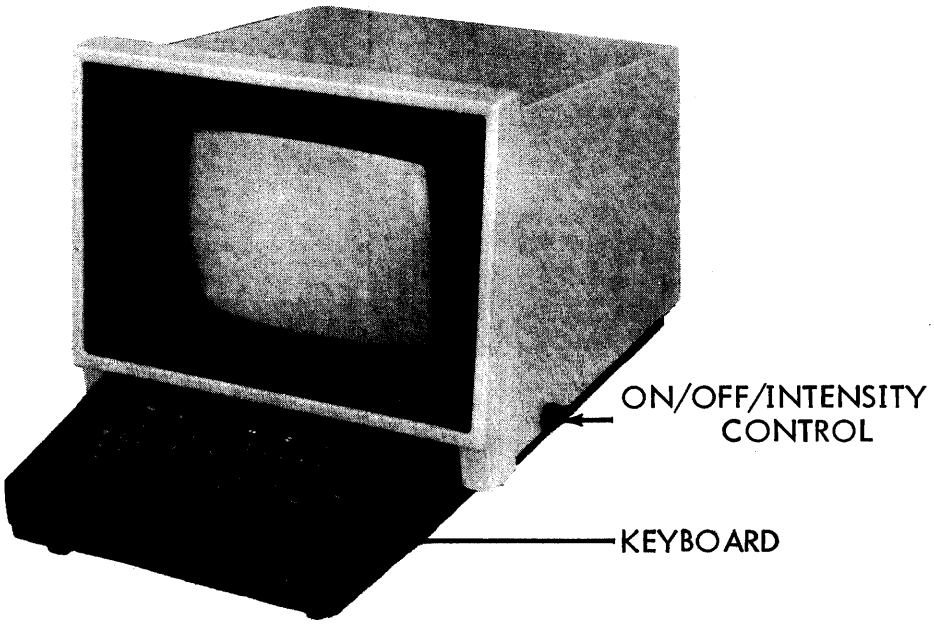


Figure 2-6. Display Station

Four rows of keys on the Display Station keyboard enter symbols into the delay line for display on the crt. Depression of a key enters the code for the symbol indicated on the key into memory at the position of the entry marker, generates the symbol on the crt, and advances the entry marker. The keyboard is inoperative during the following intervals:

(a) SEND key is depressed until the end of a read message from or a write message to that station.

(b) PRINT key depressed until printout is complete. The CLEAR key is not locked out during printout.

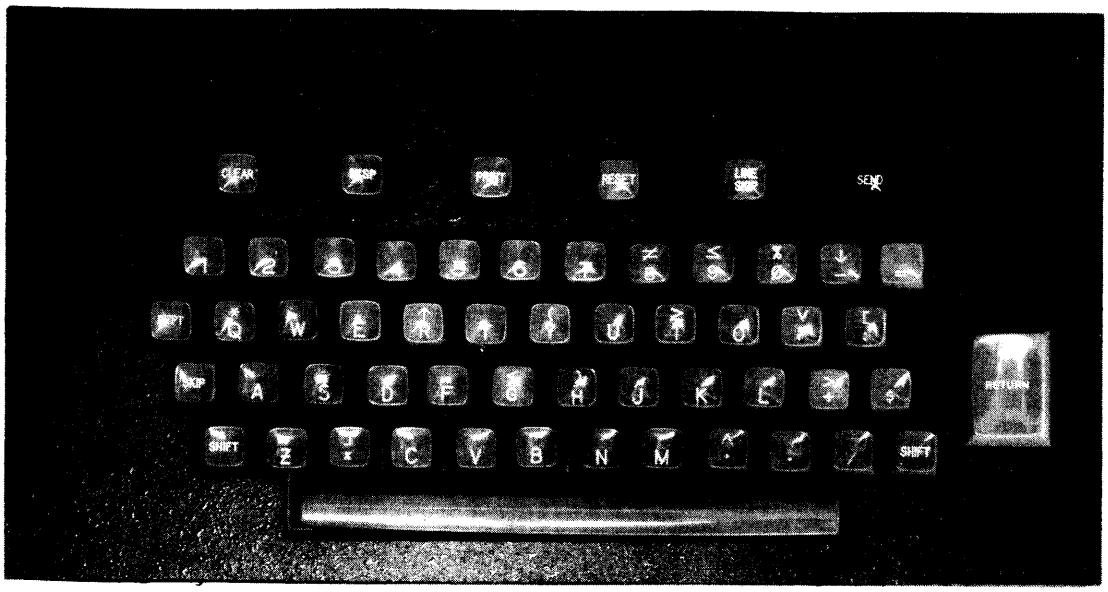


Figure 2-7. Display Station Keyboard

(c) The station is connected and the Channel Busy signal is a logical 1.

(d) Reset function or reset clear function is being performed by the Display Station.

The following list explains the operation of the control keys.

Clear.

Depress the CLEAR key to clear all data from the delay line and from the crt. The entry marker moves to the upper left corner of the screen. This operation prevents sending or receiving data from the time the key is depressed until 16.8 microseconds to 20 milliseconds after the key is released. (The time variation is due to latency characteristics of the delay line).

Reset.

Depress the RESET key to move the entry marker to the upper left corner without affecting data. This operation prevents sending or receiving data from the time the key is depressed until 16.8 microseconds to 20 milliseconds after the key is released.

Shift.

Continued depression of either SHIFT key enables entry of the upper symbol on the two-symbol keys. Operation of the single-symbol keys is not affected by the SHIFT keys; all alphabetic symbols are displayed in uppercase form. The SHIFT keys are nonlocking.

Space.

Operating the SPACE key stores a space code in the delay line at the position of the entry marker and advances the entry marker. Data is not affected.

Skip.

Depress the SKIP key to move the entry marker one space forward. Data is unchanged.

Repeat.

Operating the REPT key in conjunction with another key enables a repeated action of that key's character/function. CLEAR, PRINT, RESET, SEND, and SHIFT keys are not affected by the REPT key.

Backspace.

The BKSP key moves the entry marker one space back without changing data. Backspace is accomplished in 10 milliseconds minimum to 90 milliseconds maximum, during which time no data can be transferred on the data channel.

Line Skip.

Depress the LINE SKIP key to advance the entry marker to the beginning of the next line. Line skip is accomplished in 151.2 microseconds minimum to 1 millisecond maximum, during which time no data is transferred between a connected Display Station and the computer.

Return.

Operation of the RETURN key inserts a carriage return code at the entry marker position and moves the entry marker to the first symbol position on the next line. The carriage return is displayed as a superscript dash ($\bar{}$). The return takes from 151.2 microseconds (if the entry marker is at the end of a line) to 1 millisecond (if the entry marker is at the beginning of a line), during which time no data can be transferred between the Display Station and the computer.

Send.

The SEND key stores an end of message symbol (elevated Δ) at the entry marker position and moves the entry marker to the upper left corner. Data transfer is prevented during the time (16.8 microseconds minimum to 20 milliseconds maximum) the entry marker is moving.

Print.

Operation of the PRINT key stores an end of print code (') at the entry marker position, moves the entry marker to the upper left corner, and initiates printout of data from the upper left corner to the end of print code on an associated Printer Station. The keyboard, except for the CLEAR key, is disabled during printout. During printout, the Display Station is not ready to the computer.

PRINTER STATION.

Figure 2-8 shows the Printer Station typewriter controls. Note the location of the ON/OFF switch to the right of the keyboard. A multipaper adjustment (top left) 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.

Refer to the IBM Selectric Manual supplied with the equipment for more detailed information about the typewriter.

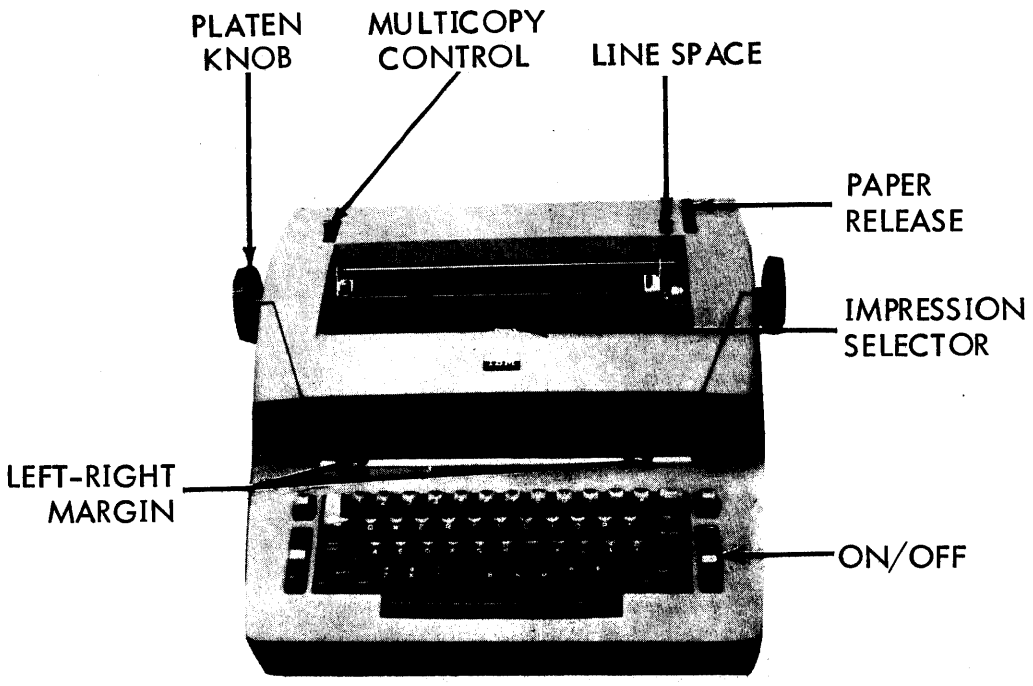


Figure 2-8. Printer Station Typewriter Controls

OPERATING PROCEDURES.

The remainder of this section describes normal operating procedures for the display equipment. Included are turn on/turn off procedures followed by a typical operation sequence.

TURN ON/TURN OFF.

Turn on/turn off procedures are listed in table 2-2. For precautionary measures, it is recommended the steps be followed in the order listed.

TABLE 2-2. TURN ON/TURN OFF PROCEDURES

STEP	LOCATION	OPERATION
		TURN ON
1	Display Controller	Place the POWER ON/OFF switch in the ON position. Move RUN/MASTER CLEAR switch to MASTER CLEAR position, then to RUN position.
2	Display Stations	Rotate the ON/OFF/INTENSITY control to the ON position. Depress the CLEAR key. After a 30-second warmup period, rotate ON/OFF/ INTENSITY control until the entry marker is visible.
3	Printer Stations	Depress the ON/OFF rocker switch to the ON position.
		TURN OFF
1	Printer Stations	Depress the ON/OFF rocker switch to the OFF position.
2	Display Stations	Rotate the ON/OFF/INTENSITY control to the OFF position.
3	Display Controller	Place the POWER ON/OFF switch in the OFF position.

TYPICAL OPERATION SEQUENCE.

Figure 2-9 is a flow diagram depicting a typical operation sequence. Depress the CLEAR key on the Display Station keyboard to clear the display screen. The operator then enters data via data entry keys. When data is properly composed, it may be sent to the computer by actuation of the SEND key, or to a Printer Station, which shares memory with the Display Station, by depressing the PRINT key.

The computer may respond to properly transmitted data by sending the requested data or a message acknowledging receipt of the transmitted data. The operator may then print the reply data, or edit it (eg, filling in information on a blank form, or updating stored data), and transmit the edited data back to the computer.

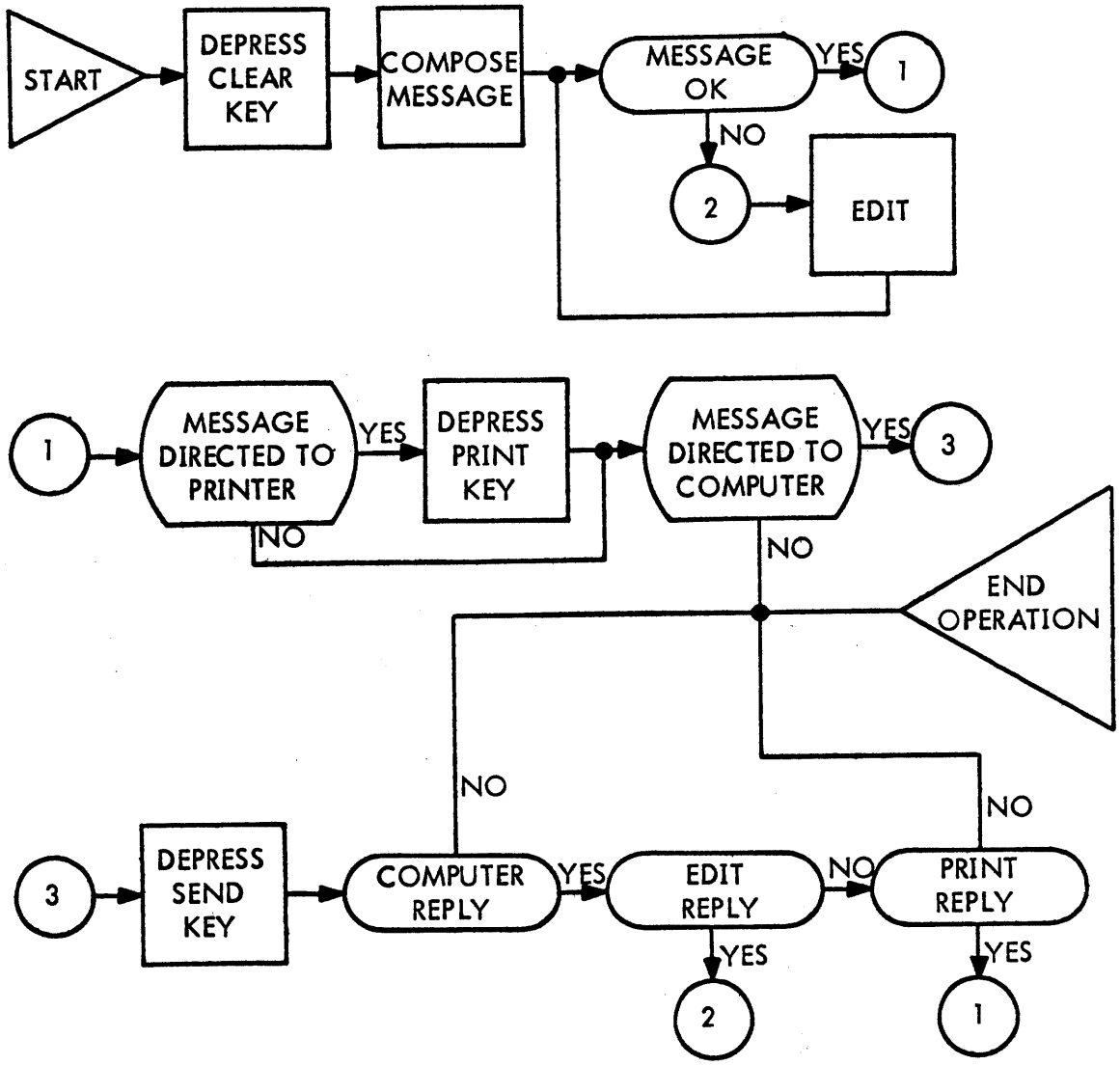


Figure 2-9. Typical Operation Sequence Flow Diagram

SECTION III

PROGRAMMING

This section describes programming aspects of the display equipment. It provides a complete description of signals, function and status codes, interrupts, symbol data, word formats, various read/write operations, and programming aids for both interface and poller assemblies.

INTERFACE SIGNAL LINES.

The Display Controller operates from the standard (12 bit) 3000 Series standard communications channels. Figure 3-1 shows the interconnecting data and control lines between the computer communications channel and the Display Controller. Following is a description of each line or group of lines.

DATA LINES (12).

There are 12 bidirectional data lines. During a read operation (input to the computer), these data lines carry data, 12 bits at a time, from the Display Controller to the computer. During a write operation (output from the computer), the data lines carry data from the computer to the Display Controller. The data lines also are used to transmit the 12-bit connect and function codes associated with Connect and Function signals, respectively.

PARITY LINE.

A parity bit accompanies each 12 bits of data, connect code, and function code transmitted between the computer and the Display Controller. Odd parity is used, ie, the total number of 1's transmitted is always an odd number.

CONNECT LINE.

A Connect signal is sent to the Display Controller when a 12-bit connect code is available on the data lines. The Display Controller connects only if the following conditions are met:

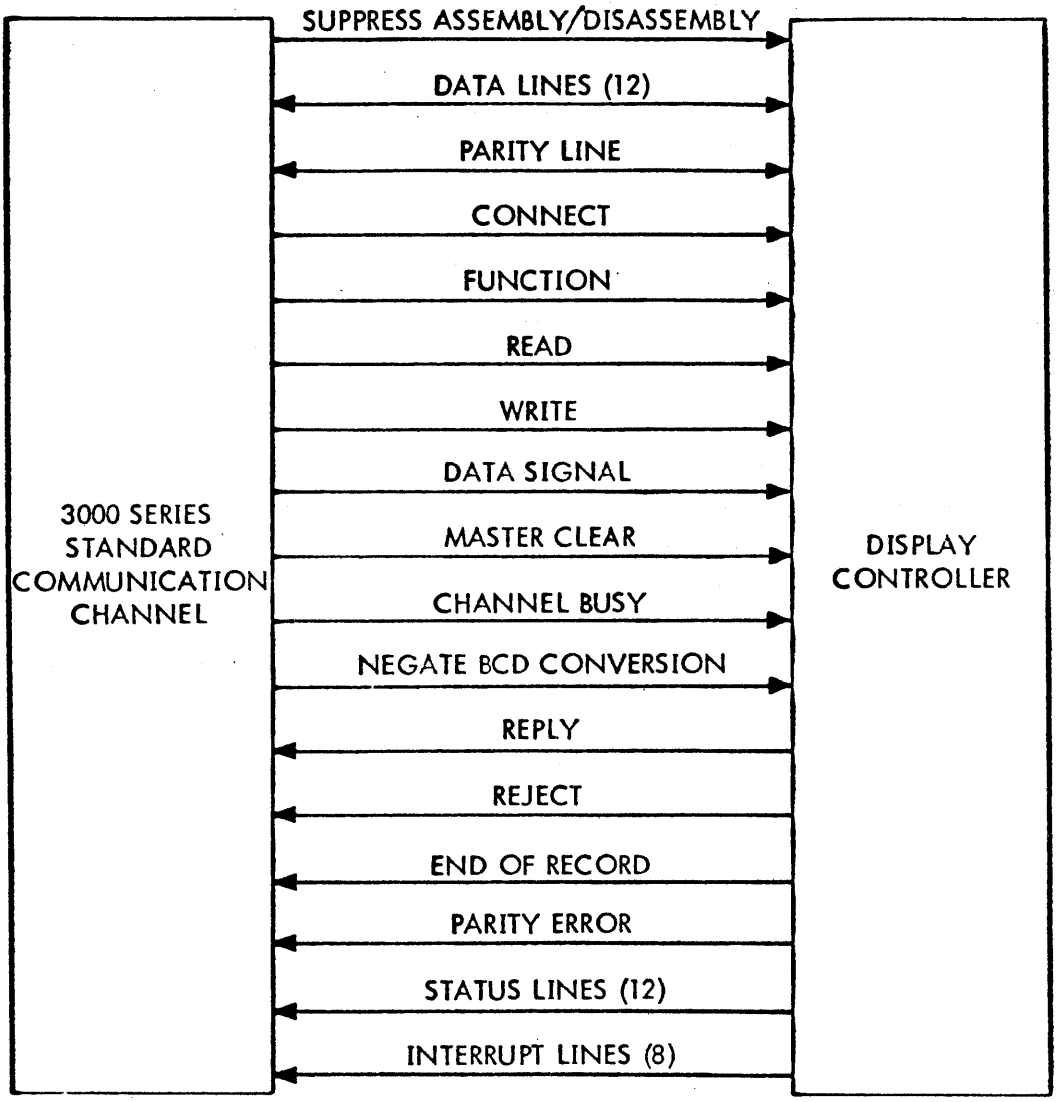


Figure 3-1. Computer/Display Controller Interface Lines

(a) The most significant 3 bits of the connect code must match the number setting of the EQUIPMENT SELECTOR switch.

(b) Display Controller power is on.

(c) The RUN/MASTER CLEAR switch is in the RUN position.

(d) Parity is correct.

No response is returned when a parity error exists on the connect code; however, the red PARITY error indicator on the Display Controller maintenance panel (figure 2-1) lights on all Display Controllers and external equipment controllers associated with that communications channel. After a delay of 100 microseconds, the communications channel generates its own internal Reject signal.

Once a Display Controller is connected to the computer, it remains connected until the communications channel initiates a disconnect. To perform a disconnect, send any connect code with the upper 3 bits not matching the Display Controller EQUIPMENT SELECTOR switch setting, a Master Clear signal, or a release function code.

FUNCTION LINE.

A Function signal is sent to the Display Controller when a 12-bit function code is available on the data lines (function codes are listed under interface control codes). If the Display Controller is connected to the computer and is capable of executing the specified function at the time it receives the Function signal, it initiates the function and returns a Reply signal. If the Display Controller cannot perform the function, it returns a Reject signal. The Function signal and 12-bit function code drop when a Reply or Reject signal is returned. If a Reply or Reject signal is not returned within 100 microseconds, the computer generates its own internal reject.

The specified function is not performed if a parity error exists on the function code; however, a Parity Error signal is returned by the Display Controller and the red PARITY error indicator on the Display Controller maintenance panel (figure 2-1) lights.

Once a function code is accepted by the Display Controller, all other function codes are locked out until the first one is acted upon. The Display Controller does not hold or stack up the function codes; a Reply or Reject signal is returned within 5 microseconds. If a second function code is received which specifies the same function as the previous function code, the second function code is rejected unless the function can be performed immediately a second time.

READ LINE.

A Read signal transmitted to the Display Controller directs the Display Controller to begin reading data from a specified Display Station memory.

WRITE LINE.

A Write signal transmitted to the Display Controller directs the Display Controller to begin writing data into a specified Display Station memory.

DATA SIGNAL LINE.

A Data signal is sent from the computer to the Display Controller for each 12-bit data word during read and write operations. The Data signal drops when a Reply (or End of Record) signal is transmitted by the Display Controller.

During a read operation, the Data signal indicates that the computer is ready to accept a 12-bit data word from the Display Controller. During a write operation, the Data signal indicates that the computer placed a 12-bit data word on the data lines.

MASTER CLEAR LINE.

A Master Clear signal sent from the computer returns the Display Controller to its initial clear condition and starts the polling operation.

CHANNEL BUSY LINE.

A Channel Busy signal is sent to the Display Controller when the computer communications channel is active during a read or write operation.

NEGATE BCD CONVERSION LINE.

When the Negate BCD Conversion signal is a logical 1, external BCD codes are used; when the Negate BCD Conversion signal is a logical 0, internal BCD codes are used. Refer to Symbol Data in this section.

REPLY LINE.

The Display Controller transmits a Reply signal in response to the following:

(a) A connect code having no parity error and containing a matching Display Controller EQUIPMENT SELECTOR switch equipment select code and proper select code.

(b) A function code received with no parity error if the Display Controller is capable of executing the specified function at the time it receives the Function signal.

(c) During a write operation after the Display Controller has read a data word.

(d) During a read operation when the Display Controller has a word on the data lines (see End of Record signal for exception).

The Reply signal drops when the Connect, Function, or Data signal drops.

REJECT LINE.

The Display Controller transmits a Reject signal in response to the following:

(a) A connect code (with no parity error) specifying a nonexistent or busy station.

(b) A function code (with no parity error) specifying an illegal function.

(c) A function code (with no parity error) which cannot be performed within 5 microseconds after receipt of the Function signal (refer to programming aids for such conditions).

(d) An alert function to a poller that had its alert request status cleared, or an alert function to any station other than a poller.

SUPPRESS ASSEMBLY/DISASSEMBLY LINE.

During a read operation, the Suppress Assembly/Disassembly signal forces the Display Controller to assemble logical 0's in bits 6 through 11 of each 12-bit data byte. In a write operation, bits 6 through 11 are not used when the Suppress Assembly/Disassembly line is enabled. The signal has no effect on the address word during a read operation initiated by an interrupt.

END OF RECORD LINE.

The Display Controller transmits an End of Record signal (instead of a Reply signal) in response to the next Data signal following transmission of EOM signal. The End of Record signal drops when the Data signal drops. If the Read signal drops before the read operation completes, the End of Record signal is not transmitted because the remaining data is not transmitted.

PARITY ERROR LINE.

The Display Controller transmits a Parity Error signal when a parity error occurs on a function code or write operation. No Parity Error signal is generated for a parity error occurring on a connect code or read operation. During a write operation, a parity error on one word of a 12-bit byte results in display of both words as parity error symbols when the Suppress signal equals 0.

STATUS LINES (12).

The Display Controller places information on the 12 available status lines following a connect operation to indicate its operating conditions to the computer. Display equipment status remains enabled to the computer until a disconnect is sent from the computer. The computer may sample the status lines at any time. Status bits are listed under interface control codes.

INTERRUPT LINES (8).

Each Display Controller and external equipment controller attached to a given computer communications channel is assigned to one of eight separate interrupt lines selected by the EQUIPMENT SELECTOR switch. The interrupt line indicates to the computer that a predetermined condition has been reached. The interrupting condition can be determined by program sampling the status lines following transmission of an Interrupt signal if connected.

INTERFACE CONTROL CODES.

Interface control codes include connect, function, and status codes. The connect code is used in addressing the display equipment. Function codes, with

the exception of reset, alert, and release, set up and remove interrupt conditions in the Display Controller. Status codes indicate what conditions exist at the Display Controller. Following is a description of the connect code, display equipment function codes, and status line assignments.

CONNECT CODE.

The connect code is 12 bits long and is transmitted to the Display Controller on the 12 data lines along with a Connect signal on the connect line. The Display Controller interprets the connect code (figure 3-2) as follows:

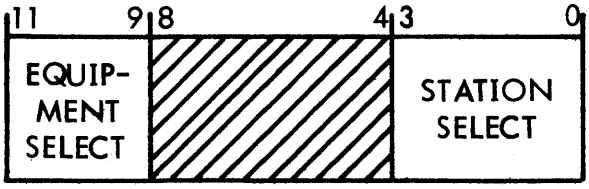


Figure 3-2. Connect Code

Bits 9 through 11 designate the number setting of the Display Controller EQUIPMENT SELECTOR switch. The station select portion of the connect code allows selection of a Display Station or poller or selection of a Display Station or poller that caused an interrupt. Bits 4 through 8 are not interpreted.

FUNCTION CODES.

Function codes are 12 bits long and are transmitted to the Display Controller on the data lines along with a Function signal on the function line. Table 3-1 lists and describes Display Controller function codes.

STATUS CODES.

Twelve status lines are available for indicating display equipment operating conditions to the computer. The computer may sample these lines at any time.

TABLE 3-1. DISPLAY CONTROLLER FUNCTION CODES

OCTAL CODE	FUNCTION	DESCRIPTION
0000	Release	Disconnects the Display Controller from the computer and clears all interrupt selections and parity error indications. Also master clears a poller if the poller is connected.
0010	Reset Entry Marker	Positions the entry marker on selected Display Station or poller to upper left corner to prepare for a read or write. The Display Station or poller indicates busy status for 3.2 microseconds to 20 milliseconds after receipt of the function. Generally precedes a write or computer-initiated read.
0011	Reset-Clear	Similar to a reset entry marker function except data is cleared from the delay line. When addressed to a poller, the function does not clear the delay line but clears existing send requests. The Display Station or poller indicates busy status for 20 to 40 milliseconds upon receipt. Generally precedes a write to local station.
0020	Select Interrupt for Ready and Not Busy (Note 1)	Allows generation of an interrupt when printer operation completes. Reselection removes an interrupt resulting from a previous selection.
0021	Clear Interrupt Enable for Ready and Not Busy (Note 1)	Removes interrupt and selection resulting from code 0020.
0022	Select Interrupt on End of Operation (Note 1)	Allows generation of an interrupt when the read or write operations or a reset or a reset clear operation completes. Reselection removes interrupt resulting from a previous operation.

TABLE 3-1. DISPLAY CONTROLLER FUNCTION CODES (CONT)

OCTAL CODE	FUNCTION	DESCRIPTION
0023	Clear Interrupt on End of Operation (Note 1)	Removes interrupt and selection resulting from code 0022.
0024	Select Alert Interrupt	Allows generation of an interrupt upon completion of an alert message by a poller. Reselection removes an interrupt resulting from a previous operation.
0025	Clear Alert Interrupt	Clears interrupt and selection due to code 0024.
0026	Select Station Interrupt (Note 1)	Allows generation of an interrupt if a SEND key on a Display Station is depressed, if a poller receives a read message in response to a poll message or if an error is indicated. Reselection removes an interrupt resulting from a previous selection if a read or write operation is performed on the interrupting station prior to reselection. Stacking of station interrupts is possible and, if more than one station has had its SEND key depressed, another interrupt occurs immediately after reselection.
0027	Clear Station Interrupt (Note 1)	Removes interrupt and selection resulting from code 0026.
(Note 2)	Alert Poller	Instructs connected poller to send an alert message to the addressed remote site and station. Alert occurs in the polling sequence. If the alert is sent to a local station, it is rejected.

Note 1 — affect all stations simultaneously.

Note 2 — 1XXXXXXX0011 binary.

Table 3-2 identifies status conditions, lines, and octal codes characteristic of the Display Controller. The computer may sample any single status line or group of lines.

All conditions listed in table 3-2 except send request and print request, are general status conditions; ie, the computer connects only to the Display Controller and any existing station before sampling status. Lines 0, 2, 3, 4, 5, and 10 are on a per station basis, ie, a specific station must be referred to before sampling status. Lines not listed in table 3-2 are not used.

TABLE 3-2. DISPLAY CONTROLLER STATUS CONDITIONS

LINE	OCTAL CODE	CONDITION	DESCRIPTION
0	XXX1	Ready	The Display Controller is ready when power is on and the RUN/MASTER CLEAR switch is in the RUN position. A particular station may become not ready if an operator depresses the PRINT key and the printer begins printout.
1	XXX2	Busy	The Display Controller is busy when the Channel Busy and the Read signal or Write signal is active, or when the reset or reset-clear function is executed. The Display Station keys are inoperative during a read or write operation.
2	XXX4	Send Request	Indicates on a per station basis that an operator depressed the SEND key or that a connected poller has a read message or a message in error.
3	XX1X	Print Request	Indicates on a per station basis that a print operation is requested by the station or it is performing a print operation.
4	XX2X	Poll Message Error	Indicates that the connected poller was unable to receive an expected response to a poll message in three attempts.

TABLE 3-2. DISPLAY CONTROLLER STATUS CONDITIONS (CONT)

LINE	OCTAL CODE	CONDITION	DESCRIPTION
5	XX4X	Alert Request	A connected poller is ready to process an alert function from the computer. Any previous alert function has been processed.
6	X1XX	Station Interrupt	Indicates that a station interrupt was caused by depressing one or more SEND keys, or that a poller detected a message in error or received a read message.
7	X2XX	Ready and Not Busy Interrupt	Indicates that a ready and not busy interrupt was generated when printout completed and that the ready and not busy interrupt was selected.
8	X4XX	End of Operation Interrupt	Indicates that an interrupt was generated by the end of a read/write operation, reset, or reset-clear function. A new function, or read or write operation may be initiated following the end of operation interrupt.
9	1XXX	Alert Interrupt	Interrupt generated by completion of an Alert message to a remote site.
10	2XXX	Poller Error	Error condition after three attempted write, clear-write, write-reset, or alert messages to a remote site from the connected poller.

INTERRUPTS.

The interrupt permits the display equipment to indicate to the computer certain preprogrammed conditions. The computer can selectively activate or deactivate these interrupt conditions.

Four conditions generate an interrupt and four function codes enable these interrupts to the computer for the Display Controller. Table 3-3 lists the interrupt conditions, enabling functions, and disabling functions. Refer to the specific enabling function code (table 3-2) for a complete description of the interrupt condition.

TABLE 3-3. DISPLAY CONTROLLER INTERRUPTS

INTERRUPT	FUNCTION CODE	
	ENABLE	DISABLE
Ready and Not Busy	0020	0021
End of Operation	0022	0023
Alert	0024	0025
Station	0026	0027

The computer must first connect to a specific Display Station before issuing any interrupt enable function codes. Normally, status is checked immediately following the connect. If the computer desires to perform a reset operation (function code 0010), or a read or write operation, and wants to be informed when the operation is completed, it transmits function code 0022 (interrupt on end of operation) prior to the operation.

An end of printout operation can interrupt the computer if the ready and not busy interrupt is enabled. After connecting to a specific Display Station and finding the station busy executing a printout, the computer has the option to discontinue the printout or select the interrupt on ready and not busy condition (function code 0020). Even though the function code is directed to a specific Display Station, it enables a station interrupt from any Display Station satisfying the ready and not busy condition.

If the computer wants to receive the data from a local Display Station, function code 0026 (station interrupt enable) is transmitted. An interrupt transmits when the SEND key on this station, or any other Display Station, is depressed.

Upon receiving an interrupt from the display equipment, the computer normally connects to the Display Controller and samples status to determine what caused the interrupt. It can immediately perform a read operation following a connect word having a select code 0000 if the interrupt is a station interrupt. A write operation or other interrupt requires connecting to a specific station before beginning the operation. After servicing an interrupt, the interrupt line may be cleared by reselecting or deselecting the same interrupt except station interrupt.

SYMBOL DATA.

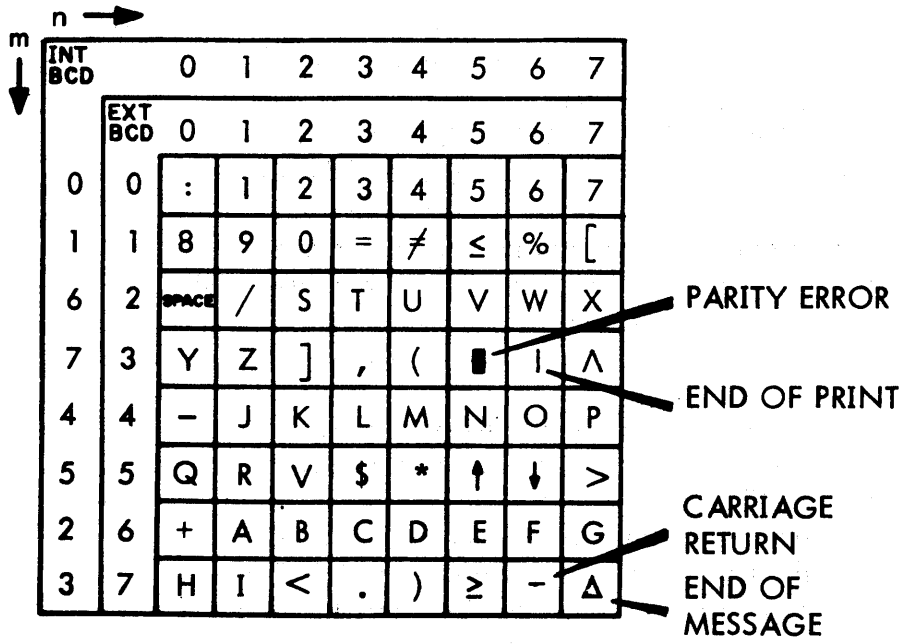
The display equipment symbol repertoire includes the alphabet in uppercase, arabic numerals (0 through 9), punctuation marks, and special symbols.

Table 3-4 presents the Display Controller symbol repertoire in alphabetic and numeric order. Figure 3-3 shows two quick reference charts for locating a

TABLE 3-4. SYMBOL REPERTOIRE

SYMBOL	BCD EXT	BCD INT	SYMBOL	BCD EXT	BCD INT	SYMBOL	BCD EXT	BCD INT
A	61	21	X	27	67	Comma ,	33	73
B	62	22	Y	30	70	Left paren (	34	74
C	63	23	Z	31	71	Parity error ■	35	75
D	64	24	Colon :	00	12	End of print (Note) '	36	76
E	65	25	1	01	01	Logical OR ∧	37	77
F	66	26	2	02	02	Hyphen -	40	40
G	67	27	3	03	03	Logical AND ∨	52	52
H	70	30	4	04	04	Dollar sign $	53	53
I	71	31	5	05	05	Asterisk *	54	54
J	41	41	6	06	06	Arrow up ↑	55	55
K	42	42	7	07	07	Arrow down ↓	56	56
L	43	43	8	10	10	Greater than >	57	57
M	44	44	9	11	11	Plus +	60	20
N	45	45	ø	12	00	Less than <	72	32
O	46	46	Equal =	13	13	Period .	73	33
P	47	47	Not equal ≠	14	14	Right paren)	74	34
Q	50	50	Less than or equal to ≤	15	15	Greater than or equal to ≥	75	35
R	51	51	Percent %	16	16	Carriage return (Note) -	76	36
S	22	62	Left bracket [	17	17	End of message Δ	77	37
T	23	63	Space	20	60			
U	24	64	Right diagonal /	21	61			
V	25	65	Right bracket]	32	12			
W	26	66						

Note — displayed as superscript, does not print.



m	INT BCD	n=0	n=1	n=2	n=3	n=4	n=5	n=6	n=7
	EXT BCD	0	1	2	3	4	5	6	7
0	0	:	1	2	3	4	5	6	7
1	1	8	9	0	=	≠	≤	%	[
6	2	SPACE	/	S	T	U	V	W	X
7	3	Y	Z	]	,	(	■	!	Λ
4	4	–	J	K	L	M	N	O	P
5	5	Q	R	V	$	*	↑	↓	>
2	6	+	A	B	C	D	E	F	G
3	7	H	I	<	.	)	≥	–	Δ

NOTE:

00 internal BCD equals 12 external BCD
00 external BCD equals 12 internal BCD

Figure 3-3. Symbol Code Quick Reference Chart

symbol when given the 6-bit octal or BCD code. A two-digit code of the form m/n uniquely specifies each code, eg, external BCD code 65 represents the letter E.

Standard display format is 20 lines of 50 symbols per line with an optional display format of 13 lines of 80 symbols available. The Display Station INTENSITY/ ON/OFF switch adjusts symbol intensity. Symbol size is adjustable internally and is normally set to generate symbols 1/8-inch wide by 1/4-inch high.

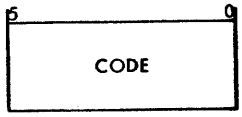
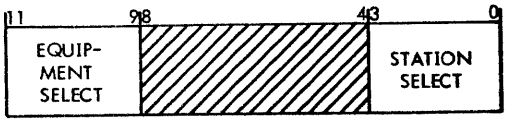
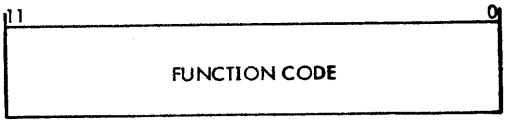
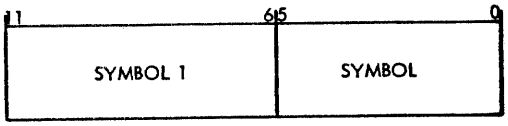
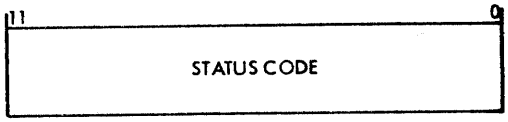
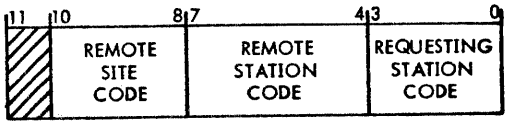
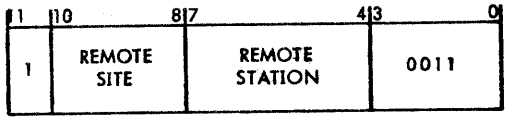
WORD FORMATS.

The display word format is 6 bits. Each 6-bit word specifies a symbol code or control code as listed in the symbol repertoire table.

Besides the display word format, there are five 12-bit interface word formats. The connect, function, data, and station word are transmitted on the data lines and are identified by a signal transmitted on a corresponding signal line. The status word is enabled to the computer on the status lines whenever the Display Controller is connected to the computer.

Table 3-5 lists all word formats and identifies the distinguishing signal where applicable.

TABLE 3-5. WORD FORMATS

WORD	FORMAT	SIGNAL
Display		—
Connect		Connect
Function		Function
Data		Data
Status		—
Station		Data
Alert Function		Function

The connect word contains information which directs the Display Controller to connect the computer data channel to the designated Display Station or poller. Bits 9 through 11, the equipment select code, designates the equipment number which may be chosen on the EQUIPMENT SELECTOR switch. Bits 0 through 3 (the station select code) are used to select the specific local Display Station or poller with which the computer is to communicate. A station select code of 0001 through 1100 binary designates the corresponding numbered Display Station or poller. A station select code of 0000 binary indicates that the computer requests a check of status conditions, or requests to communicate with the lowest numbered Display Station causing an interrupt. If no interrupt is present, connection is prevented.

Figure 3-4 shows the sequence of events upon receipt of a Connect signal. If the Display Controller is in a ready state, parity is checked upon receipt of the Connect signal. A parity error at this time illuminates the PARITY indicator and the display equipment disconnects in approximately 1 microsecond. Assuming parity is correct, the EQUIPMENT SELECTOR switch setting is compared to the equipment select code. If the two do not compare, a disconnect is performed in about 1 microsecond. An exact comparison allows the status lines to be enabled. After comparing the equipment select code, the Display Controller examines the station select code to see if it is addressing an existing Display Station or poller. If the device is nonexistent or busy, a Reject signal is transmitted to the computer no sooner than 2 microseconds after the condition is detected. Assuming the Display Station or poller exists and is not busy, the Display Controller responds with a Reply signal in about 2 microseconds.

If the station select code contains all 0's and an interrupt condition is not pending, a Reject signal is sent to the computer. An interrupt condition at this time draws a Reply signal response from the Display Controller and the interrupting Display Station or poller is connected. The computer then reads at least one word (the station word) and normally continues the read operation until all of that station's data is read. If the interrupt condition is nonexistent, a connect is made to the Display Controller for reading Display Controller status only. No read or write operation is performed.

Once connected, the Display Controller is ready to perform any function desired by the computer in addition to a read or write operation. Figure 3-5 shows the sequence of events upon receipt of a Function signal. If the Display Controller is not connected, it takes no action in response to a Function signal.

An assembly/disassembly register in the Display Controller handles packing and unpacking chores for read and write operations respectively. The most significant 6 bits of the data word are always filled or emptied first. If the computer enables the Suppress Assembly/Disassembly line, the most significant 6 bits would

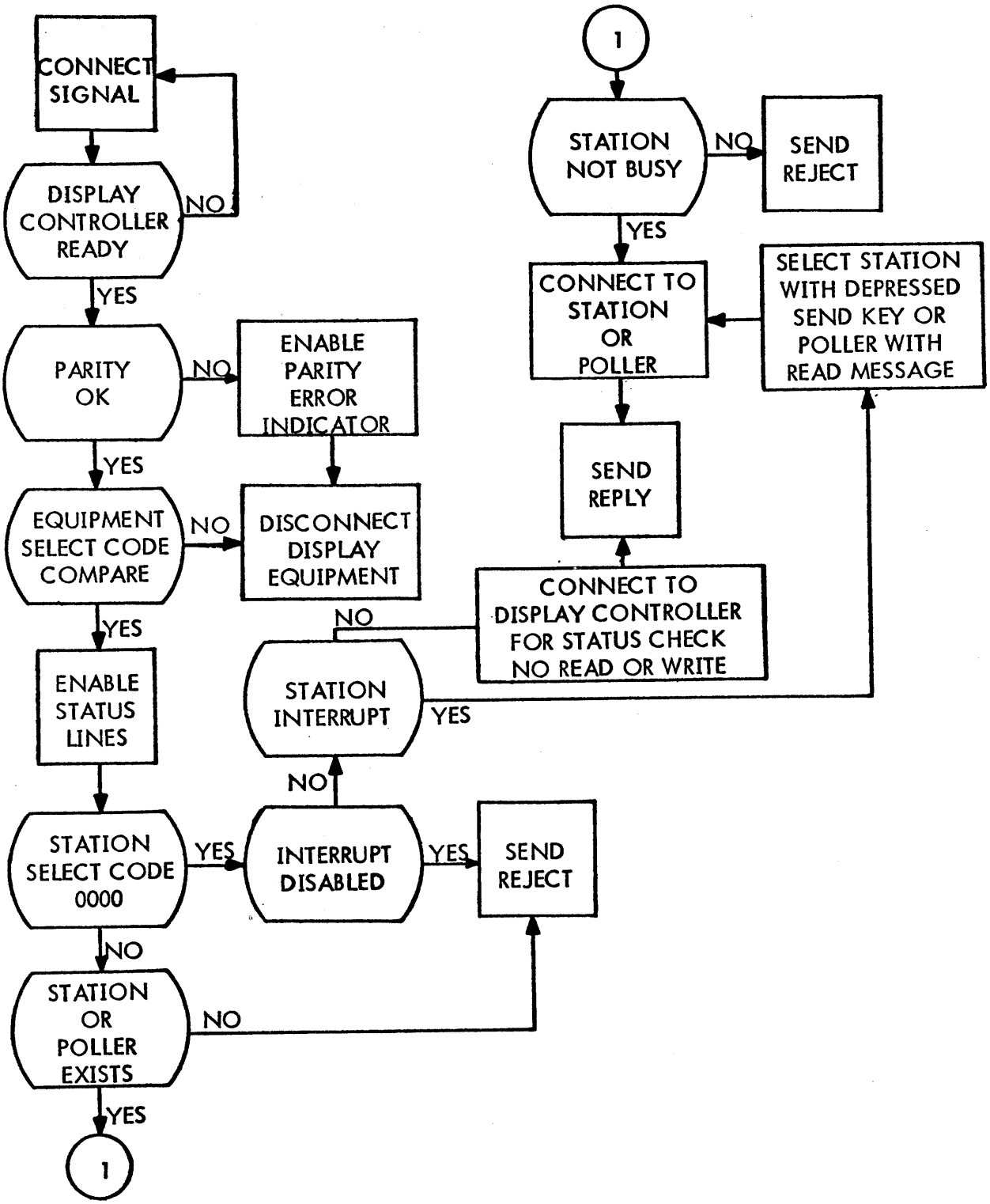


Figure 3-4. Connect Sequence

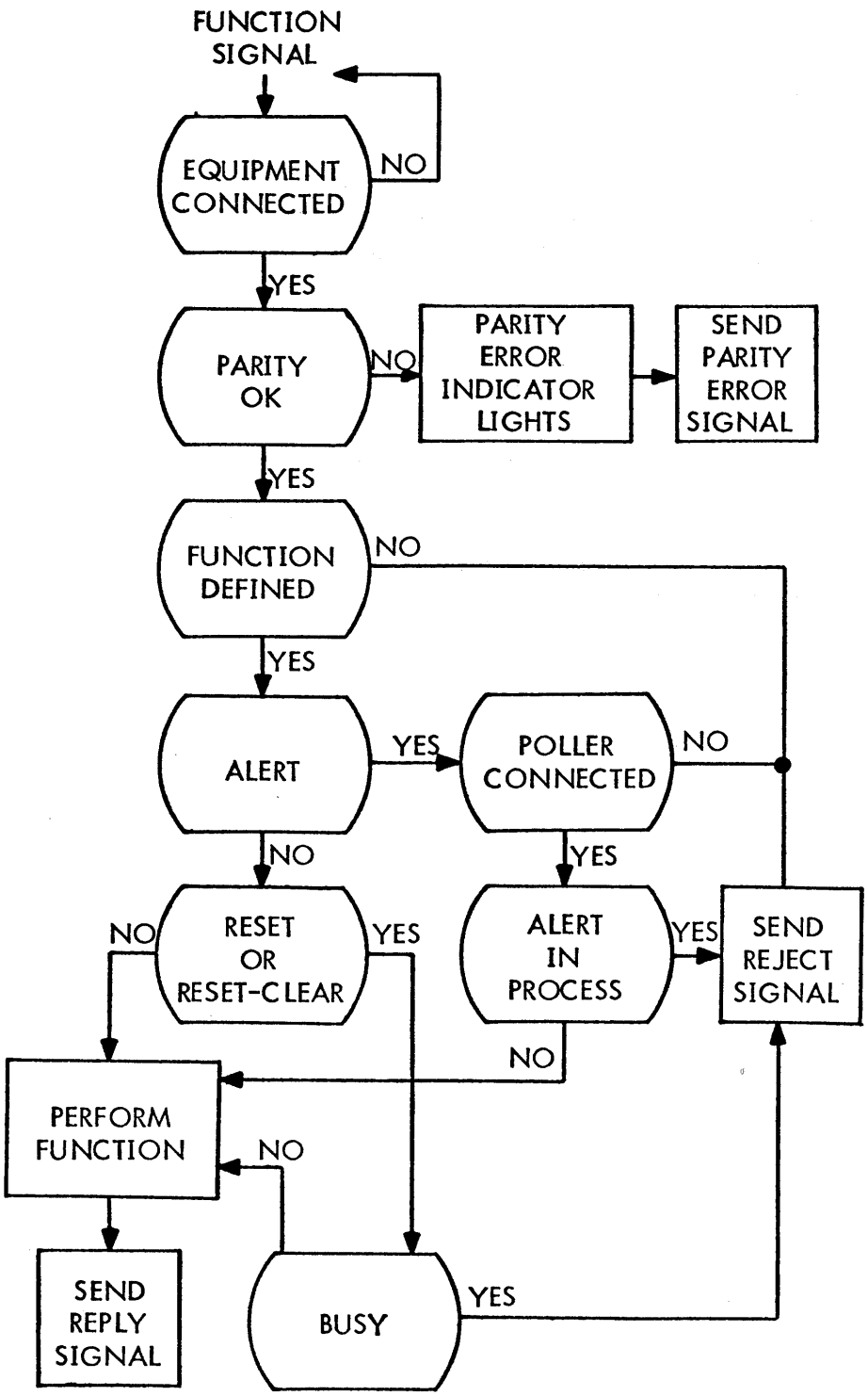


Figure 3-5. Function Sequence

neither be filled or emptied for the duration of the signal. The least significant 6 bits are unaffected; therefore, data transmission takes place in the form of one 6-bit word at a time.

READ/WRITE OPERATIONS.

Read or write operations to or from a local Display Station may be performed any time at the discretion of the computer, after checking status. The computer-initiated action takes priority over the operator. If a read or write operation is initiated during a period when an operator is composing a message from the keyboard, the operator's keyboard is locked out and computer operation takes over. A read or write operation to a Display Station performing a printout results in termination of the printout and the read or write operation is performed at the specified Display Station.

The Display Controller allows the computer to enable an interrupt on an end of printout condition. Following connection to a specific Display Station and sampling status, print request status (line 3) is enabled if the Display Station requests a print operation or if it is presently performing a printout. Not ready status indicates the Display Station is actually performing a printout. Using function code 0020 octal, the computer may enable the select interrupt on ready and not busy condition. Upon completing printout, an interrupt is sent to the computer and status line 7 (ready and not busy interrupt) is made active. The 0020 function code enables an interrupt to generate when any Display Station completes printout.

Computer read and write operations do not take priority in the poller. The poller scans the remote stations to determine if a SEND key is depressed. If this condition exists, the selected station transmits a read message to the poller. After storing the message in memory, the poller generates a send request and the computer responds with a read operation. In response to the read message, the computer must send a write message to the selected poller. The poller then relays this message to the remote station.

The alert function turns on the ALERT light and audible alarm at the remote station; the SEND key must be depressed to turn them off. The subsequent read message enables the computer to perform a write operation.

Read operations may be initiated from the local or remote Display Stations by an operator depressing the SEND key or from the computer by programmed instructions (local Display Station only). A write operation is initiated only from the computer. Following is a description of read and write operations.

READ OPERATION INITIATED BY A REQUESTING STATION.

A requesting station is a local Display Station at which a SEND key was depressed, or a poller which received a read message from a remote station. At a requesting station an end of message symbol is inserted at the entry marker position, the entry marker is moved to the upper left corner, and a station interrupt is initiated if the station interrupt is enabled by the computer. The computer responds to the interrupt with a connect word containing a station select code of 00 octal. The Display Controller then connects to the requesting station in scanning sequence and activates the status lines. The computer must perform a read operation to clear the send request. If a read operation is not performed, the station interrupt is sent again upon receipt of the station interrupt enable.

The station word (shown in table 3-5), containing the number of the scanner selected requesting station, is sent in response to the first Data signal during a station-interrupt initiated read operation. If the selected requesting station is a poller, the remote site and station are indicated in bits 4 through 10. Successive words after the station word contain data stored in the delay line starting at the entry marker position.

When the end of message code is detected, it is sent to the computer in a data word. In response to the next Data signal following an end of message code, the End of Record signal accompanied by an all-zero data word is sent instead of the Reply signal. The Read signal terminates the read operation and becomes disabled for more than 200 nanoseconds. Data may therefore be read beyond the end of message code if the Read signal remains enabled. Figure 3-6 shows simplified read operation timing.

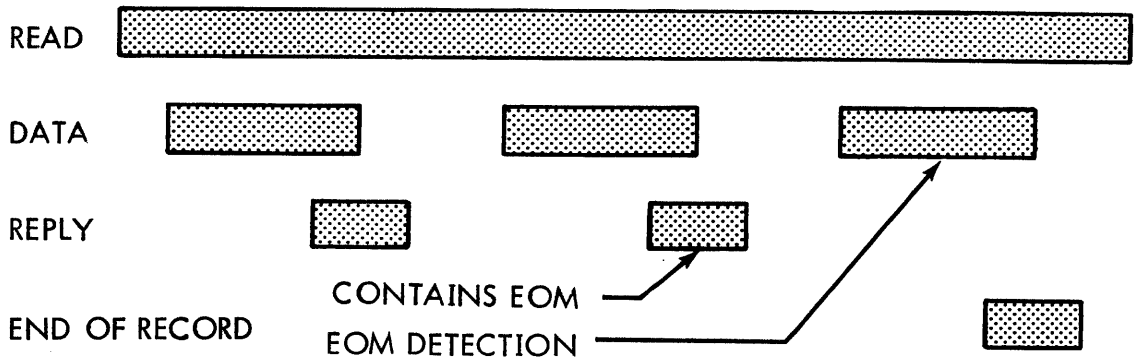


Figure 3-6. Simplified Read Timing

If successive read operations are performed without resetting the entry marker (such as repetitive one-word reads) one symbol is lost each time the Read signal is dropped.

READ OPERATION INITIATED BY THE COMPUTER.

The computer may initiate a read operation at any time the connected local Display Station or poller is not busy. Discretion is required in the use of this operation since it prevents entry of data by a Display Station operator. After connecting, the entry marker may be moved to the upper left corner by the reset function or may be left at its current position. In response to the Read and Data signals, data words are sent along with the Reply signal. A read operation performed on a connect to a specific station does not send the station word.

WRITE OPERATION TO A LOCAL DISPLAY STATION.

Data may be written into a connected station at any time the station is not busy. After connecting and checking status, the computer sends data words to be written on the crt starting at the position of the entry marker. A reset or reset-clear function may move the entry marker to the upper left corner before writing data. Sequential symbols in data words are written from left to right and from top to bottom on the crt. After the last symbol is written in the lower right corner, the entry marker moves to the upper left corner and data writing may continue, with the later data replacing data written earlier. Figure 3-7 shows simplified write operation timing.

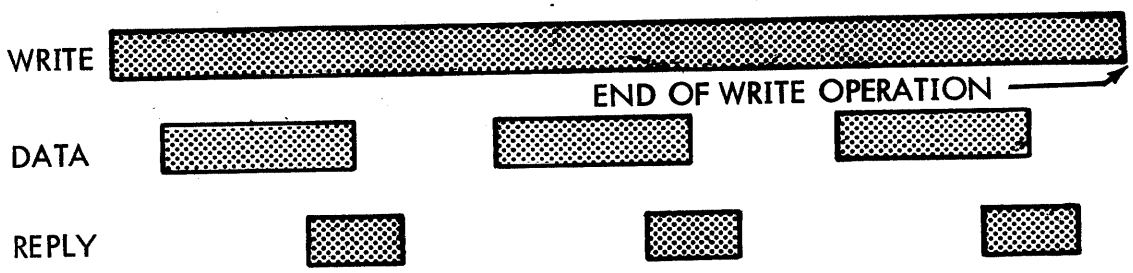


Figure 3-7. Simplified Write Timing

WRITE OPERATION TO A POLLER.

Data is always transferred to a poller after a read operation from the poller. After connecting to the poller and checking status, the computer sends data words

to be written into the poller memory starting at the position of the entry marker. The entry marker is always at start-of-memory after any computer read operation.

A reset function immediately preceding a write to the poller results in a write-reset message from the poller to the remote station; a reset-clear function results in a clear-write message. No function results in write message. Sequential symbols in data words are written into the poller memory. The poller is informed that it is to send the message when the Write signal drops. The write, write-reset, or clear-write message is sent to the remote station which had just previously sent a read message.

PROGRAMMING AIDS.

Following are several points concerning display equipment timing:

(a) The Display Controller is busy for 33 microseconds after the last Reply signal is sent at the end of a write operation.

(b) The Display Controller is busy from 3.2 microseconds to 20 milliseconds after receipt of a reset function.

(c) If a read or write operation follows a reset function which transmits an interrupt upon completion, 20-millisecond delay (after the end of operation interrupt is sent) occurs before the first data word is stored or read from memory.

(d) One symbol time is 16.8 microseconds. Each data word contains two symbols and requires 33.6 microseconds. The delay-line memory cycle time is 20 milliseconds. During a read or write operation, successive data words must follow within 33.6 microseconds (time required to read or write two symbols) or a 20-millisecond delay occurs between bytes due to delay line latency characteristics.

PROGRAMMING RESTRICTIONS.

(a) It is necessary to read at least two 12-bit words to clear the send ff when a connect is issued after an interrupt.

(b) There should not be any unsolicited read or write operations (poller only).

(c) Sending an end of print message to a Display Station initiates operation of its associated Printer Station(s).

POLLER TRANSLATION.

The poller converts all codes and signals to a format which is compatible with Data Set operation. Signals transmitted between the poller and the Data Set meet or exceed the minimum of EIA Standard RS-232. A negative voltage of greater than -6 volts represents a logical 1; a positive voltage greater than +6 volts represents a logical 0. Half duplex, 2- or 4-wire operation, DATA-PHONE Data Set 201A or 201B service is required. Private communications lines are necessary and no provision is made for automatic ringing or answering.

A single-phase, 120-volt, 60-Hz, three-wire outlet from the Display Controller is supplied for the Data Set, so the same ground bus is used for both. This measure is necessary to prevent impulse noise potentials which might otherwise develop and cause data errors.

The poller sends and receives data in an 8-bit code which is transmitted serially over Send Data and Receive Data lines. These bits are synchronized with the Serial Clock Receive and Serial Clock Transmit signals. Data Set 201A operates at 2000 baud, Data Set 201B at 2400 baud.

INTERFACE SIGNALS.

Figure 3-8 shows interface signals between the Data Set and the poller. The arrows indicate signal origin. Following paragraphs provide an elaboration on the signals shown in figure 3-8.

Send Data.

The Send Data signal originates in the poller and contains serial data. Positive polarity represents a logical 0 and negative polarity represents a logical 1. Data bits are provided to the Data Set at the time of positive transition of the Serial Clock Transmit signal.

Request to Send.

The poller makes the Request to Send signal positive when a transmit operation is desired. Placing a negative potential on the line returns the Data Set to a receive condition.

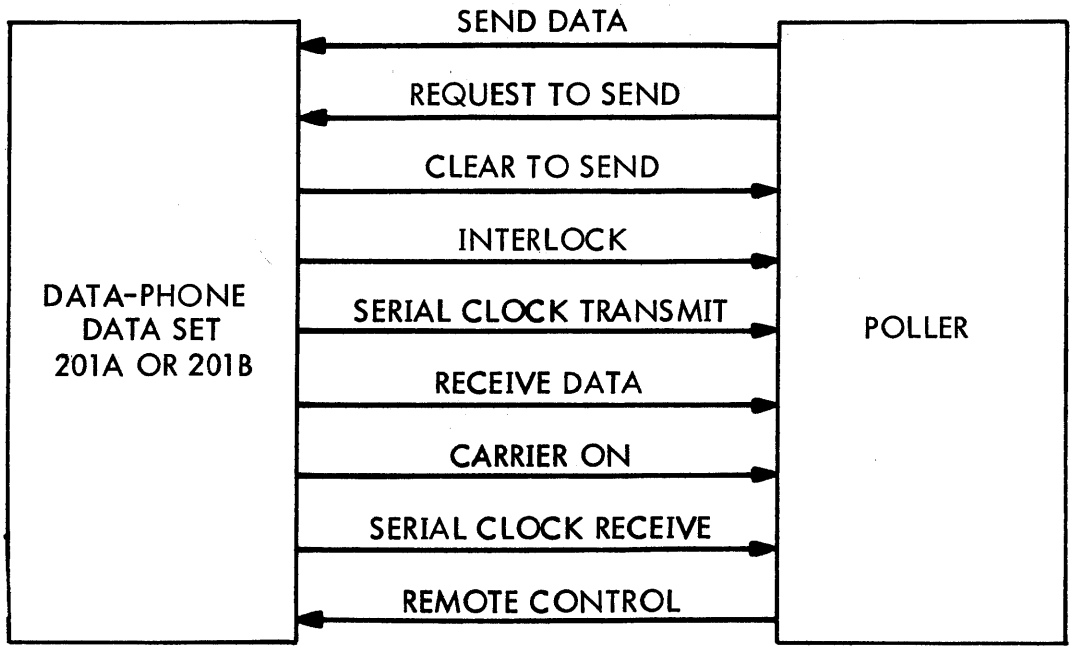


Figure 3-8. Poller Interface Signals

Clear to Send.

The Data Set makes the Clear to Send signal positive in response to a Request to Send signal from the poller. The amount of time elapsed between the leading edge of the Request to Send and the leading edge of Clear to Send is determined by the Data Set strapping options. The Data Set makes the Clear to Send signal negative when the Request to Send signal drops.

Interlock.

A +6 volts on the Interlock Line indicates that the Data Set is ready to send or receive data. A 0-volt signal indicates that the Data Set is not in an operating condition.

Serial Clock Transmit.

The Serial Clock Transmit signal is a symmetrical square wave of +6 volts to -6 volts amplitude originating in the Data Set which is used to synchronize the acceptance of data by the Data Set. Data is placed on the Send Data line at the time of the positive transition of the Serial Clock Transmit signal and is sampled by the Data Set at the time of negative transition.

Receive Data.

The Receive Data signal contains serial binary data which is synchronized with the Serial Clock Receive signal. Positive polarity is defined as a logical 0 and negative polarity as a logical 1.

Carrier On.

A positive potential at the Carrier On terminal indicates that the Data Set is receiving the carrier. A negative potential indicates that no carrier is being received. The Carrier On signal changes from negative to positive within 9 milliseconds after carrier appears at the receiver terminal.

Remote Control.

A positive potential indicates that the poller is ready to communicate with the Data Set.

Serial Clock Receive.

The Serial Clock Receive signal is a symmetrical square wave of +6 volts to -6 volts amplitude. The square wave is synchronized with the receiver timing circuits. Data bits on the Receive Data line are initiated synchronously with the positive transition of the Serial Clock Receive signal and are sampled at the negative transition.

POLLER CONTROL CODES.

The basic poller codes are eight bits long and are used for communication between the poller and the remote sites. The most significant bit, which is received last serially, is the parity bit. Parity is odd. The following paragraphs list poller codes. Table 3-6 lists control codes and their octal translation.

TABLE 3-6. CONTROL CODES

DESCRIPTION	7-BIT OCTAL TRANSLATION
Start of Message (SOM)	001
USASCII End of Message (USASCII EOM)	003
Poll	005
Acknowledge (ACK)	006
Alert	007
Reset-Write	014
Write	021
Clear-Write	022
Read	023
Synchronization (SYNC)	026
Reject	030

Start of Message.

The start of message code indicates that the next 7-bit word contains the site address. The start of message code follows the synchronization codes. It is both initiated and received by the poller.

Alert.

The poller initiates the alert code when instructed by the computer. The alert code designates a message which turns on the ALERT light on the addressed remote site Display Station.

USASCII End of Message.

The USASCII end of message code indicates that the previous word was the last word of data. The word following the USASCII end of message code is the message parity word. This code is both initiated and received by the poller.

Message Parity.

Message parity is applicable from the start of message through the USASCII end of message code, and excludes all sync codes. The message parity code is odd. The parity bit is excluded.

Poll.

The poller initiates the poll code which designates the poll message. The poll message instructs the remote site to respond with a read message if a SEND key has been depressed or a read request active is set or a reject message if the above two conditions do not exist.

Acknowledge.

The acknowledge code originates at a remote site and designates a message which acknowledges receipt of a write, reset-write, clear-write, or alert message with no errors.

Reset-Write.

The poller transmits the reset-write code when instructed by the computer. The code designates a message which instructs the addressed display equipment to write data starting at the upper left corner. The reset-write code is followed by 12 sync codes to allow time for the entry marker to reset.

Write.

The poller initiates the write code when instructed by a computer message. The message contains data to be written on the remote crt starting at the current entry marker position.

Clear-Write.

The poller initiates the clear-write code when instructed by the computer. This code designates a message which instructs the addressed Display Station to clear data from the crt and write the contained data starting at the upper left corner. The poller transmits 12 sync codes following the clear-write code to allow time for the entry marker to reset.

Read.

The read code originates at a remote site and designates a message containing data on the Display Station crt which is to be sent to the computer.

Synchronization.

The poller receives and transmits the sync code. Four sync codes are transmitted at the beginning of each message to assure receiver synchronization. These codes are not considered for purposes of message parity.

Sync codes also act as synchronization idles when contained within the message structure (reset-write and clear-write).

Reject.

The reject code originates at a remote site. This code designates a message which informs the poller that a SEND key was not depressed, a read request active was not set before receipt of the poll message, or because of a busy condition, a write, reset-write or clear-write was rejected.

SYMBOL SUBSET.

The symbol subset codes (codes with bit 5 or 6 a logical 1, but not both) are stored in the delay-line memory and specify data presented or are displayed on the crt of a Display Station at a remote site. These codes are the data sent in read, write, reset-write, and clear-write messages.

An escape code (76) followed by any code other than carriage return, E1, E2, or E3 codes will be converted to a space code (20 external BCD or 60 internal BCD). Refer to tables 3-7 and 3-8.

TABLE 3-7. SYMBOL SUBSET CONVERSION TO COMPUTER

INTERNAL CODE	EXTERNAL CODE	ESCAPE CODE RECEIVED
36	76	76 01 (CR)
37	77	76 02 (E1)
76	36	76 40 (E2)
75	35	76 41 (E3)

TABLE 3-8. SYMBOL SUBSET CONVERSION FROM COMPUTER

INTERNAL BCD	EXTERNAL BCD	ESCAPE CODE SENT
36	76	76 01 (CR)
37	77	76 02 (E1)
76	36	76 40 (E2)
75	35	76 41 (E3)

Station Address.

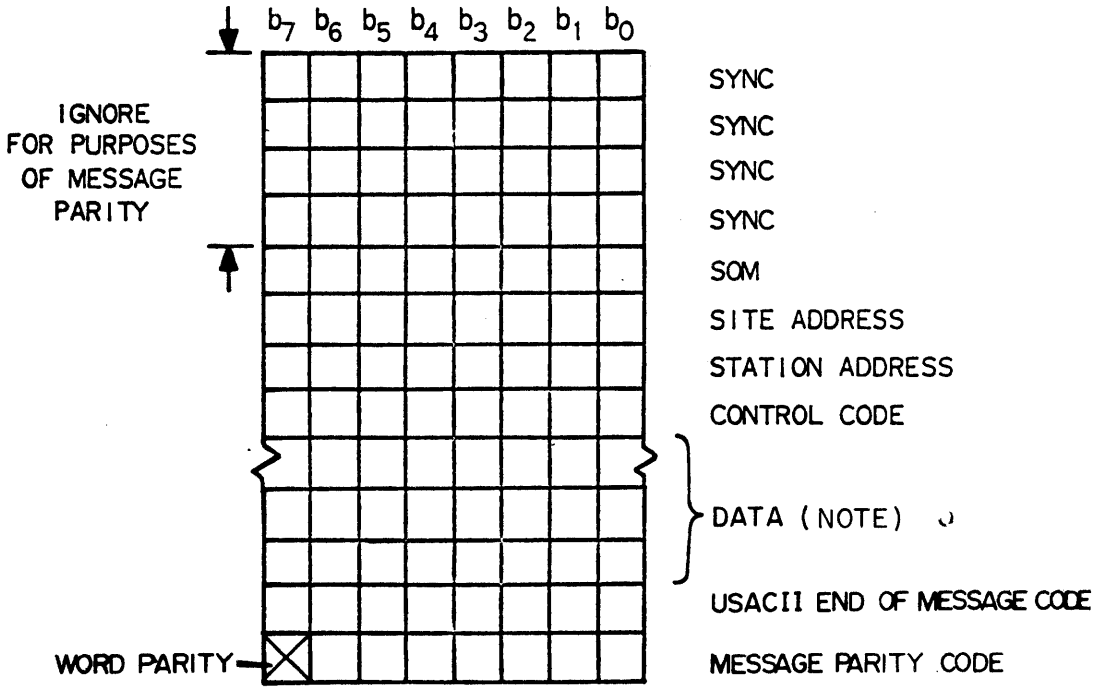
The station address code designates the remote site Display Station to which a poller is communicating. The station address in a read message is retained by the poller and sent to the computer. The next write, reset-write, or clear-write message from the computer to the poller is automatically sent to the Display Station from which the read message was received.

Site Address.

The site address code designates the remote site to which a message is addressed or from which a message is received. The remote sites polled are designated by site address switches on the Display Controller auxiliary maintenance panels. Polling takes place in numerical order.

MESSAGE FORMAT.

Messages received and sent by the poller consist of several codes. The general message format is shown in figure 3-9. All messages transmitted are preceded by four sync codes to assure synchronization recovery on the receiving end. The start of message code designates that the next code is the first word of the message. The site address and station address follow in that order. The control code defines the command or data which follows. Data to or from a remote Display Station may consist of 1 to 1040 words. The USASCII end of message code designates that the previous word was the last word of the message. The message parity code follows the end of message code. Message parity is applicable from the start of message through the end of message code inclusive and excludes all sync codes. Specific messages sent and received are listed in tables 3-9 and 3-10.



NOTE: 1-1000 WORDS (50X20) DISPLAY FORMAT).
1-1040 WORDS (80X13) DISPLAY FORMAT).

Figure 3-9. General Message Format

Synchronization.

After the Data Set turns on the Carrier On signal, data input from the Data Set is fed into a buffer register. After each data bit is received, the contents of the buffer register is examined to determine if the code is a sync code. When two

TABLE 3-9. MESSAGES SENT BY THE POLLER

MESSAGE	CODE
Alert	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS ALERT USASCII END OF MESSAGE MESSAGE PARITY
Poll	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS POLL USASCII END OF MESSAGE MESSAGE PARITY
Write	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS WRITE ↕ 1 to 1000* words of data USASCII END OF MESSAGE MESSAGE PARITY
Clear-Write	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS

* 1040 words if 80 by 13 display format

TABLE 3-9. MESSAGES SENT BY THE POLLER (CONT)

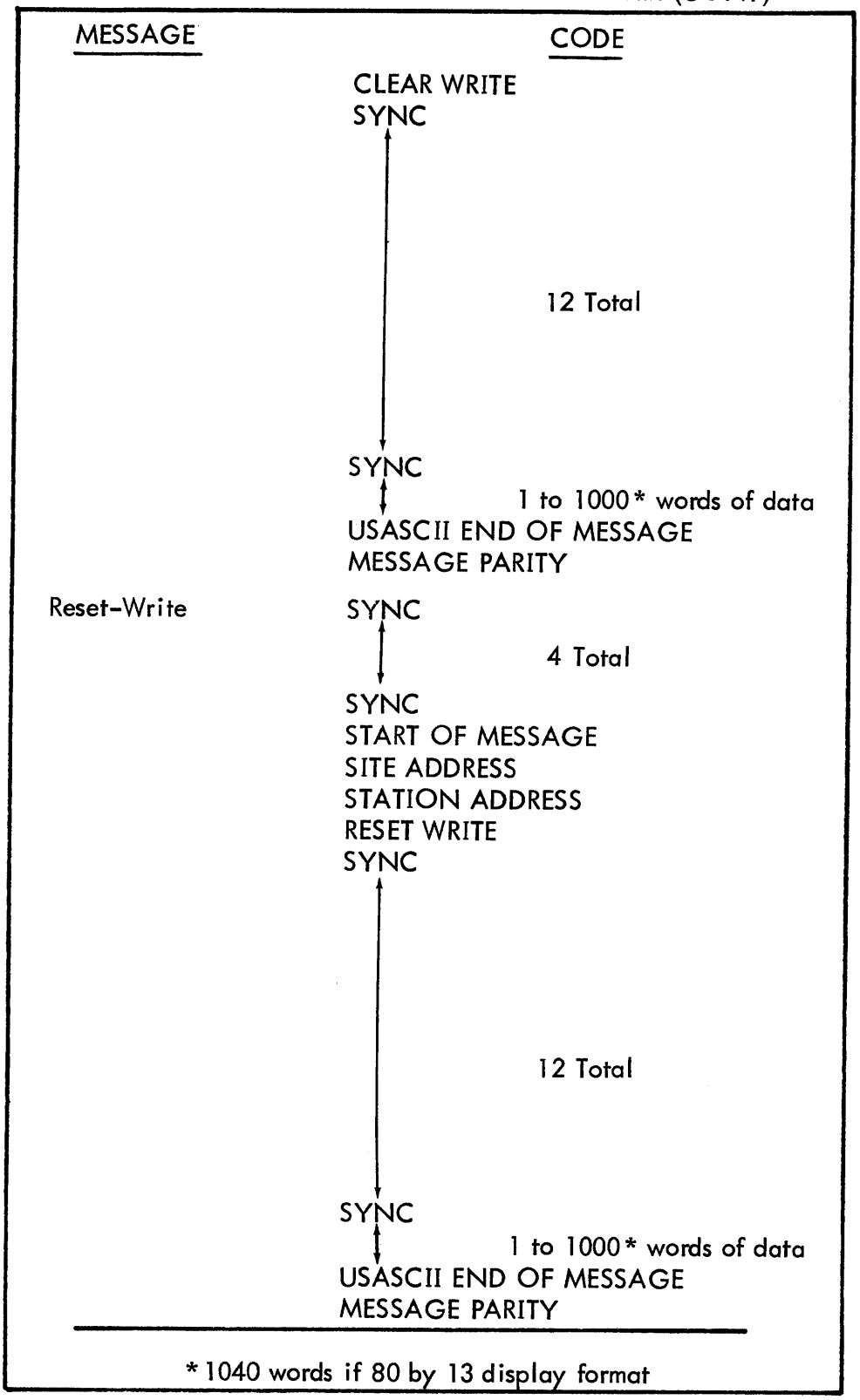


TABLE 3-10. MESSAGES RECEIVED BY THE POLLER

MESSAGE	CODE
Reject	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS REJECT USASCII END OF MESSAGE MESSAGE PARITY
Read	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS READ ↕ 1 to 1000* words of data USASCII END OF MESSAGE MESSAGE PARITY
Acknowledge	SYNC ↕ 4 Total SYNC START OF MESSAGE SITE ADDRESS STATION ADDRESS ACKNOWLEDGE USASCII END OF MESSAGE MESSAGE PARITY

* 1040 words if 80 by 13 display format

consecutive sync codes are detected, the poller assembles the next 8 bits and examines the contents to detect the start of message code. Unless at least two successive sync codes followed by a start of message code are detected, the poller again searches for the same pattern.

Alert Message.

The computer cannot directly send a write, reset-write, or clear-write message to be written on a remote Display Station. It can indicate to a remote display equipment that the computer has a message to be written by initiating an alert message. The alert message is initiated by the computer as an alert function to the poller.

At the time the poller would normally poll a site, it determines if an alert function was received for that site. The poller then sends an alert message instead of a poll message. The remote Display Station, upon receipt of an alert message, lights the ALERT indicator and responds with an acknowledge message. Operator action (depress SEND key) is necessary before a write message can be sent.

Polling.

The following description of the poller operation assumes that no error occurred while being transmitted over the DATA-PHONE and that the remote site is operating properly.

The poller is normally in a poll status during which time it sends periodic and sequential poll messages to the sites. If a SEND key is depressed at a site, the remote display equipment responds with a read message. If a SEND key is not depressed, the remote display equipment responds with a reject message. If a read message is received, it is transferred to the computer as a message from a local station would be transferred. The poller responds with a reset-write, write, or clear-write message addressed to the Display Station at which the SEND key was depressed. The poller sends the message to the remote Display Station. The remote display equipment responds to the reset-write, write, or clear-write message with an acknowledge message which completes the communication.

Reject Message.

The reject message is a reply from a remote site to a poll message indicating that a SEND key was not depressed. The reject message also is used to inform the poller that the previous write, clear-write, reset-write or alert function was not performed. The poller interprets this as an error.

Read Message.

The read message is a reply from a remote site to a poll message indicating a SEND key was depressed. The data, read from the crt, begins at the upper left corner and terminates with the data subset end of message code. The read message enables send request status and the station interrupt. The computer then reads the site address and station address in the station word. After reading the station word, the computer may continue to read the rest of the data in the message or may send a write message immediately. The computer reading a data word clears the send request.

Write Message.

The write message contains data from the computer to be written on the crt of a remote Display Station, starting at the present or reset entry marker position. A write, reset-write, or clear-write message is always sent in reply to a read message (with correct parity) from a remote site. After receiving a write message with correct channel parity from the computer, the poller switches to transmit and transfers the data to a remote site.

Acknowledge Message.

If the message is an acknowledge in response to an alert message, alert request and poll interrupt status are set. The computer, upon reading status, is informed that the alert message was received by the remote Display Station. An acknowledge response to a write, reset-write, or clear-write message turns the site indicator off and the polling resumes.

ERROR PROCESSING.

Errors may arise between the sending of a message to a remote site and receiving a message from a remote site. The poller recognizes these errors:

(a) Lack of response before time out.

(b) Parity error in a received message.

(c) An unexpected response such as a read message in response to a write message.

Any one of the error conditions causes the message to be retransmitted. The message is transmitted up to three times in attempting to get an error-free response. If, after three transmissions, an error-free response cannot be obtained, the poller ceases trying to communicate with that remote site.

If three attempts to successfully communicate an alert message to a remote display equipment fail, the Interrupt signal is enabled and the poller resumes polling. When the computer selects the poller, poll interrupt, poller error, and alert request status are indicated.

Three unsuccessful attempts to communicate a write, write-reset, or clear-write message to a remote site results in an Interrupt signal. Selection of the poller indicates poller error, station interrupt, and send request status. The computer must then read the station word. The computer may reread the station word, if it contained a parity error, by reconnecting to station 0. In order to clear the status bits and resume polling, it is necessary that the computer send a release function.

If a poll message cannot be successfully communicated in three attempts, the Interrupt signal is, again, enabled. When the poller is connected, it indicates send request, poll failure, and station interrupt status. The computer then reads the station word.

POLLER SYMBOL REPERTOIRE.

The poller communicates with a 7-bit code plus parity. The least significant bit (bit 0) is received first, and bit 7 is parity.

Codes with bit 6 or bit 5 (but not both) a logical 1 are stored in the delay-line memory associated with the connected poller. These codes are the data sent in read, write, reset-write, and clear-write communications with the remote sites. Remaining codes specify various functions, site address, and station address. Figure 3-10 lists symbol and function codes according to their binary translation.

				NOTE 1		DATA SUBSET					
			b_6	0	0	0	0	1	1	1	1
			b_5	0	0	1	1	0	0	1	1
b_3	b_2	b_1	b_4 / b_0	0	1	0	1	0	1	0	1
0	0	0	0			- MINUS (E2)	+	: COLON	BLANK	STATION ADDRESS ON POLL	0
0	0	0	1	SOM	WRITE	J (E3)	A	! (CR)	/	1	1
0	0	1	0		CLEAR-WRITE	K	B	2 (E1)	S	2	2
0	0	1	1	US ASCII EOM	READ	L	C	3	T	3	3
0	1	0	0			M	D	4	U	4	4
0	1	0	1	POLL		N	E	5	V	5	5
0	1	1	0	ACK	SYNC	O	F	6	W	6	6
0	1	1	1	ALERT		P	G	7	X	7	7
1	0	0	0		REJECT	Q	H	8	Y	8	
1	0	0	1			R	I	9	Z	9	
1	0	1	0			V	<	ø	]	10	
1	0	1	1			$	. PERIOD	=	, COMMA	11	
1	1	0	0			*	)	≠	(	12	
1	1	0	1			↑	≥	≤			
1	1	1	0			↓	ESCAPE	%			
1	1	1	1			>		[	^		

SITE ADDRESS

STATION ADDRESS

NOTES:

1. Set aside for USASCII control codes.
2. The lower portion of the four two-symbol data subset blocks are the interpretation of the codes when they immediately follow an escape code.

Figure 3-10. Symbol and Function Codes, Binary Translation

TABLE 1A-1. POWERS OF 2

2^n	n	2^{-n}
1	0	1.0
2	1	0.5
4	2	0.25
8	3	0.125
16	4	0.062 5
32	5	0.031 25
64	6	0.015 625
128	7	0.007 812 5
256	8	0.003 906 25
512	9	0.001 953 125
1 024	10	0.000 976 562 5
2 048	11	0.000 488 281 25
4 096	12	0.000 244 140 625
8 192	13	0.000 122 070 312 5
16 384	14	0.000 061 035 156 25
32 768	15	0.000 030 517 578 125
65 536	16	0.000 015 258 789 062 5
131 072	17	0.000 007 629 394 531 25
262 144	18	0.000 003 814 697 265 625
524 288	19	0.000 001 907 348 632 812 5
1 048 576	20	0.000 000 953 674 316 406 25
2 097 152	21	0.000 000 476 837 158 203 125
4 194 304	22	0.000 000 238 418 579 101 562 5
8 388 608	23	0.000 000 119 209 289 550 781 25
16 777 216	24	0.000 000 059 604 644 775 390 625
33 554 432	25	0.000 000 029 802 322 387 695 312 5
67 108 864	26	0.000 000 014 901 161 193 847 656 25
134 217 728	27	0.000 000 007 450 580 596 923 828 125
268 435 456	28	0.000 000 003 725 290 298 461 914 062 5
536 870 912	29	0.000 000 001 862 645 149 230 957 031 25
1 073 741 824	30	0.000 000 000 931 322 574 615 478 515 625
2 147 483 648	31	0.000 000 000 465 661 287 307 739 257 812 5
4 294 967 296	32	0.000 000 000 232 830 643 653 869 628 906 25
8 589 934 592	33	0.000 000 000 116 415 321 826 934 814 453 125
17 179 869 184	34	0.000 000 000 058 207 660 913 467 407 226 562 5
34 359 738 368	35	0.000 000 000 029 103 830 456 733 703 613 281 25
68 719 476 736	36	0.000 000 000 014 551 915 228 366 851 806 640 625
137 438 953 472	37	0.000 000 000 007 275 957 614 183 425 903 320 312 5
274 877 906 944	38	0.000 000 000 003 637 978 807 091 712 951 660 156 25
549 755 813 888	39	0.000 000 000 001 818 989 403 545 856 475 830 078 125

TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 1 OF 4)

	0	1	2	3	4	5	6	7
0000	0000	0001	0002	0003	0004	0005	0006	0007
0010	0008	0009	0010	0011	0012	0013	0014	0015
0020	0016	0017	0018	0019	0020	0021	0022	0023
0030	0024	0025	0026	0027	0028	0029	0030	0031
0040	0032	0033	0034	0035	0036	0037	0038	0039
0050	0040	0041	0042	0043	0044	0045	0046	0047
0060	0048	0049	0050	0051	0052	0053	0054	0055
0070	0056	0057	0058	0059	0060	0061	0062	0063
0100	0064	0065	0066	0067	0068	0069	0070	0071
0110	0072	0073	0074	0075	0076	0077	0078	0079
0120	0080	0081	0082	0083	0084	0085	0086	0087
0130	0088	0089	0090	0091	0092	0093	0094	0095
0140	0096	0097	0098	0099	0100	0101	0102	0103
0150	0104	0105	0106	0107	0108	0109	0110	0111
0160	0112	0113	0114	0115	0116	0117	0118	0119
0170	0120	0121	0122	0123	0124	0125	0126	0127
0200	0128	0129	0130	0131	0132	0133	0134	0135
0210	0136	0137	0138	0139	0140	0141	0142	0143
0220	0144	0145	0146	0147	0148	0149	0150	0151
0230	0152	0153	0154	0155	0156	0157	0158	0159
0240	0160	0161	0162	0163	0164	0165	0166	0167
0250	0168	0169	0170	0171	0172	0173	0174	0175
0260	0176	0177	0178	0179	0180	0181	0182	0183
0270	0184	0185	0186	0187	0188	0189	0190	0191
0300	0192	0193	0194	0195	0196	0197	0198	0199
0310	0200	0201	0202	0203	0204	0205	0206	0207
0320	0208	0209	0210	0211	0212	0213	0214	0215
0330	0216	0217	0218	0219	0220	0221	0222	0223
0340	0224	0225	0226	0227	0228	0229	0230	0231
0350	0232	0233	0234	0235	0236	0237	0238	0239
0360	0240	0241	0242	0243	0244	0245	0246	0247
0370	0248	0249	0250	0251	0252	0253	0254	0255

	0	1	2	3	4	5	6	7
0400	0256	0257	0258	0259	0260	0261	0262	0263
0410	0264	0265	0266	0267	0268	0269	0270	0271
0420	0272	0273	0274	0275	0276	0277	0278	0279
0430	0280	0281	0282	0283	0284	0285	0286	0287
0440	0288	0289	0290	0291	0292	0293	0294	0295
0450	0296	0297	0298	0299	0300	0301	0302	0303
0460	0304	0305	0306	0307	0308	0309	0310	0311
0470	0312	0313	0314	0315	0316	0317	0318	0319
0500	0320	0321	0322	0323	0324	0325	0326	0327
0510	0328	0329	0330	0331	0332	0333	0334	0335
0520	0336	0337	0338	0339	0340	0341	0342	0343
0530	0344	0345	0346	0347	0348	0349	0350	0351
0540	0352	0353	0354	0355	0356	0357	0358	0359
0550	0360	0361	0362	0363	0364	0365	0366	0367
0560	0368	0369	0370	0371	0372	0373	0374	0375
0570	0376	0377	0378	0379	0380	0381	0382	0383
0600	0384	0385	0386	0387	0388	0389	0390	0391
0610	0392	0393	0394	0395	0396	0397	0398	0399
0620	0400	0401	0402	0403	0404	0405	0406	0407
0630	0408	0409	0410	0411	0412	0413	0414	0415
0640	0416	0417	0418	0419	0420	0421	0422	0423
0650	0424	0425	0426	0427	0428	0429	0430	0431
0660	0432	0433	0434	0435	0436	0437	0438	0439
0670	0440	0441	0442	0443	0444	0445	0446	0447
0700	0448	0449	0450	0451	0452	0453	0454	0455
0710	0456	0457	0458	0459	0460	0461	0462	0463
0720	0464	0465	0466	0467	0468	0469	0470	0471
0730	0472	0473	0474	0475	0476	0477	0478	0479
0740	0480	0481	0482	0483	0484	0485	0486	0487
0750	0488	0489	0490	0491	0492	0493	0494	0495
0760	0496	0497	0498	0499	0500	0501	0502	0503
0770	0504	0505	0506	0507	0508	0509	0510	0511

0000 (Octal)	0000 (Decimal)
to	to
0777 (Octal)	0511 (Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
1000	0512	0513	0514	0515	0516	0517	0518	0519
1010	0520	0521	0522	0523	0524	0525	0526	0527
1020	0528	0529	0530	0531	0532	0533	0534	0535
1030	0536	0537	0538	0539	0540	0541	0542	0543
1040	0544	0545	0546	0547	0548	0549	0550	0551
1050	0552	0553	0554	0555	0556	0557	0558	0559
1060	0560	0561	0562	0563	0564	0565	0566	0567
1070	0568	0569	0570	0571	0572	0573	0574	0575
1100	0576	0577	0578	0579	0580	0581	0582	0583
1110	0584	0585	0586	0587	0588	0589	0590	0591
1120	0592	0593	0594	0595	0596	0597	0598	0599
1130	0600	0601	0602	0603	0604	0605	0606	0607
1140	0608	0609	0610	0611	0612	0613	0614	0615
1150	0616	0617	0618	0619	0620	0621	0622	0623
1160	0624	0625	0626	0627	0628	0629	0630	0631
1170	0632	0633	0634	0635	0636	0637	0638	0639
1200	0640	0641	0642	0643	0644	0645	0646	0647
1210	0648	0649	0650	0651	0652	0653	0654	0655
1220	0656	0657	0658	0659	0660	0661	0662	0663
1230	0664	0665	0666	0667	0668	0669	0670	0671
1240	0672	0673	0674	0675	0676	0677	0678	0679
1250	0680	0681	0682	0683	0684	0685	0686	0687
1260	0688	0689	0690	0691	0692	0693	0694	0695
1270	0696	0697	0698	0699	0700	0701	0702	0703
1300	0704	0705	0706	0707	0708	0709	0710	0711
1310	0712	0713	0714	0715	0716	0717	0718	0719
1320	0720	0721	0722	0723	0724	0725	0726	0727
1330	0728	0729	0730	0731	0732	0733	0734	0735
1340	0736	0737	0738	0739	0740	0741	0742	0743
1350	0744	0745	0746	0747	0748	0749	0750	0751
1360	0752	0753	0754	0755	0756	0757	0758	0759
1370	0760	0761	0762	0763	0764	0765	0766	0767

	0	1	2	3	4	5	6	7
1400	0768	0769	0770	0771	0772	0773	0774	0775
1410	0776	0777	0778	0779	0780	0781	0782	0783
1420	0784	0785	0786	0787	0788	0789	0790	0791
1430	0792	0793	0794	0795	0796	0797	0798	0799
1440	0800	0801	0802	0803	0804	0805	0806	0807
1450	0808	0809	0810	0811	0812	0813	0814	0815
1460	0816	0817	0818	0819	0820	0821	0822	0823
1470	0824	0825	0826	0827	0828	0829	0830	0831
1500	0832	0833	0834	0835	0836	0837	0838	0839
1510	0840	0841	0842	0843	0844	0845	0846	0847
1520	0848	0849	0850	0851	0852	0853	0854	0855
1530	0856	0857	0858	0859	0860	0861	0862	0863
1540	0864	0865	0866	0867	0868	0869	0870	0871
1550	0872	0873	0874	0875	0876	0877	0878	0879
1560	0880	0881	0882	0883	0884	0885	0886	0887
1570	0888	0889	0890	0891	0892	0893	0894	0895
1600	0896	0897	0898	0899	0900	0901	0902	0903
1610	0904	0905	0906	0907	0908	0909	0910	0911
1620	0912	0913	0914	0915	0916	0917	0918	0919
1630	0920	0921	0922	0923	0924	0925	0926	0927
1640	0928	0929	0930	0931	0932	0933	0934	0935
1650	0936	0937	0938	0939	0940	0941	0942	0943
1660	0944	0945	0946	0947	0948	0949	0950	0951
1670	0952	0953	0954	0955	0956	0957	0958	0959
1700	0960	0961	0962	0963	0964	0965	0966	0967
1710	0968	0969	0970	0971	0972	0973	0974	0975
1720	0976	0977	0978	0979	0980	0981	0982	0983
1730	0984	0985	0986	0987	0988	0989	0990	0991
1740	0992	0993	0994	0995	0996	0997	0998	0999
1750	1000	1001	1002	1003	1004	1005	1006	1007
1760	1008	1009	1010	1011	1012	1013	1014	1015
1770	1016	1017	1018	1019	1020	1021	1022	1023

1000 (Octal)	0512 (Decimal)
to	to
1777 (Octal)	1023 (Decimal)

TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 2 OF 4)

2000 to 2777 (Octal) — 1024 to 1535 (Decimal)

	0	1	2	3	4	5	6	7
2000	1024	1025	1026	1027	1028	1029	1030	1031
2010	1032	1033	1034	1035	1036	1037	1038	1039
2020	1040	1041	1042	1043	1044	1045	1046	1047
2030	1048	1049	1050	1051	1052	1053	1054	1055
2040	1056	1057	1058	1059	1060	1061	1062	1063
2050	1064	1065	1066	1067	1068	1069	1070	1071
2060	1072	1073	1074	1075	1076	1077	1078	1079
2070	1080	1081	1082	1083	1084	1085	1086	1087
2100	1088	1089	1090	1091	1092	1093	1094	1095
2100	1096	1097	1098	1099	1100	1101	1102	1103
2120	1104	1105	1106	1107	1108	1109	1110	1111
2130	1112	1113	1114	1115	1116	1117	1118	1119
2140	1120	1121	1122	1123	1124	1125	1126	1127
2150	1128	1129	1130	1131	1132	1133	1134	1135
2160	1136	1137	1138	1139	1140	1141	1142	1143
2170	1144	1145	1146	1147	1148	1149	1150	1151
2200	1152	1153	1154	1155	1156	1157	1158	1159
2210	1160	1161	1162	1163	1164	1165	1166	1167
2220	1168	1169	1170	1171	1172	1173	1174	1175
2230	1176	1177	1178	1179	1180	1181	1182	1183
2240	1184	1185	1186	1187	1188	1189	1190	1191
2250	1192	1193	1194	1195	1196	1197	1198	1199
2260	1200	1201	1202	1203	1204	1205	1206	1207
2270	1208	1209	1210	1211	1212	1213	1214	1215
2300	1216	1217	1218	1219	1220	1221	1222	1223
2310	1224	1225	1226	1227	1228	1229	1230	1231
2320	1232	1233	1234	1235	1236	1237	1238	1239
2330	1240	1241	1242	1243	1244	1245	1246	1247
2340	1248	1249	1250	1251	1252	1253	1254	1255
2350	1256	1257	1258	1259	1260	1261	1262	1263
2360	1264	1265	1266	1267	1268	1269	1270	1271
2370	1272	1273	1274	1275	1276	1277	1278	1279

	0	1	2	3	4	5	6	7
2400	1280	1281	1282	1283	1284	1285	1286	1287
2410	1288	1289	1290	1291	1292	1293	1294	1295
2420	1296	1297	1298	1299	1300	1301	1302	1303
2430	1304	1305	1306	1307	1308	1309	1310	1311
2440	1312	1313	1314	1315	1316	1317	1318	1319
2450	1320	1321	1322	1323	1324	1325	1326	1327
2460	1328	1329	1330	1331	1332	1333	1334	1335
2470	1336	1337	1338	1339	1340	1341	1342	1343
2500	1344	1345	1346	1347	1348	1349	1350	1351
2510	1352	1353	1354	1355	1356	1357	1358	1359
2520	1360	1361	1362	1363	1364	1365	1366	1367
2530	1368	1369	1370	1371	1372	1373	1374	1375
2540	1376	1377	1378	1379	1380	1381	1382	1383
2550	1384	1385	1386	1387	1388	1389	1390	1391
2560	1392	1393	1394	1395	1396	1397	1398	1399
2570	1400	1401	1402	1403	1404	1405	1406	1407
2600	1408	1409	1410	1411	1412	1413	1414	1415
2610	1416	1417	1418	1419	1420	1421	1422	1423
2620	1424	1425	1426	1427	1428	1429	1430	1431
2630	1432	1433	1434	1435	1436	1437	1438	1439
2640	1440	1441	1442	1443	1444	1445	1446	1447
2650	1448	1449	1450	1451	1452	1453	1454	1455
2660	1456	1457	1458	1459	1460	1461	1462	1463
2670	1464	1465	1466	1467	1468	1469	1470	1471
2700	1472	1473	1474	1475	1476	1477	1478	1479
2710	1480	1481	1482	1483	1484	1485	1486	1487
2720	1488	1489	1490	1491	1492	1493	1494	1495
2730	1496	1497	1498	1499	1500	1501	1502	1503
2740	1504	1505	1506	1507	1508	1519	1510	1511
2750	1512	1513	1514	1515	1516	1517	1518	1519
2760	1520	1521	1522	1523	1524	1525	1526	1527
2770	1528	1529	1530	1531	1532	1533	1534	1535

Octal / Decimal

10000 - 4096
20000 - 8192
30000 - 12288
40000 - 16384
50000 - 20480
60000 - 24576
70000 - 28672

3000 to 3777 (Octal) — 1536 to 2047 (Decimal)

	0	1	2	3	4	5	6	7
3000	1536	1537	1538	1539	1540	1541	1542	1543
3010	1544	1545	1546	1547	1548	1549	1550	1551
3020	1552	1553	1554	1555	1556	1557	1558	1559
3030	1560	1561	1562	1563	1564	1565	1566	1567
3040	1568	1569	1570	1571	1572	1573	1574	1575
3050	1576	1577	1578	1579	1580	1581	1582	1583
3060	1584	1585	1586	1587	1588	1589	1590	1591
3070	1592	1593	1594	1595	1596	1597	1598	1599
3100	1600	1601	1602	1603	1604	1605	1606	1607
3110	1608	1609	1610	1611	1612	1613	1614	1615
3120	1616	1617	1618	1619	1620	1621	1622	1623
3130	1624	1625	1626	1627	1628	1629	1630	1631
3140	1632	1633	1634	1635	1636	1637	1638	1639
3150	1640	1641	1642	1643	1644	1645	1646	1647
3160	1648	1649	1650	1651	1652	1653	1654	1655
3170	1656	1657	1658	1659	1660	1661	1662	1663
3200	1664	1665	1666	1667	1668	1669	1670	1671
3210	1672	1673	1674	1675	1676	1677	1678	1679
3220	1680	1681	1682	1683	1684	1685	1686	1687
3230	1688	1689	1690	1691	1692	1693	1694	1695
3240	1696	1697	1698	1699	1700	1701	1702	1703
3250	1704	1705	1706	1707	1708	1709	1710	1711
3260	1712	1713	1714	1715	1716	1717	1718	1719
3270	1720	1721	1722	1723	1724	1725	1726	1727
3300	1728	1729	1730	1731	1732	1733	1734	1735
3310	1736	1737	1738	1739	1740	1741	1742	1743
3320	1744	1745	1746	1747	1748	1749	1750	1751
3330	1752	1753	1754	1755	1756	1757	1758	1759
3340	1760	1761	1762	1763	1764	1765	1766	1767
3350	1768	1769	1770	1771	1772	1773	1774	1775
3360	1776	1777	1778	1779	1780	1781	1782	1783
3370	1784	1785	1786	1787	1788	1789	1790	1791

	0	1	2	3	4	5	6	7
3400	1792	1793	1794	1795	1796	1797	1798	1799
3410	1800	1801	1802	1803	1804	1805	1806	1807
3420	1808	1809	1810	1811	1812	1813	1814	1815
3430	1816	1817	1818	1819	1820	1821	1822	1823
3440	1824	1825	1826	1827	1828	1829	1830	1831
3450	1832	1833	1834	1835	1836	1837	1838	1839
3460	1840	1841	1842	1843	1844	1845	1846	1847
3470	1848	1849	1850	1851	1852	1853	1854	1855
3500	1856	1857	1858	1859	1860	1861	1862	1863
3510	1864	1865	1866	1867	1868	1869	1870	1871
3520	1872	1873	1874	1875	1876	1877	1878	1879
3530	1880	1881	1882	1883	1884	1885	1886	1887
3540	1888	1889	1890	1891	1892	1893	1894	1895
3550	1896	1897	1898	1899	1900	1901	1902	1903
3560	1904	1905	1906	1907	1908	1909	1910	1911
3570	1912	1913	1914	1915	1916	1917	1918	1919
3600	1920	1921	1922	1923	1924	1925	1926	1927
3610	1928	1929	1930	1931	1932	1933	1934	1935
3620	1936	1937	1938	1939	1940	1941	1942	1943
3630	1944	1945	1946	1947	1948	1949	1950	1951
3640	1952	1953	1954	1955	1956	1957	1958	1959
3650	1960	1961	1962	1963	1964	1965	1966	1967
3660	1968	1969	1970	1971	1972	1973	1974	1975
3670	1976	1977	1978	1979	1980	1981	1982	1983
3700	1984	1985	1986	1987	1988	1989	1990	1991
3710	1992	1993	1994	1995	1996	1997	1998	1999
3720	2000	2001	2002	2003	2004	2005	2006	2007
3730	2008	2009	2010	2011	2012	2013	2014	2015
3740	2016	2017	2018	2019	2020	2021	2022	2023
3750	2024	2025	2026	2027	2028	2029	2030	2031
3760	2032	2033	2034	2035	2036	2037	2038	2039
3770	2040	2041	2042	2043	2044	2045	2046	2047

TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 3 OF 4)

	0	1	2	3	4	5	6	7
4000	2048	2049	2050	2051	2052	2053	2054	2055
4010	2056	2057	2058	2059	2060	2061	2062	2063
4020	2064	2065	2066	2067	2068	2069	2070	2071
4030	2072	2073	2074	2075	2076	2077	2078	2079
4040	2080	2081	2082	2083	2084	2085	2086	2087
4050	2088	2089	2090	2091	2092	2093	2094	2095
4060	2096	2097	2098	2099	2100	2101	2102	2103
4070	2104	2105	2106	2107	2108	2109	2110	2111
4100	2112	2113	2114	2115	2116	2117	2118	2119
4110	2120	2121	2122	2123	2124	2125	2126	2127
4120	2128	2129	2130	2131	2132	2133	2134	2135
4130	2136	2137	2138	2139	2140	2141	2142	2143
4140	2144	2145	2146	2147	2148	2149	2150	2151
4150	2152	2153	2154	2155	2156	2157	2158	2159
4160	2160	2161	2162	2163	2164	2165	2166	2167
4170	2168	2169	2170	2171	2172	2173	2174	2175
4200	2176	2177	2178	2179	2180	2181	2182	2183
4210	2184	2185	2186	2187	2188	2189	2190	2191
4220	2192	2193	2194	2195	2196	2197	2198	2199
4230	2200	2201	2202	2203	2204	2205	2206	2207
4240	2208	2209	2210	2211	2212	2213	2214	2215
4250	2216	2217	2218	2219	2220	2221	2222	2223
4260	2224	2225	2226	2227	2228	2229	2230	2231
4270	2232	2233	2234	2235	2236	2237	2238	2239
4300	2240	2241	2242	2243	2244	2245	2246	2247
4310	2248	2249	2250	2251	2252	2253	2254	2255
4320	2256	2257	2258	2259	2260	2261	2262	2263
4330	2264	2265	2266	2267	2268	2269	2270	2271
4340	2272	2273	2274	2275	2276	2277	2278	2279
4350	2280	2281	2282	2283	2284	2285	2286	2287
4360	2288	2289	2290	2291	2292	2293	2294	2295
4370	2296	2297	2298	2299	2300	2301	2302	2303

	0	1	2	3	4	5	6	7
4400	2304	2305	2306	2307	2308	2309	2310	2311
4410	2312	2313	2314	2315	2316	2317	2318	2319
4420	2320	2321	2322	2323	2324	2325	2326	2327
4430	2328	2329	2330	2331	2332	2333	2334	2335
4440	2336	2337	2338	2339	2340	2341	2342	2343
4450	2344	2345	2346	2347	2348	2349	2350	2351
4460	2352	2353	2354	2355	2356	2357	2358	2359
4470	2360	2361	2362	2363	2364	2365	2366	2367
4500	2368	2369	2370	2371	2372	2373	2374	2375
4510	2376	2377	2378	2379	2380	2381	2382	2383
4520	2384	2385	2386	2387	2388	2389	2390	2391
4530	2392	2393	2394	2395	2396	2397	2398	2399
4540	2400	2401	2402	2403	2404	2405	2406	2407
4550	2408	2409	2410	2411	2412	2413	2414	2415
4560	2416	2417	2418	2419	2420	2421	2422	2423
4570	2424	2425	2426	2427	2428	2429	2430	2431
4600	2432	2433	2434	2435	2436	2437	2438	2439
4610	2440	2441	2442	2443	2444	2445	2446	2447
4620	2448	2449	2450	2451	2452	2453	2454	2455
4630	2456	2457	2458	2459	2460	2461	2462	2463
4640	2464	2465	2466	2467	2468	2469	2470	2471
4650	2472	2473	2474	2475	2476	2477	2478	2479
4660	2480	2481	2482	2483	2484	2485	2486	2487
4670	2488	2489	2490	2491	2492	2493	2494	2495
4700	2496	2497	2498	2499	2500	2501	2502	2503
4710	2504	2505	2506	2507	2508	2509	2510	2511
4720	2512	2513	2514	2515	2516	2517	2518	2519
4730	2520	2521	2522	2523	2524	2525	2526	2527
4740	2528	2529	2530	2531	2532	2533	2534	2535
4750	2536	2537	2538	2539	2540	2541	2542	2543
4760	2544	2545	2546	2547	2548	2549	2550	2551
4770	2552	2553	2554	2555	2556	2557	2558	2559

4000	2048
to	to
4777	2559
(Octal)	(Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
5000	2560	2561	2562	2563	2564	2565	2566	2567
5010	2568	2569	2570	2571	2572	2573	2574	2575
5020	2576	2577	2578	2579	2580	2581	2582	2583
5030	2584	2585	2586	2587	2588	2589	2590	2591
5040	2592	2593	2594	2595	2596	2597	2598	2599
5050	2600	2601	2602	2603	2604	2605	2606	2607
5060	2608	2609	2610	2611	2612	2613	2614	2615
5070	2616	2617	2618	2619	2620	2621	2622	2623
5100	2624	2625	2626	2627	2628	2629	2630	2631
5110	2632	2633	2634	2635	2636	2637	2638	2639
5120	2640	2641	2642	2643	2644	2645	2646	2647
5130	2648	2649	2650	2651	2652	2653	2654	2655
5140	2656	2657	2658	2659	2660	2661	2662	2663
5150	2664	2665	2666	2667	2668	2669	2670	2671
5160	2672	2673	2674	2675	2676	2677	2678	2679
5170	2680	2681	2682	2683	2684	2685	2686	2687
5200	2688	2689	2690	2691	2692	2693	2694	2695
5210	2696	2697	2698	2699	2700	2701	2702	2703
5220	2704	2705	2706	2707	2708	2709	2710	2711
5230	2712	2713	2714	2715	2716	2717	2718	2719
5240	2720	2721	2722	2723	2724	2725	2726	2727
5250	2728	2729	2730	2731	2732	2733	2734	2735
5260	2736	2737	2738	2739	2740	2741	2742	2743
5270	2744	2745	2746	2747	2748	2749	2750	2751
5300	2752	2753	2754	2755	2756	2757	2758	2759
5310	2760	2761	2762	2763	2764	2765	2766	2767
5320	2768	2769	2770	2771	2772	2773	2774	2775
5330	2776	2777	2778	2779	2780	2781	2782	2783
5340	2784	2785	2786	2787	2788	2789	2790	2791
5350	2792	2793	2794	2795	2796	2797	2798	2799
5360	2800	2801	2802	2803	2804	2805	2806	2807
5370	2808	2809	2810	2811	2812	2813	2814	2815

	0	1	2	3	4	5	6	7
5400	2816	2817	2818	2819	2820	2821	2822	2823
5410	2824	2825	2826	2827	2828	2829	2830	2831
5420	2832	2833	2834	2835	2836	2837	2838	2839
5430	2840	2841	2842	2843	2844	2845	2846	2847
5440	2848	2849	2850	2851	2852	2853	2854	2855
5450	2856	2857	2858	2859	2860	2861	2862	2863
5460	2864	2865	2866	2867	2868	2869	2870	2871
5470	2872	2873	2874	2875	2876	2877	2878	2879
5500	2880	2881	2882	2883	2884	2885	2886	2887
5510	2888	2889	2890	2891	2892	2893	2894	2895
5520	2896	2897	2898	2899	2900	2901	2902	2903
5530	2904	2905	2906	2907	2908	2909	2910	2911
5540	2912	2913	2914	2915	2916	2917	2918	2919
5550	2920	2921	2922	2923	2924	2925	2926	2927
5560	2928	2929	2930	2931	2932	2933	2934	2935
5570	2936	2937	2938	2939	2940	2941	2942	2943
5600	2944	2945	2946	2947	2948	2949	2950	2951
5610	2952	2953	2954	2955	2956	2957	2958	2959
5620	2960	2961	2962	2963	2964	2965	2966	2967
5630	2968	2969	2970	2971	2972	2973	2974	2975
5640	2976	2977	2978	2979	2980	2981	2982	2983
5650	2984	2985	2986	2987	2988	2989	2990	2991
5660	2992	2993	2994	2995	2996	2997	2998	2999
5670	3000	3001	3002	3003	3004	3005	3006	3007
5700	3008	3009	3010	3011	3012	3013	3014	3015
5710	3016	3017	3018	3019	3020	3021	3022	3023
5720	3024	3025	3026	3027	3028	3029	3030	3031
5730	3032	3033	3034	3035	3036	3037	3038	3039
5740	3040	3041	3042	3043	3044	3045	3046	3047
5750	3048	3049	3050	3051	3052	3053	3054	3055
5760	3056	3057	3058	3059	3060	3061	3062	3063
5770	3064	3065	3066	3067	3068	3069	3070	3071

5000	2560
to	to
5777	3071
(Octal)	(Decimal)

TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 4 OF 4)

6000	3072
to	to
6777	3583
(Octal)	(Decimal)

Octal	Decimal
10000	4096
20000	8192
30000	12288
40000	16384
50000	20480
60000	24576
70000	28672

	0	1	2	3	4	5	6	7
6000	3072	3073	3074	3075	3076	3077	3078	3079
6010	3080	3081	3082	3083	3084	3085	3086	3087
6020	3088	3089	3090	3091	3092	3093	3094	3095
6030	3096	3097	3098	3099	3100	3101	3102	3103
6040	3104	3105	3106	3107	3108	3109	3110	3111
6050	3112	3113	3114	3115	3116	3117	3118	3119
6060	3120	3121	3122	3123	3124	3125	3126	3127
6070	3128	3129	3130	3131	3132	3133	3134	3135
6100	3136	3137	3138	3139	3140	3141	3142	3143
6110	3144	3145	3146	3147	3148	3149	3150	3151
6120	3152	3153	3154	3155	3156	3157	3158	3159
6130	3160	3161	3162	3163	3164	3165	3166	3167
6140	3168	3169	3170	3171	3172	3173	3174	3175
6150	3176	3177	3178	3179	3180	3181	3182	3183
6160	3184	3185	3186	3187	3188	3189	3190	3191
6170	3192	3193	3194	3195	3196	3197	3198	3199
6200	3200	3201	3202	3203	3204	3205	3206	3207
6210	3208	3209	3210	3211	3212	3213	3214	3215
6220	3216	3217	3218	3219	3220	3221	3222	3223
6230	3224	3225	3226	3227	3228	3229	3230	3231
6240	3232	3233	3234	3235	3236	3237	3238	3239
6250	3240	3241	3242	3243	3244	3245	3246	3247
6260	3248	3249	3250	3251	3252	3253	3254	3255
6270	3256	3257	3258	3259	3260	3261	3262	3263
6300	3264	3265	3266	3267	3268	3269	3270	3271
6310	3272	3273	3274	3275	3276	3277	3278	3279
6320	3280	3281	3282	3283	3284	3285	3286	3287
6330	3288	3289	3290	3291	3292	3293	3294	3295
6340	3296	3297	3298	3299	3300	3301	3302	3303
6350	3304	3305	3306	3307	3308	3309	3310	3311
6360	3312	3313	3314	3315	3316	3317	3318	3319
6370	3320	3321	3322	3323	3324	3325	3326	3327

	0	1	2	3	4	5	6	7
6400	3328	3329	3330	3331	3332	3333	3334	3335
6410	3336	3337	3338	3339	3340	3341	3342	3343
6420	3344	3345	3346	3347	3348	3349	3350	3351
6430	3352	3353	3354	3355	3356	3357	3358	3359
6440	3360	3361	3362	3363	3364	3365	3366	3367
6450	3368	3369	3370	3371	3372	3373	3374	3375
6460	3376	3377	3378	3379	3380	3381	3382	3383
6470	3384	3385	3386	3387	3388	3389	3390	3391
6500	3392	3393	3394	3395	3396	3397	3398	3399
6510	3400	3401	3402	3403	3404	3405	3406	3407
6520	3408	3409	3410	3411	3412	3413	3414	3415
6530	3416	3417	3418	3419	3420	3421	3422	3423
6540	3424	3425	3426	3427	3428	3429	3430	3431
6550	3432	3433	3434	3435	3436	3437	3438	3439
6560	3440	3441	3442	3443	3444	3445	3446	3447
6570	3448	3449	3450	3451	3452	3453	3454	3455
6600	3456	3457	3458	3459	3460	3461	3462	3463
6610	3464	3465	3466	3467	3468	3469	3470	3471
6620	3472	3473	3474	3475	3476	3477	3478	3479
6630	3480	3481	3482	3483	3484	3485	3486	3487
6640	3488	3489	3490	3491	3492	3493	3494	3495
6650	3496	3497	3498	3499	3500	3501	3502	3503
6660	3504	3505	3506	3507	3508	3509	3510	3511
6670	3512	3513	3514	3515	3516	3517	3518	3519
6700	3520	3521	3522	3523	3524	3525	3526	3527
6710	3528	3529	3530	3531	3532	3533	3534	3535
6720	3536	3537	3538	3539	3540	3541	3542	3543
6730	3544	3545	3546	3547	3548	3549	3550	3551
6740	3552	3553	3554	3555	3556	3557	3558	3559
6750	3560	3561	3562	3563	3564	3565	3566	3567
6760	3568	3569	3570	3571	3572	3573	3574	3575
6770	3576	3577	3578	3579	3580	3581	3582	3583

7000	3584
to	to
7777	4095
(Octal)	(Decimal)

	0	1	2	3	4	5	6	7
7000	3584	3585	3586	3587	3588	3589	3590	3591
7010	3592	3593	3594	3595	3496	3497	3598	3599
7020	3600	3601	3602	3603	3604	3605	3606	3607
7030	3608	3609	3610	3611	3612	3613	3614	3615
7040	3616	3617	3618	3619	3620	3621	3622	3623
7050	3624	3625	3626	3627	3628	3629	3630	3631
7060	3632	3633	3634	3635	3636	3637	3638	3639
7070	3640	3641	3642	3643	3644	3645	3646	3647
7100	3648	3649	3650	3651	3652	3653	3654	3655
7110	3656	3657	3658	3659	3660	3661	3662	3663
7120	3664	3665	3666	3667	3668	3669	3670	3671
7130	3672	3673	3674	3675	3676	3677	3678	3679
7140	3680	3681	3682	3683	3684	3685	3686	3687
7150	3688	3689	3690	3691	3692	3693	3694	3695
7160	3696	3697	3698	3699	3700	3701	3702	3703
7170	3704	3705	3706	3707	3708	3709	3710	3711
7200	3712	3713	3714	3715	3716	3717	3718	3719
7210	3720	3721	3722	3723	3724	3725	3726	3727
7220	3728	3729	3730	3731	3732	3733	3734	3735
7230	3736	3737	3738	3739	3740	3741	3742	3743
7240	3744	3745	3746	3747	3748	3749	3750	3751
7250	3752	3753	3754	3755	3756	3757	3758	3759
7260	3760	3761	3762	3763	3764	3765	3766	3767
7270	3768	3769	3770	3771	3772	3773	3774	3775
7300	3776	3777	3778	3779	3780	3781	3782	3783
7310	3784	3785	3786	3787	3788	3789	3790	3791
7320	3792	3793	3794	3795	3796	3797	3798	3799
7330	3800	3801	3802	3803	3804	3805	3806	3807
7340	3808	3809	3810	3811	3812	3813	3814	3815
7350	3816	3817	3818	3819	3820	3821	3822	3823
7360	3824	3825	3826	3827	3828	3829	3830	3831
7370	3832	3833	3834	3835	3836	3837	3838	3839

	0	1	2	3	4	5	6	7
7400	3840	3841	3842	3843	3844	3845	3846	3847
7410	3848	3849	3850	3851	3852	3853	3854	3855
7420	3856	3857	3858	3859	3860	3861	3862	3863
7430	3864	3865	3866	3867	3868	3869	3870	3871
7440	3872	3873	3874	3875	3876	3877	3878	3879
7450	3880	3881	3882	3883	3884	3885	3886	3887
7460	3888	3889	3890	3891	3892	3893	3894	3895
7470	3896	3897	3898	3899	3900	3901	3902	3903
7500	3904	3905	3906	3907	3908	3909	3910	3911
7510	3912	3913	3914	3915	3916	3917	3918	3919
7520	3920	3921	3922	3923	3924	3925	3926	3927
7530	3928	3929	3930	3931	3932	3933	3934	3935
7540	3936	3937	3938	3939	3940	3941	3942	3943
7550	3944	3945	3946	3947	3948	3949	3950	3951
7560	3952	3953	3954	3955	3956	3957	3958	3959
7570	3960	3961	3962	3963	3964	3965	3966	3967
7600	3968	3969	3970	3971	3972	3973	3974	3975
7610	3976	3977	3978	3979	3980	3981	3982	3983
7620	3984	3985	3986	3987	3988	3989	3990	3991
7630	3992	3993	3994	3995	3996	3997	3998	3999
7640	4000	4001	4002	4003	4004	4005	4006	4007
7650	4008	4009	4010	4011	4012	4013	4014	4015
7660	4016	4017	4018	4019	4020	4021	4022	4023
7670	4024	4025	4026	4027	4028	4029	4030	4031
7700	4032	4033	4034	4035	4036	4037	4038	4039
7710	4040	4041	4042	4043	4044	4045	4046	4047
7720	4048	4049	4050	4051	4052	4053	4054	4055
7730	4056	4057	4058	4059	4060	4061	4062	4063
7740	4064	4065	4066	4067	4068	4069	4070	4071
7750	4072	4073	4074	4075	4076	4077	4078	4079
7760	4080	4081	4082	4083	4084	4085	4086	4087
7770	4088	4089	4090	4091	4092	4093	4094	4095

TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 1 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000	.000000	.100	.125000	.200	.250000	.300	.375000
.001	.001953	.101	.126953	.201	.251953	.301	.376953
.002	.003906	.102	.128906	.202	.253906	.302	.378906
.003	.005859	.103	.130859	.203	.255859	.303	.380859
.004	.007812	.104	.132812	.204	.257812	.304	.382812
.005	.009765	.105	.134765	.205	.259765	.305	.384765
.006	.011718	.106	.136718	.206	.261718	.306	.386718
.007	.013671	.107	.138671	.207	.263671	.307	.388671
.010	.015625	.110	.140625	.210	.265625	.310	.390625
.011	.017578	.111	.142578	.211	.267578	.311	.392578
.012	.019531	.112	.144531	.212	.269531	.312	.394531
.013	.021484	.113	.146484	.213	.271484	.313	.396484
.014	.023437	.114	.148437	.214	.273437	.314	.398437
.015	.025390	.115	.150390	.215	.275390	.315	.400390
.016	.027343	.116	.152343	.216	.277343	.316	.402343
.017	.029296	.117	.154296	.217	.279296	.317	.404296
.020	.031250	.120	.156250	.220	.281250	.320	.406250
.021	.033203	.121	.158203	.221	.283203	.321	.408203
.022	.035156	.122	.160156	.222	.285156	.322	.410156
.023	.037109	.123	.162109	.223	.287109	.323	.412109
.024	.039062	.124	.164062	.224	.289062	.324	.414062
.025	.041015	.125	.166015	.225	.291015	.325	.416015
.026	.042968	.126	.167968	.226	.292968	.326	.417968
.027	.044921	.127	.169921	.227	.294921	.327	.419921
.030	.046875	.130	.171875	.230	.296875	.330	.421875
.031	.048828	.131	.173828	.231	.298828	.331	.423828
.032	.050781	.132	.175781	.232	.300781	.332	.425781
.033	.052734	.133	.177734	.233	.302734	.333	.427734
.034	.054687	.134	.179687	.234	.304687	.334	.429687
.035	.056640	.135	.181640	.235	.306640	.335	.431640
.036	.058593	.136	.183593	.236	.308593	.336	.433593
.037	.060546	.137	.185546	.237	.310546	.337	.435546
.040	.062500	.140	.187500	.240	.312500	.340	.437500
.041	.064453	.141	.189453	.241	.314453	.341	.439453
.042	.066406	.142	.191406	.242	.316406	.342	.441406
.043	.068359	.143	.193359	.243	.318359	.343	.443359
.044	.070312	.144	.195312	.244	.320312	.344	.445312
.045	.072265	.145	.197265	.245	.322265	.345	.447265
.046	.074218	.146	.199218	.246	.324218	.346	.449218
.047	.076171	.147	.201171	.247	.326171	.347	.451171
.050	.078125	.150	.203125	.250	.328125	.350	.453125
.051	.080078	.151	.205078	.251	.330078	.351	.455078
.052	.082031	.152	.207031	.252	.332031	.352	.457031
.053	.083984	.153	.208984	.253	.333984	.353	.458984
.054	.085937	.154	.210937	.254	.335937	.354	.460937
.055	.087890	.155	.212890	.255	.337890	.355	.462890
.056	.089843	.156	.214843	.256	.339843	.356	.464843
.057	.091796	.157	.216796	.257	.341796	.357	.466796
.060	.093750	.160	.218750	.260	.343750	.360	.468750
.061	.095703	.161	.220703	.261	.345703	.361	.470703
.062	.097656	.162	.222656	.262	.347656	.362	.472656
.063	.099609	.163	.224609	.263	.349609	.363	.474609
.064	.101562	.164	.226562	.264	.351562	.364	.476562
.065	.103515	.165	.228515	.265	.353515	.365	.478515
.066	.105468	.166	.230468	.266	.355468	.366	.480468
.067	.107421	.167	.232421	.267	.357421	.367	.482421
.070	.109375	.170	.234375	.270	.359375	.370	.484375
.071	.111328	.171	.236328	.271	.361328	.371	.486328
.072	.113281	.172	.238281	.272	.363281	.372	.488281
.073	.115234	.173	.240234	.273	.365234	.373	.490234
.074	.117187	.174	.242187	.274	.367187	.374	.492187
.075	.119140	.175	.244140	.275	.369140	.375	.494140
.076	.121093	.176	.246093	.276	.371093	.376	.496093
.077	.123046	.177	.248046	.277	.373046	.377	.498046

TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 2 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000400	.000976	.000500	.001220	.000600	.001464	.000700	.001708
.000401	.000980	.000501	.001224	.000601	.001468	.000701	.001712
.000402	.000984	.000502	.001228	.000602	.001472	.000702	.001716
.000403	.000988	.000503	.001232	.000603	.001476	.000703	.001720
.000404	.000991	.000504	.001235	.000604	.001480	.000704	.001724
.000405	.000995	.000505	.001239	.000605	.001483	.000705	.001728
.000406	.000999	.000506	.001243	.000606	.001487	.000706	.001731
.000407	.001003	.000507	.001247	.000607	.001491	.000707	.001735
.000410	.001007	.000510	.001251	.000610	.001495	.000710	.001739
.000411	.001010	.000511	.001255	.000611	.001499	.000711	.001743
.000412	.001014	.000512	.001258	.000612	.001502	.000712	.001747
.000413	.001018	.000513	.001262	.000613	.001506	.000713	.001750
.000414	.001022	.000514	.001266	.000614	.001510	.000714	.001754
.000415	.001026	.000515	.001270	.000615	.001514	.000715	.001758
.000416	.001029	.000516	.001274	.000616	.001518	.000716	.001762
.000417	.001033	.000517	.001277	.000617	.001522	.000717	.001766
.000420	.001037	.000520	.001281	.000620	.001525	.000720	.001770
.000421	.001041	.000521	.001285	.000621	.001529	.000721	.001773
.000422	.001045	.000522	.001289	.000622	.001533	.000722	.001777
.000423	.001049	.000523	.001293	.000623	.001537	.000723	.001781
.000424	.001052	.000524	.001296	.000624	.001541	.000724	.001785
.000425	.001056	.000525	.001300	.000625	.001544	.000725	.001789
.000426	.001060	.000526	.001304	.000626	.001548	.000726	.001792
.000427	.001064	.000527	.001308	.000627	.001552	.000727	.001796
.000430	.001068	.000530	.001312	.000630	.001556	.000730	.001800
.000431	.001071	.000531	.001316	.000631	.001560	.000731	.001804
.000432	.001075	.000532	.001319	.000632	.001564	.000732	.001808
.000433	.001079	.000533	.001323	.000633	.001567	.000733	.001811
.000434	.001083	.000534	.001327	.000634	.001571	.000734	.001815
.000435	.001087	.000535	.001331	.000635	.001575	.000735	.001819
.000436	.001091	.000536	.001335	.000636	.001579	.000736	.001823
.000437	.001094	.000537	.001338	.000637	.001583	.000737	.001827
.000440	.001098	.000540	.001342	.000640	.001586	.000740	.001831
.000441	.001102	.000541	.001346	.000641	.001590	.000741	.001834
.000442	.001106	.000542	.001350	.000642	.001594	.000742	.001838
.000443	.001110	.000543	.001354	.000643	.001598	.000743	.001842
.000444	.001113	.000544	.001358	.000644	.001602	.000744	.001846
.000445	.001117	.000545	.001361	.000645	.001605	.000745	.001850
.000446	.001121	.000546	.001365	.000646	.001609	.000746	.001853
.000447	.001125	.000547	.001369	.000647	.001613	.000747	.001857
.000450	.001129	.000550	.001373	.000650	.001617	.000750	.001861
.000451	.001132	.000551	.001377	.000651	.001621	.000751	.001865
.000452	.001136	.000552	.001380	.000652	.001625	.000752	.001869
.000453	.001140	.000553	.001384	.000653	.001628	.000753	.001873
.000454	.001144	.000554	.001388	.000654	.001632	.000754	.001876
.000455	.001148	.000555	.001392	.000655	.001636	.000755	.001880
.000456	.001152	.000556	.001396	.000656	.001640	.000756	.001884
.000457	.001155	.000557	.001399	.000657	.001644	.000757	.001888
.000460	.001159	.000560	.001403	.000660	.001647	.000760	.001892
.000461	.001163	.000561	.001407	.000661	.001651	.000761	.001895
.000462	.001167	.000562	.001411	.000662	.001655	.000762	.001899
.000463	.001171	.000563	.001415	.000663	.001659	.000763	.001903
.000464	.001174	.000564	.001419	.000664	.001663	.000764	.001907
.000465	.001178	.000565	.001422	.000665	.001667	.000765	.001911
.000466	.001182	.000566	.001426	.000666	.001670	.000766	.001914
.000467	.001186	.000567	.001430	.000667	.001674	.000767	.001918
.000470	.001190	.000570	.001434	.000670	.001678	.000770	.001922
.000471	.001194	.000571	.001438	.000671	.001682	.000771	.001926
.000472	.001197	.000572	.001441	.000672	.001686	.000772	.001930
.000473	.001201	.000573	.001445	.000673	.001689	.000773	.001934
.000474	.001205	.000574	.001449	.000674	.001693	.000774	.001937
.000475	.001209	.000575	.001453	.000675	.001697	.000775	.001941
.000476	.001213	.000576	.001457	.000676	.001701	.000776	.001945
.000477	.001216	.000577	.001461	.000677	.001705	.000777	.001949

TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 3 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000000	.000000	.000100	.000244	.000200	.000488	.000300	.000732
.000001	.000003	.000101	.000247	.000201	.000492	.000301	.000736
.000002	.000007	.000102	.000251	.000202	.000495	.000302	.000740
.000003	.000011	.000103	.000255	.000203	.000499	.000303	.000743
.000004	.000015	.000104	.000259	.000204	.000503	.000304	.000747
.000005	.000019	.000105	.000263	.000205	.000507	.000305	.000751
.000006	.000022	.000106	.000267	.000206	.000511	.000306	.000755
.000007	.000026	.000107	.000270	.000207	.000514	.000307	.000759
.000010	.000030	.000110	.000274	.000210	.000518	.000310	.000762
.000011	.000034	.000111	.000278	.000211	.000522	.000311	.000766
.000012	.000038	.000112	.000282	.000212	.000526	.000312	.000770
.000013	.000041	.000113	.000286	.000213	.000530	.000313	.000774
.000014	.000045	.000114	.000289	.000214	.000534	.000314	.000778
.000015	.000049	.000115	.000293	.000215	.000537	.000315	.000782
.000016	.000053	.000116	.000297	.000216	.000541	.000316	.000785
.000017	.000057	.000117	.000301	.000217	.000545	.000317	.000789
.000020	.000061	.000120	.000305	.000220	.000549	.000320	.000793
.000021	.000064	.000121	.000308	.000221	.000553	.000321	.000797
.000022	.000068	.000122	.000312	.000222	.000556	.000322	.000801
.000023	.000072	.000123	.000316	.000223	.000560	.000323	.000805
.000024	.000076	.000124	.000320	.000224	.000564	.000324	.000808
.000025	.000080	.000125	.000324	.000225	.000568	.000325	.000812
.000026	.000083	.000126	.000328	.000226	.000572	.000326	.000816
.000027	.000087	.000127	.000331	.000227	.000576	.000327	.000820
.000030	.000091	.000130	.000335	.000230	.000579	.000330	.000823
.000031	.000095	.000131	.000339	.000231	.000583	.000331	.000827
.000032	.000099	.000132	.000343	.000232	.000587	.000332	.000831
.000033	.000102	.000133	.000347	.000233	.000591	.000333	.000835
.000034	.000106	.000134	.000350	.000234	.000595	.000334	.000839
.000035	.000110	.000135	.000354	.000235	.000598	.000335	.000843
.000036	.000114	.000136	.000358	.000236	.000602	.000336	.000846
.000037	.000118	.000137	.000362	.000237	.000606	.000337	.000850
.000040	.000122	.000140	.000366	.000240	.000610	.000340	.000854
.000041	.000125	.000141	.000370	.000241	.000614	.000341	.000858
.000042	.000129	.000142	.000373	.000242	.000617	.000342	.000862
.000043	.000133	.000143	.000377	.000243	.000621	.000343	.000865
.000044	.000137	.000144	.000381	.000244	.000625	.000344	.000869
.000045	.000141	.000145	.000385	.000245	.000629	.000345	.000873
.000046	.000144	.000146	.000389	.000246	.000633	.000346	.000877
.000047	.000148	.000147	.000392	.000247	.000637	.000347	.000881
.000050	.000152	.000150	.000396	.000250	.000640	.000350	.000885
.000051	.000156	.000151	.000400	.000251	.000644	.000351	.000888
.000052	.000160	.000152	.000404	.000252	.000648	.000352	.000892
.000053	.000164	.000153	.000408	.000253	.000652	.000353	.000896
.000054	.000167	.000154	.000411	.000254	.000656	.000354	.000900
.000055	.000171	.000155	.000415	.000255	.000659	.000355	.000904
.000056	.000175	.000156	.000419	.000256	.000663	.000356	.000907
.000057	.000179	.000157	.000423	.000257	.000667	.000357	.000911
.000060	.000183	.000160	.000427	.000260	.000671	.000360	.000915
.000061	.000186	.000161	.000431	.000261	.000675	.000361	.000919
.000062	.000190	.000162	.000434	.000262	.000679	.000362	.000923
.000063	.000194	.000163	.000438	.000263	.000682	.000363	.000926
.000064	.000198	.000164	.000442	.000264	.000686	.000364	.000930
.000065	.000202	.000165	.000446	.000265	.000690	.000365	.000934
.000066	.000205	.000166	.000450	.000266	.000694	.000366	.000938
.000067	.000209	.000167	.000453	.000267	.000698	.000367	.000942
.000070	.000213	.000170	.000457	.000270	.000701	.000370	.000946
.000071	.000217	.000171	.000461	.000271	.000705	.000371	.000949
.000072	.000221	.000172	.000465	.000272	.000709	.000372	.000953
.000073	.000225	.000173	.000469	.000273	.000713	.000373	.000957
.000074	.000228	.000174	.000473	.000274	.000717	.000374	.000961
.000075	.000232	.000175	.000476	.000275	.000720	.000375	.000965
.000076	.000236	.000176	.000480	.000276	.000724	.000376	.000968
.000077	.000240	.000177	.000484	.000277	.000728	.000377	.000972

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