

Systems

**An Introduction to the
IBM 3270 Information
Display System**

IBM

Preface

This publication provides customer executives, installation managers and planners, and IBM marketing representatives with planning information about the IBM 3270 Information Display System. The 3270 display system is composed of the following units:

- 3271 Control Unit, Models 1 and 2
- 3272 Control Unit, Models 1 and 2
- 3275 Display Station, Models 1 and 2
- 3277 Display Station, Models 1 and 2
- 3284 Printer, Models 1, 2, and 3
- 3286 Printer, Models 1 and 2

The 3270 display system is offered with the following programming support:

- BTAM under DOS and OS
- DIDOCS and SDS

This book is divided into ten chapters. Chapter 1 provides an introduction to the 3270 display system, highlighting the most important aspects of the product. Chapter 2 is concerned with configuring applications-oriented display systems and also describes the many

special features available to expand performance. Appendixes A and B support this chapter by providing a configurator and a features list, respectively. Chapter 3 highlights the functional capabilities of the display system. A reader who is concerned with the detailed operation of these capabilities will find them described in depth in Appendix C. Chapter 4 discusses types of applications that can be served by the 3270 display system. Chapter 5 describes highlights of the programming support, and Chapter 6 cites programming considerations for converting from an IBM 2260/2848 or an IBM 2265/2845 display system to a 3270 display system. Chapters 7 through 10 provide descriptions of human factors considerations, installation planning, reliability and availability, and performance considerations, respectively.

The book assumes that a reader has a basic understanding of display systems and their relationship to a central processor. Someone reading those chapters related to programming is expected to have an understanding of an operating system and applications-related display system programming support. Chapter 5, Programming Support, and Chapter 8, Installation Planning, provide references to other IBM documentation for additional information on their respective subjects.

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A 3270 Information Display System (Design Model)

The IBM 3270 Information Display System is a new family of display products that can significantly reduce total display system cost through:

- Configuration and feature flexibility.
- Advanced hardware, programming, and operator capabilities.
- Increased reliability and availability.

The 3270 display system can be tailored to meet the needs of all alphanumeric display applications. It sets a new standard for display system price/performance by offering improved response times and transaction rates based on increased transmission and operator efficiency. In addition, the 3270 display system is easy to operate and well suited to an office environment.

Configurations and Features

The 3270 display system has outstanding configuration flexibility:

- It can be a standalone unit, a small cluster, or a large cluster (of up to 32 units).
- It can include 480-character display stations (Figure 1-1) or large-capacity 1920-character display stations (Figure 1-2) or both.
- It can also include printers (40 or 66 characters per second).
- It can be attached locally (directly to the channel) or remotely (through communications facilities).
- It allows more display stations to be attached to each communications line and is compatible with other BSC devices.

The 3270 display system also has exceptional feature flexibility:

- It offers typewriter, data entry, and operator console keyboards and a selector pen.
- It provides local data transfer rates of up to 650,000 characters per second and remote line speeds of up to 4800 bits per second (using a modem such as the IBM 4872 High-Speed Digital Modem, Models 2 and 3).
- It includes data security enhancement features, such as a key lock, an operator identification card reader, and the ability to enter data without it being displayed.

For details about configurations and features, see Chapter 2.

Functional Capabilities

The advanced capabilities of the 3270 display system include:

- Hardware capabilities for data compaction (which reduces the number of characters that have to be transmitted) to improve response time by increasing transmission efficiency.
- Programming capabilities for screen formatting and operator capabilities for screen editing to improve transaction rates by increasing operator efficiency.

Chapter 3 describes functional capabilities of the 3270 display system; performance considerations are described in Chapter 10.

Applications, Programming Support, Conversion

The 3270 display system is designed for the whole range of alphanumeric display applications, including simple, interactive, or complex inquiry applications, data or order entry applications, and system console applications. Chapter 4 contains a survey of applications and a description of advantages and highlights of the 3270 display system in relation to these applications.

Programming support for the 3270 display system includes:

- General-purpose Basic Telecommunications Access Method (BTAM) support under both the System/360 Disk Operating System and the System/360 Operating System.
- Display console support (DIDOCs) and status display support (SDS) under the System/360 Operating System for using the local 3270 display system as a system console to control a system and to present status displays.

Chapter 5 discusses the programming support.

For information about converting from IBM 2260/2848 or IBM 2265/2845 display systems to 3270 display systems, see Chapter 6.

Reliability and Availability

The 3270 display system provides customers with much higher reliability and availability:

- The latest solid-state components ensure extremely reliable character generation and image control and regeneration.

- The decentralized design, which places more circuitry in the display station and less in the control unit, minimizes the failure of one unit from affecting the availability of the rest of the display system.

Chapter 9 gives more information on reliability and availability.

Human Factors and Installation Planning

The 3270 display system has been carefully designed with human factors and installation planning considerations in mind:

- The display image is of a high quality in terms of clarity, stability, and brightness.

- The display stations are easy to operate: features such as movable keyboards with layouts familiar to typists, data entry operators, or system operators contribute to maximum operator efficiency with minimum retraining.
- The display systems are easy to install in a normal office or computer room environment: the units are comparatively small in size and light in weight and do not require air conditioning.

For details about human factors and installation planning, see Chapter 7 and 8, respectively.



Figure 1-1. 3277 Display Station, Model 1 (Design Model)



Figure 1-2. 3277 Display Station, Model 2 (Design Model)

The 3270 family of display system products was described in the previous chapter as being flexible. Flexibility includes the ability to configure a variety of display systems from one basic group of IBM units:

3271 Control Unit

- Model 1 - 480 character buffer capacity.
- Model 2 - 1920 character buffer capacity.
- Attaches to a System/360 or System/370 via data sets and an IBM 2701 Data Adapter Unit, an IBM 2703 Transmission Control Unit, or an Integrated Communications Adapter.

3272 Control Unit

- Model 1 - 480 character buffer capacity.
- Model 2 - 1920 character buffer capacity.
- Attaches to a System/360 or a System/370 via a selector, multiplexer, or block multiplexer channel.

3275 Display Station

- Model 1 - 480 character display image.
- Model 2 - 1920 character display image.
- A stand-alone unit that attaches to a System/360 or System/370 via data sets and an IBM 2701, an IBM 2703, or an Integrated Communications Adapter.

3277 Display Station

- Model 1 - 480 character display image.
- Model 2 - 1920 character display image.
- Attaches to a 3271 or a 3272 control unit.

3284 Printer

- Model 1 - 480 character buffer capacity with a 40-cps printout rate.
- Model 1 attaches to a 3271 or a 3272 control unit, model 1 or 2.
- Model 2 - 1920 character buffer capacity with a 40-cps printout rate.
- Model 2 attaches to a 3271 or a 3272 control unit, model 2.
- Model 3 - no buffer is provided; the printout rate is 40 cps.
- Model 3 attaches to a 3275 display station, model 1 or 2.

3286 Printer

- Model 1 - 480 character buffer capacity with a 66-cps printout rate.
- Model 1 attaches to a 3271 or a 3272 control unit, model 1 or 2.
- Model 2 - 1920 character buffer capacity with a 66-cps printout rate.
- Model 2 attaches to a 3271 or a 3272 control unit, model 2.

A 3270 display system, configured from the list of units just introduced, can be one that fits the needs of most applications. The flexibility of configuring the display system is further enhanced by the number of IBM systems with which it can be operated. Among the systems that can operate with 3270 display systems are:

System/360 Models 25, 30, 40, 50, 65, 67*, 75, 85, and 195.

System/370 Models 135, 145, 155, and 165.

The following text describes how to configure a local or a remote 3270 display system.

EXAMPLE DISPLAY SYSTEM CONFIGURATIONS

The 3272 control unit, model 1, can direct the operation of up to 32 attached:

- 3277 display stations, model 1.
- 3284 printers, model 1.
- 3286 printers, model 1.

The 3272 control unit, model 2, can direct the operation of up to 32 attached:

- 3277 display stations, model 1 or 2.
- 3284 printers, model 1 or 2.
- 3286 printers, model 1 or 2.

At least one display station with a keyboard must be attached to any control unit (Figure 2-1). Local (direct) attachment of a control unit to a System/360 or System/370 is through a selector, multiplexer, or block multiplexer channel; the control unit attaches via one of

*The System/360 Operating System (OS) will support attachment in 65 mode only.

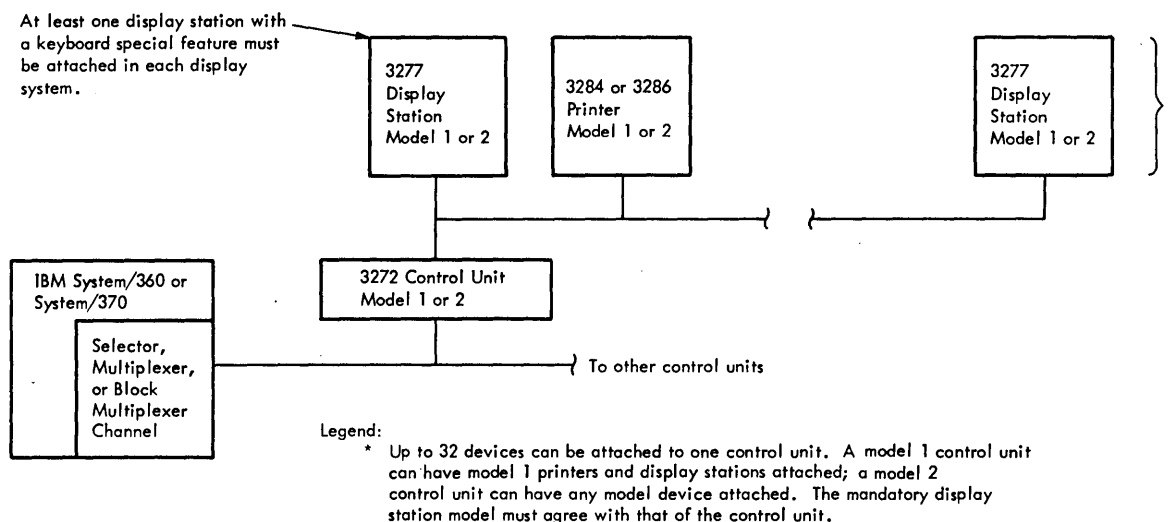


Figure 2-1. Locally Attached 3270 Display System

the eight control unit positions on the channel interface. The channel provides the control unit with data that is to be displayed and with control information that is needed to direct the operation of the display station or printer controller that may be attached to the control unit. Buffer storage in the devices (display station or printer) stores digitally coded data from the control unit for display or printing. The buffer permits simultaneous display image presentation and message composition from a keyboard at each display station.

Locally attached control units can be positioned up to 200 feet from the system channel, depending upon system and channel configuration. Each attached device can operate up to 2000 feet from a control unit, allowing computer access from a display operator's normal working area. Sharing of the control unit by several devices results in economical configurations.

Remotely attached 3270 display systems use a 3271 control unit, model 1 or 2 (Figure 2-2). Remote attachment differs from local attachment in the medium through which the control unit and system channel communicate. In a local configuration, the control unit is cabled directly to the system channel. In a remote configuration, a transmission control unit (TCU) is cabled locally to the system channel. The TCU relays display data and control information from the system channel to the control unit in a binary synchronous communications (BSC) multipoint data link mode of operation via data sets and common carrier leased voice grade channels or the customer's own equivalent communication facilities (telephone lines, microwave transmission, or satellite).

A stand-alone remote display system, the 3275 display station, model 1 or 2, provides added convenience for locations requiring a single display device. The 3275 display station does not require a control unit to communicate and is therefore more economical than a control unit with a

single 3277 display station attached. The 3275 display station unit can be expanded by attaching a 3284 printer, model 3 (Figure 2-3), to provide a paper copy of computer messages. The 3275 display station can be attached (dropped) to the same remote communication line as other 3270 display systems and other IBM products that use the BSC mode of operation.

FEATURES

Many features are available for installation on 3270 display system units. The features are described below, and a three-page display system configurator is provided in Appendix A.

Features are categorized as Specify or Special. A Specify (standard) feature is one that must be chosen (at no extra cost) to make a display system functional. A special feature is one that involves extra costs but is not required to make the display system functional; this feature will improve performance, provide additional operational capability, or permit expansion of the display system.

Appendix B lists all features, Specify and Special, now available.

Specify Features

Power

Display stations and printers in the United States all operate with 115V, 60Hz power; control units, however, operate from any one of three different power sources. All units available through the IBM World Trade Corporation can operate from one of eight different power sources.

Character Generator

Character generators are designed in United States English, United Kingdom English, and German.

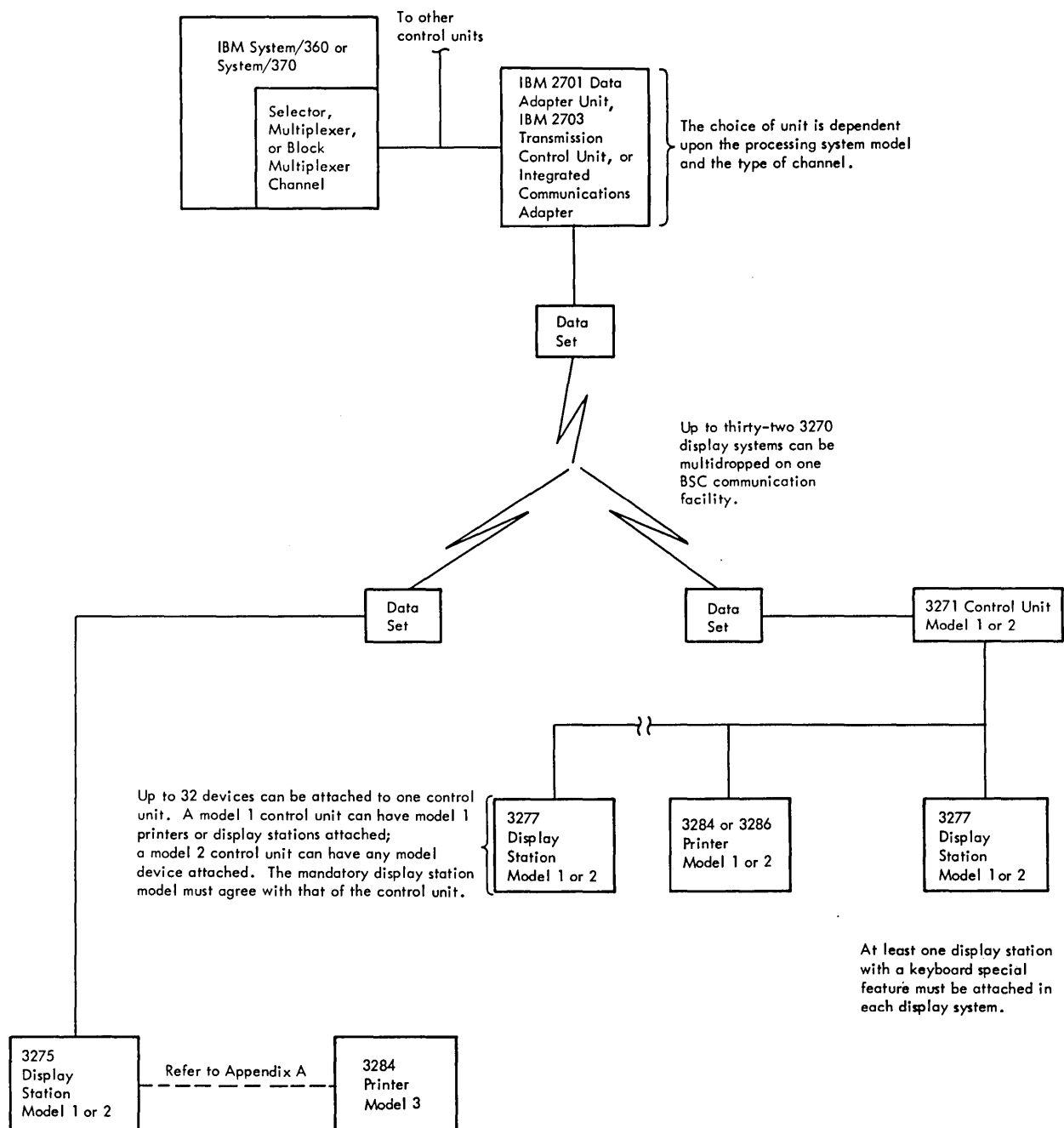


Figure 2-2. Remotely Attached 3270 Display System



Figure 2-3. 3275 Display Station with 3284 Printer, Model 3 (Design Model)

Special Features

Device Adapter

Every control unit has one built-in device adapter. This adapter provides a control unit with the facilities necessary to communicate with, and service up to, four devices (display stations or printers). Since each control unit can operate with up to 32 devices, up to 7 device adapters can be added to a basic control unit.

1200-bps Transmission Speed

The 3271 control units and 3275 display stations can communicate with a central processing unit from a remote location via communication facilities at speeds of 1200-, 2000-*, 2400-, or 4800-bps.

At the 2000-*, 2400-, or 4800-bps rates, the data set must provide the necessary clocking. At the 1200-bps transmission rate, clocking is not provided by the data set.

*2000-bps is not available to World Trade customers.

When this situation exists, a 1200-bps transmission speed feature is required to provide the needed clocking.

4800-bps Transmission Speed

Installing this feature in a 3271 control unit or a 3275 display station permits operation with communication facilities at a speed of 4800-bps.

ASCII Transmission Code

This feature allows the display system to be attached to central processing systems that communicate in ASCII code.

ASCII Character Generator

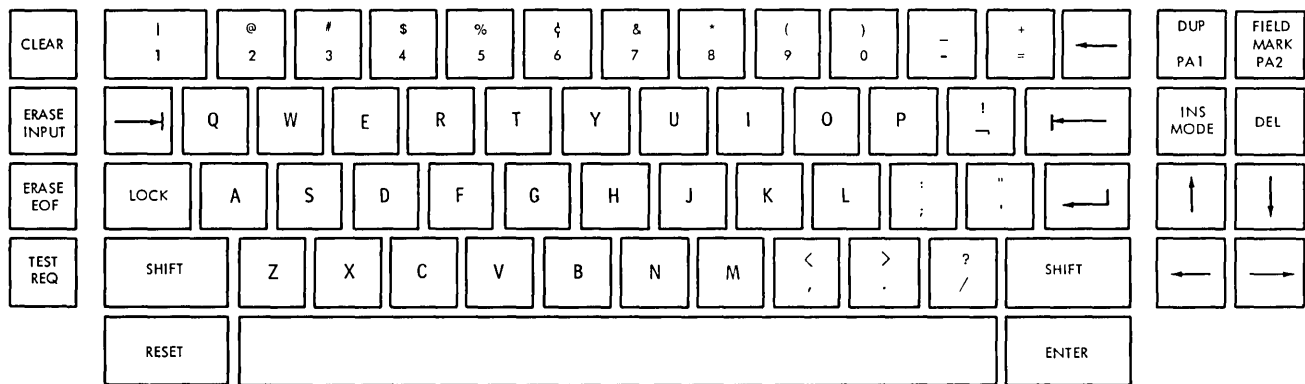
An ASCII character generator feature is required for each unit that will display or print the ASCII character set.

Keyboards

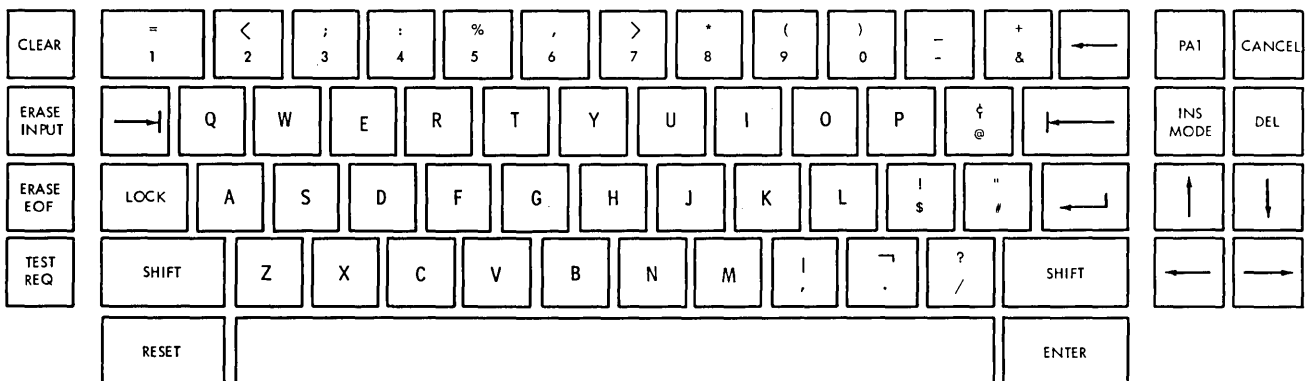
Fifteen different keyboard features are available. Variations between keyboards include 78- and 66-key versions: operator console, data entry, typewriter EBCDIC, and typewriter ASCII layouts and four different languages (American English, United Kingdom English, French, and German). Refer to Appendix B for a list of keyboard features.

Basic display operator needs are fulfilled by the 66-key keyboard. The 78-key keyboard provides expanded operator-to-program message flexibility with 12 additional application program defined keys.

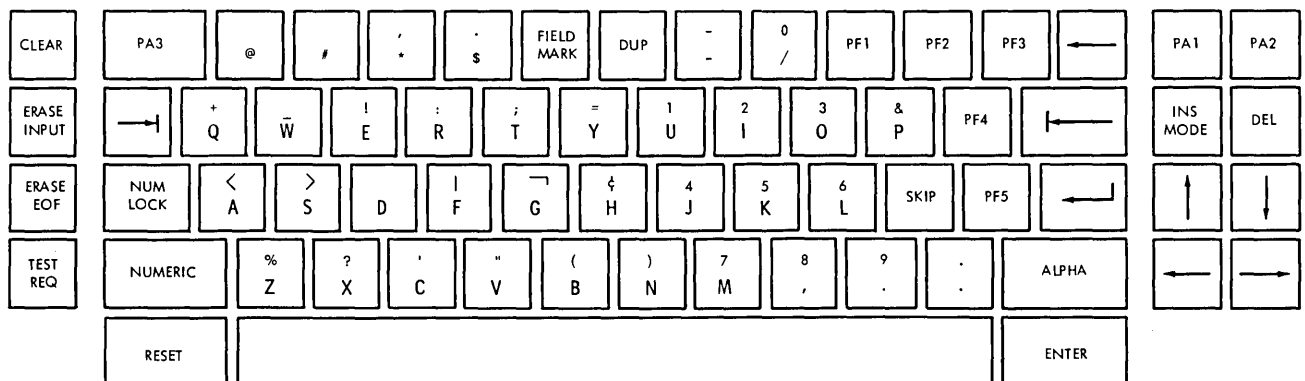
The operator console key layout, which is the same as an IBM 1052 Model 7 keyboard, is available only as a 78-key keyboard. The data entry key layout, which is similar to the keyboard on the IBM 24, 26, 29, 129, and 59 keypunch equipment, is available only as a 66-key keyboard.



Typewriter Keyboard



Operator Console Keyboard



Data Entry Keyboard

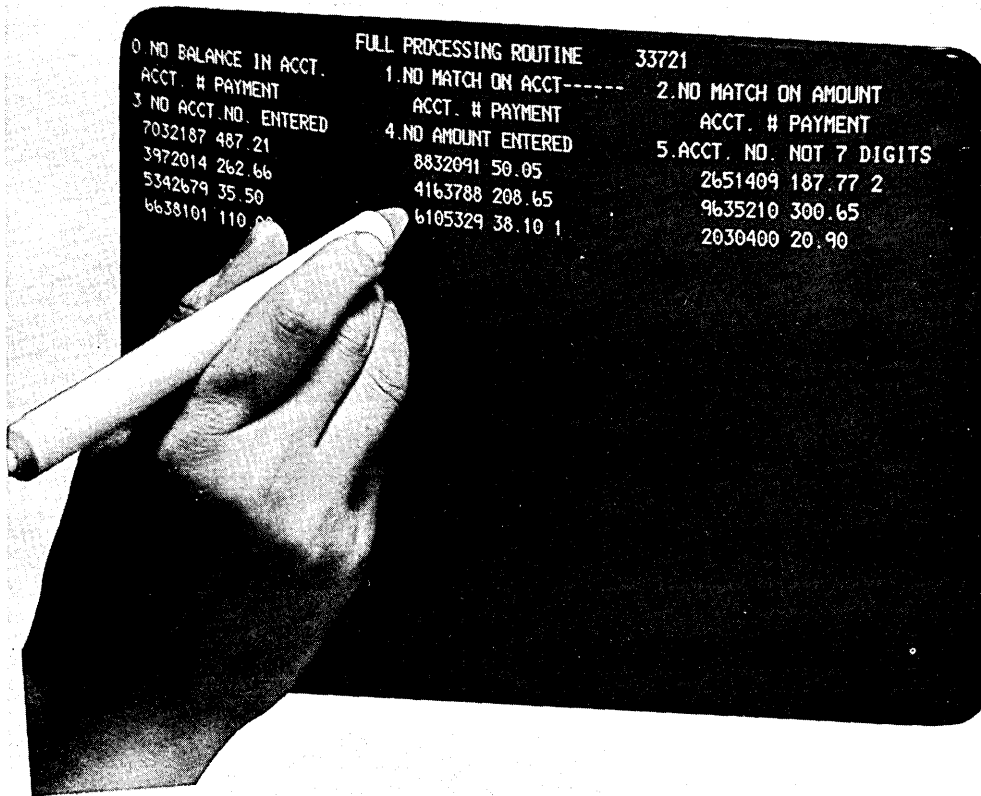
Keyboard Numeric Lock

This feature is used in conjunction with a keyboard to provide a means of alerting the operator to a keying mistake. During a numeric operation, this feature inhibits keyboard input operations whenever the operator attempts to enter alphabetic data without purposely overriding the feature. Once inhibited, keyboard input operations can be resumed only after the operator presses the RESET key at the keyboard. Although this feature is available for all

keyboards, its primary application is in a data entry environment where large quantities of numeric data are being entered into the system.

Selector Pen

This feature provides a light-sensitive pen with which an operator can identify a portion of a displayed message for entry into the data processing system.



Selector Pen in Use

Audible Alarm

The audible alarm feature can be installed on any display station. This feature causes a short audible tone to be sounded whenever an operator enters a character in the next-to-last position of the display image or whenever the tone is called for under program control.

Key Lock

This feature provides key-operated control over communication with the program. With the key off, only a cursor will appear on the display image, the unit will be

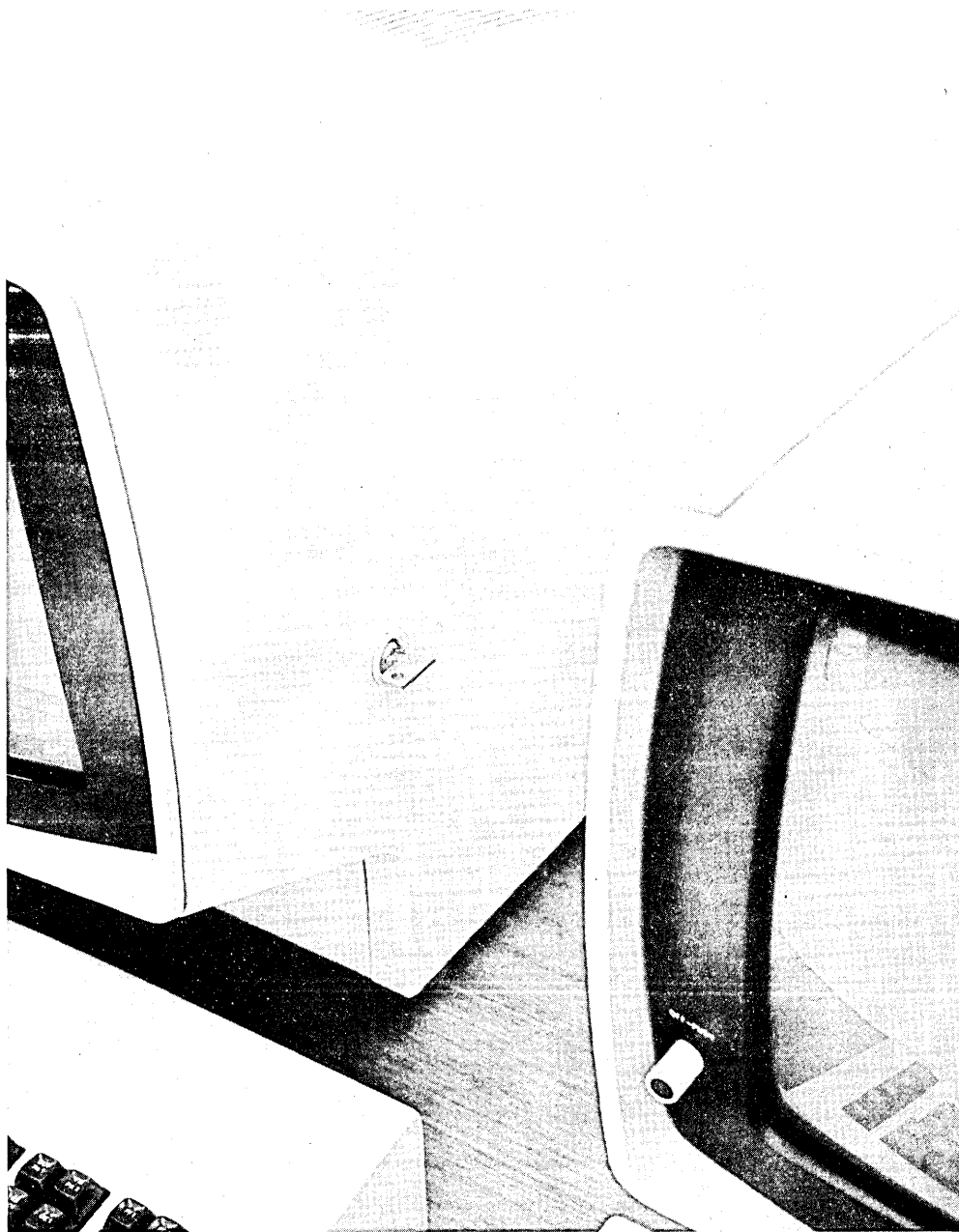
unavailable to the program, and the display operator will be unable to input messages to the program.

Printer Adapter

This feature provides a 3275 display station with control circuitry and cable connection outlets to permit attachment of a 3284 printer, model 3.

Operator Identification Card Reader

This feature provides a card reader unit to permit an operator to identify himself to a program.



Key Lock Feature Installed on a 3277 Display Station

The IBM 3270 Information Display System introduces a new dimension to display systems design: functional control capability. Design and evaluation of the IBM 2260 Display System led to the conclusion that the total cost of a system can be significantly reduced by minimizing:

- Communication line facilities.
- Transmission control facilities.
- CPU overhead.
- Channel utilization.

To reduce system costs associated with these items, numerous hardware and programming features that together provide functional control capability have been incorporated in the 3270 display system.

Functional Control Capability

The functional control capability of the 3270 display system consists of the following features:

- Format control by data field.
- Addressing or updating, or both, of any character position of the display image.
- Null suppression.
- BSC line control.
- Channel interface data rates up to 650,000 characters per second.
- Communication line transmission speeds up to 4800 bps.
- Protected data image format.
- Select.
- Read modified data.
- Copy.
- Erase unprotected.
- Short read.
- Repeat characters.
- Program tab.
- Remote general poll.

To use this new functional control capability effectively, the system designer must consider: the display image formats, transaction design, communication facilities, operator wait times, operator costs, channel loading, number of CPU interrupts, number of TP messages, and application program design. He can do this best by selecting

a typical transaction and evaluating the effects of functional control capability on system costs and performance. This evaluation, coupled with an evaluation of operator control capabilities, system configuration considerations, physical considerations, and installation planning considerations, will determine the best ratio between cost and performance for a display system.

Operator Control Capabilities

The 3270 display system also provides operator control capabilities that allow maximum operator efficiency with a minimum of retraining. The advantages of card punch and typewriter keyboard designs have been incorporated into the 3270 data entry and typewriter keyboard options.

The highlights of the functional capabilities of the 3270 display system are described below. For a more detailed, hardware-oriented discussion of functional capabilities, see Appendix C.

FUNCTIONAL CONTROL CAPABILITY

Format Control by Data Field

The 3270 display system provides program control by data field. Each data field is established when a field attribute control code is written in the first position of the field. The field attribute control code, which is written by the program, utilizes a single nondisplayed character position and serves as a visual separation between successive fields. A field may be started at any character position of the image. The characteristics controlled by the attribute control code include:

- Protected (fixed format).
- Unprotected (variable input data).
- Brightness (off/normal/bright).
- Alphameric input.
- Numeric input (auto shift).
- Auto lock.
- Auto skip.
- Selector pen detectable.
- Tab stop.

Character Addressing

Addressing facilities are provided by the 3270 display system to allow starting a program write at any character position of the image. The write address can be set any number of times during an image write or update, or both. This allows selective writes to various noncontiguous areas of the image. This facility also allows the modification of single or multiple field attribute control characters as well as data characters.

Null Suppression

To minimize message lengths while providing maximum length input fields, 3270 display system data fields can be erased to null codes under operator or program control. As an operator keys input data into a field, data codes replace null codes, leaving null codes in any unkeyed positions of the field. When a read message is sent to the CPU, null codes are not transmitted as part of the message. This facility eliminates the transmission of nonmeaningful codes from unused positions of a field.

BSC Line Control

The IBM BSC line control design provides maximum transmission reliability, requires significantly less transmission control overhead, and provides more comprehensive data checking.

Channel Interface Speeds

Data transfer rates of 10,000 to 650,000 characters per second are provided to allow operation at the speed of the channel to reduce response time and CPU loading by allowing faster completion of a transaction. This capability allows highly efficient local display systems to be developed and removes the restrictions imposed by the data rate (2560 characters per second) of the IBM 2260.

Communication Line Speeds

Line speeds up to 4800 bps for C2 condition lines allow nearly twice as much data to be transmitted over a single communication line. In many instances, this will significantly reduce the number of communication lines required to support remote display systems and significantly reduce response times.

Protected Data Image Format

The protected data image format capability allows a format that contains field labels, instructions, and field control information to be written to a display station once and reused any number of times with variable input or output data. For file inquiry, a protected data image format can be written to the display station once, allowing subsequent transmission of only the variable data records. Similarly, a protected data image format can be written to a display

station once and can be used many times for repetitive key entry input transactions.

Select

Display systems directly attached to a channel require a buffer load delay to prepare to execute a write operation. A select operation is provided to allow a selector or block multiplexer channel to be released for other use during this delay time.

Read Modified

A read modified operation capability is provided that transfers only operator-modified data fields with null codes suppressed. This operation reduces the message size by including essential data only, thus minimizing communication line and channel loading.

Copy

A copy operation capability is used on remote 3270 systems to control the interchange of buffer information between devices attached to the same control unit. Any display station image can be printed out at any printer by means of a copy operation. On a copy operation the device buffer transfer is concluded within the 3270 display system, thus total message transmission to the 3270 is significantly reduced. Because the internal 3270 operating rate is far greater than the remote transmission rates, substantially shorter response times can be maintained. An additional example, showing the value of the copy operation, is the case where one basic display image format is frequently used at several display stations in the 3270 display system. The image format need be transmitted to a device on the 3270 display system only once; thereafter, a copy operation can be used to copy the image format from one device buffer to another.

Erase Unprotected

An erase unprotected operation capability is provided that erases all unprotected data fields to null codes and positions the cursor in the first unprotected field of the image. This operation eliminates the buffer load delay that is associated with a normal write operation.

Short Read

To allow an operator to communicate with the program without transmitting unprotected data fields to the CPU, program attention (PA) keys have been provided. Pressing one of these keys causes a short read operation that restricts the information transmitted to that required to identify which of the keys caused the attention. This eliminates the transmission of nonmeaningful data to the CPU, thereby minimizing communication line and channel loading.

Repeat Characters

To minimize the number of data characters that must be transmitted to a display station, capability is provided to cause the display hardware to repeatedly write a specified character code from the current write address position into all positions up to a specified address. By the use of this facility, four control bytes transmitted to the display system can cause up to 480 identical character codes to be written to the display station.

Program Tab

To minimize the length of a message transmitted to a display station, capability is provided that will automatically write successive data fields into successive unprotected data fields that were previously defined by an image format. This eliminates the requirement to transmit control characters to specify the starting address of noncontiguous data, reducing the number of control characters required.

Selector Pen

The 3270 display system offers a new concept in light pen design. Previously, light pens required a heavy CPU interrupt loading, and the response characteristics of remote display systems prevented their practical use on a remotely attached display system. The 3270 selector pen provides new capability for handling transactions in the display system hardware, thereby providing a minimum of CPU interrupts and response times of less than 0.4 second for selector pens attached to both local and remote display systems.

Remote General Poll

Provisions are made in the control unit hardware to allow the program, with a general poll instruction, to interrogate all devices attached to the control unit with just one request. This results in greatly reduced polling overhead and minimizes communication line loading.

OPERATOR CONTROL CAPABILITY

The 3270 display system provides numerous operator control capabilities to maximize operator efficiency and minimize operator training costs.

Keyboard Options

Four keyboard options are provided to allow a display system to be tailored to the requirements of each application. Similar keyboards are interchangeable and may be used with any of the 3270 display stations. The following keyboard options are offered:

1. Typewriter keyboard.
2. Typewriter keyboard with 12 program function keys.

3. Data entry keyboard.
4. Operator console keyboard.

Keyboard Functions

Cursor Positioning Controls

Several cursor controls are provided to permit rapid positioning of the cursor to any character position on the display image. Included in these cursor controls are:

- UP (↑), DOWN (↓), LEFT (←), and RIGHT (→) keys
- BACKSPACE (←) key
- TAB (→) or SKIP and BACKTAB (←) keys
- NEW LINE (↵) key

Editing Controls

Two keys, INSERT MODE and DELETE, enable a display operator to perform unique editing functions. The INSERT MODE key allows characters to be inserted into a field, while all characters following the point of insertion are shifted to the right. The DELETE key has an opposite function: characters can be deleted from a field, while all characters on the same line and following the point of deletion are shifted left.

Program Function Keys

Program function (PF) keys allow any input data on the screen to be transmitted to the program together with a code that identifies which program function key was pressed. Program attention (PA) keys allow a code to be transmitted to the program to identify which key was pressed, but no input data from the screen is transmitted to the program.

Numeric Lock Feature

This feature provides a means of alerting the display operator to certain keying errors. With a data entry keyboard, when the cursor is positioned within a numeric input field the display station automatically upshifts the keyboard. With the numeric lock feature, the keyboard is electrically locked if any key other than the numerals 0 through 9, minus (-), period (.), or duplicate (DUP) is pressed.

Shift Keys

All typewriter and operator console keyboards are provided with the standard typewriter shift keys: SHIFT and LOCK. These keys function exactly like typewriter shift keys to allow access to upshift characters. Data entry keyboards are provided with the ALPHA (alphameric) and NUMERIC shift keys. The ALPHA shift key is used to override a numeric (input) field definition and the numeric lock special feature to purposely input alphameric data into a

numeric field. The NUMERIC shift key also overrides the numeric field definition and numeric lock condition to permit upshift character entry for other characters.

Duplicate (DUP) Key

This key allows a unique code, which is displayed as an asterisk (*), to be inputted to the program, while the cursor is advanced automatically to the next input field. The DUP code is typically interpreted by the program to mean duplicate this field from the previous record.

Erasing Controls

The CLEAR, ERASE EOF, and ERASE INPUT keys provide erasing functions by setting to null codes any character positions on the display image that are affected by the key operation. If the operator must erase the entire display image and the image format, the CLEAR key is used. The ERASE EOF key is used when the display operator inputs data into part of a field and wants the rest of the field erased. The ERASE INPUT key is used to erase all input fields on the display image.

Audible Alarm

This special feature can be used by the application program to alert the display operator for any application.

Additionally, the alarm sounds whenever the operator inputs a data character into the next to last character of the display image.

Security Enhancements

Key Lock

This special feature provides a display operator with a key that can be used to disable the display station whenever it is to be left unattended. The unit is enabled when the proper key is inserted in the lock and turned to the "on" position.

Operator Identification Card Reader

This feature is provided to enter system user identification. This capability enhances the (programmed) control of operator access to data and an audit of operator actions. Additionally, this feature may be used to enter any sequence of characters (prerecorded on a card) for other purposes, such as transaction control, account control, and billing.

Non-Display Keying Mode

This unique mode of operation permits program definition of fields so they will accept data entered from the keyboard without displaying the data on the screen.

Display stations can be used advantageously in many data-processing applications. The three general categories of applications for display stations are:

- Inquiry
- Data entry
- System operator's console

The material under "Application Types" discusses these categories in terms of application types that are found throughout the data-processing industry. The distinctive characteristics and the business uses of each type of application are discussed, and the features that make the 3270 display system well suited for each application type are listed.

APPLICATION TYPES

Inquiry

A display station that is used with an inquiry application allows the operator to have rapid access to the central computer file. Five types of inquiry applications are described below.

Simple Inquiry

In a simple inquiry application, there is a small input message, for example, a name or an account number. The output message is short (for example, "yes" or "no"), predictable within a narrow range of possibilities, and required quickly. This is a repetitive operation.

A credit house uses a simple inquiry application to determine whether a charge customer should be allowed to make additional charge purchases. Usually, the person who needs the information has telephoned the request to the credit house and waits for the reply.

The 3277 display station, attached locally or remotely, can be used in a simple inquiry application. The efficiency of data transmission between the system and the operator makes the 3270 display system desirable in this type of application because of the high volume of requests and the necessity for rapid retrieval of information.

Complex Inquiry

In a complex inquiry application, the input message is small (up to 100 characters). The output message is large (an entire screen or several screens of data) and often contains historical or status information.

This type of application is used by insurance companies to get policy information about policyholders. A credit house uses a complex inquiry application when getting a complete credit history of a person who is trying to establish credit.

The editing tools of the 3270 display system and its ability to transmit data efficiently are advantageous in a complex inquiry application. The 3277 display station, model 2, is useful because large amounts of output data can be displayed.

Inquiry with File Update

In an inquiry with file update application, the input message is again about 100 characters, and the output message can be several screens of data. Part of the displayed record is modified by the display operator after the output message has been viewed. A customer service application is a specialized form of the inquiry with file update application.

State and local governments (for example, departments of tax and welfare) use inquiry with file update applications to review and change official records. This application is also used by a credit house to record credit payments and by an insurance company to make policy changes.

The 3277 display station, model 1 or model 2, can be used, depending on the amount of data output from the processing program. The terminals can be attached locally or remotely. Formatting and editing tools are useful for applications that move data into specific areas or that modify input data. The 3284 or 3286 printer can be used to get a printed copy of the latest records.

Conversational Inquiry

In a conversational application, a progression of input and output messages leads up to a completed transaction. The output message often determines the next input message; for example, an output message that contains a series of items from which the operator must make a selection is the basis of the next input message.

A catalog order house uses conversational applications. In this use, an order might be entered in the following sequence:

INPUT MESSAGE, AN	
ORDER NUMBER	54763D
OUTPUT MESSAGE	Size (S, M, L)
INPUT MESSAGE	S
OUTPUT MESSAGE	Color (BLK, GRN, OR)
INPUT MESSAGE	GRN
OUTPUT MESSAGE	quantity
INPUT MESSAGE	15

Simulation programming, problem solving, and modeling are specialized versions of a conversational application.

The 3277 display station and 3284 or 3286 printer can be used in a conversational application. Editing and formatting tools aid the operator when messages consist of fill-in-the blanks and other formatted forms. Modified-data-only and null suppression for transmission efficiency aid message flow.

Conversational Inquiry with File Update

In an inquiry application that combines conversational and file update, many input and output message steps complete one transaction that initiates other processing transactions (for example, production and warehouse control, shipping, and receiving), which are not necessarily done on the display. These other processing transactions are applications that are used by distributors, manufacturers, and service order businesses.

The 3270 display system is a compatible family of general-purpose products that have been designed to solve a wide range of customer application problems. This application can use the 3277 display station, attached locally or remotely, in combination with the 3284 or 3286 printer for printed output.

Data Entry

A display used for a data entry application can replace conventional keypunch equipment. Two types of data entry applications are described below.

Source File Update

In a source file update application, the first step is some type of inquiry to get access to the data that must be modified. Next, the transaction is processed, and the data in the working file is updated immediately.

A state department of motor vehicles uses this type of application to update the large central files on drivers and vehicles as information is sent in from local offices. Remotely configured display stations of the 3270 display system can be used at local offices to provide input to the central office. The 3277 display station, attached locally at the computing installation, can be used for direct input to the computing file. Formatting and editing features aid the operator in making corrections and entering data in predefined formats.

Online Key Entry

In an online key entry application, records are batched and are entered into an intermediate file that is online, usually on disk. This file is rapidly available to the processing program. The online key entry procedure is used to copy large amounts of data and is designed for high productivity and efficiency. The aim is to eliminate from the computing

installation clerical functions that are not essential to data-processing activity (for example, receiving a job and scheduling it for keypunching and handling cards and tapes).

Payroll and inventory control are applications in which large amounts of data are entered into a computing system for separate processing by the application program.

The 3270 display system can be used for online key entry. The editing tools help the operator verify that input data is correct. Formatted fields and protected data make the operation more productive because input need not be in a character-oriented stream. Remotely attached displays can be used (even though an online key entry application is directed toward high volume) because the devices have high data-transmission efficiency.

System Operator's Console

A display station that is used as a system operator's console is used in place of conventional typewriter consoles. The display console can hold many system messages and can display them faster than a typewriter console. Two types of system operator's console applications are discussed below; either application might be useful to any computing installation. Programming support available for these applications is described under "Display Console Support" in Chapter 5.

Display Operator Console

In a display operator console application, the system operator uses the display station to control the operation of the system by entering data into the system and receiving it from the system.

The 3277 display station, model 2, displays large amounts of data. Messages can be separated into different areas on the screen, depending on the type of message that is being displayed. For example, status displays and warnings can be displayed in their own predefined areas. A keyboard is used with the display so that the operator can enter commands and other data. The program function keys and the selector pen can be used to enter predefined commands.

Output-Only Display Console

In an output-only application, the display console can be used for status displays or operator messages, but it cannot be used to enter data into the system. Display consoles used in this type of application monitor system activity. They can be used in areas away from the central processing unit, for example, in the tape and disk libraries. Also, they can be available at several locations in the computing installation as backup for the display operator console. As no data is entered from the device, a keyboard is not necessary. Since the messages are small, the 3277 display

station, model 1, can be used in an output-only display console application.

ADVANTAGES OF DISPLAY SYSTEMS

Many installations must answer questions concerning the status of an account or check the disposition of an order while someone waits on the telephone or in the office; also, there may be a high volume of requests for information. When a display station is used, the person waiting can be given fast service. Furthermore, the information is obtained directly from the computer file, thereby avoiding unnecessary clerical operations.

Because display stations can be connected remotely to the computer by means of telephone lines, they can be far from the central file. There can be many people at many locations using the system at the same time. The users at one location can have rapid response to input, even though the files are maintained at a central location that is distant.

An operator of a display station is probably familiar with several parts of the device because the parts are similar to common objects. For example, the keyboard that is used to enter data is similar to a typewriter keyboard, and the output is displayed on a TV-like screen. The display operator can treat the displayed information as if it were in a book; he can turn the pages of the file, looking at one page at a time, making additions and corrections to the data in the format displayed on the screen, checking each page for accuracy, and extracting information he needs.

ADVANTAGES OF THE 3270 DISPLAY SYSTEM

The 3270 display system is well suited to the types of applications that are listed above. Some of the specific benefits offered by the system follow.

The display operator can enter data in free form. For example, he types in the name and account number of a customer's file; then he types in an order that consists of part number, quantity, price, and special instructions. The sequence of items in the entry is important, but the location of the items on the screen is not. The data could be entered on one or two lines, or each item could be entered on one line.

The display operator can also enter data in formatted form. For example, in typing in a sell-stock order, he would type data opposite the following labels:

ACCOUNT NUMBER:
STOCK IDENTIFIER:
QUANTITY:
SELLING PRICE:

After the operation, the screen would show:

ACCOUNT NUMBER:	7246
STOCK IDENTIFIER:	ABC
QUANTITY:	50 SHARES
SELLING PRICE:	5-1/2

There are aids to help the display operator manipulate data that is to be entered in formatted form.

- He is prevented from entering data into a protected field. In an application where he must enter certain items (renewal date of driver's license, amount to be paid, and change of address), but where he cannot modify other items (driver's license number), he is prevented from doing so. He can skip over a protected field by pressing the SKIP key or the TAB key.

He can change unprotected alphanumeric data; he must use special keys to change numeric-only data. He can erase the screen, a field, or characters in a field, and can use the two edit keys (INSERT MODE and DELETE) to correct data. Characters to be corrected are located easily, because the cursor can be moved rapidly in any one of four directions.

- The display station can present selected data items at a brighter intensity than other data on the screen. Intensified data can be distinguished easily. This ability would be useful in an application in which exceptions must be apparent. For example, in a credit authorization application in which the customer's balance cannot be greater than a specified amount, the balance and the limit would be intensified, and the operator could easily compare them.
- The display operator can enter data in fields that are programmed to prevent data from being displayed or printed out. This benefits applications where there are security restrictions on some part of files. In such a use, the operator must enter a special password or identification for access to the data. This identification can be entered in nondisplay fields to prevent unauthorized acquisition of the identification.

APPLICATION HIGHLIGHTS OF A 3270 DISPLAY SYSTEM

This section describes how a 3270 display system can be used in an application. The description is simplified to emphasize the role of the display station.

A vending company sells goods and services to companies and sends its customers monthly bills. The company's accounting department is automated and uses the IBM 3277 display station, model 2, that has the optional data entry keyboard layout, numeric lock, selector pen, dual-display brightness, and audible alarm. The account-processing procedure is as follows.

A tally of goods and services is computed, and the bill that is sent is in the format:

DATE/OLD AMOUNT/LAST PAYMENT/CHARGES/ NEW TOTAL
--

All bills are sent out on the fifteenth of the month. Customers may make full or partial payment; payment is

requested within 30 days. When payment is made, the customer returns part of the bill, which shows:

CUSTOMER'S NAME
ACCOUNT NUMBER (SEVEN DIGITS)
VENDOR'S BILLING AMOUNT
PAYMENT AMOUNT

Every day, the vending company's accounting department receives payments and the returned part of the bill and sorts them alphabetically in the batches: A-E, F-J, K-O, P-T, and U-Z. One accounting department employee handles the entire accounting procedure for one batch. Each batch is divided for full-payment processing (vendor's billing amount and payment amount are equal) and other-amount processing.

Two service representatives are in direct contact with customers and must have immediate access to the latest records to take care of customers' problems. These two employees use 3277 display stations, model 2, that have the 66-key data entry EBCDIC keyboard. The display stations make the latest version of the accounts quickly available to the representatives for customers who usually discuss problems over the telephone. The 5 user-interpretable keys on the keyboard have been given special meanings to help the representatives get customer data. For example, one key is used to have the application program move the display forward to the next part of the data file, and one key is used to move the display backward to the previous part of the data file.

The accounting department employee takes one of the two sets of payments in his alphabetical batch and, using the selector pen, selects from the instructions that are first presented on the display station the name of the processing routine he will use, either FULL or OTHER. Then, instructions for the operator to follow when entering payment data are displayed on the first four lines of the screen.

When processing under the FULL payment routine, the accounting department employee types, in two predefined fields, the account number and payment amount for a customer. He can type in data for three customers on one line and up to 20 lines on each display. A maximum of 60 accounts can be entered at once.

The following aids help the employee enter data quickly:

1. The data entry keyboard layout allows all typing to be done with the right hand, leaving the left hand free to turn payment vouchers.
2. The numeric lock and program-controlled, numeric-only field definition prevent the employee from entering alphabetic data accidentally.
3. One space is skipped automatically, under program control, after the account number has been typed in. This saves a typing stroke between account number and amount.

4. The SKIP key allows the operator to skip over unused spaces in the amount field to the next account number field. The operator is freed from keeping track of how many numbers were entered for the amount and how many spaces are left in the field.

After all data has been entered, the employee presses the ENTER key, and only the information that was entered is sent to the computer. The FULL payment routine checks each account number and amount to ensure that (1) an account number and amount have been entered (for example, that no field is blank because the operator pressed the SKIP key twice), (2) the account number has seven digits and matches an account number in the balance-due file, and (3) the payment matches the amount in the balance-due file. If any of these checks fails, an error code describing the error is displayed in brighter intensity next to the incorrect entry. With the full screen of data that was entered still in view, the operator can go back through the bills and locate the data for entries that must be corrected.

Corrections are easily made by positioning the cursor at the error and typing the correction over the error or by using the text-editing control keys. Corrections are displayed immediately. The operator again presses the ENTER key, and, if no additional errors have been made, the transactions are applied to the customer's accounts. Data transmission is efficient, because only modified data is transmitted, null characters are not transmitted, and the screen can hold up to 1920 characters. The instruction lines are left on the screen, but the data entered by the display operator is cleared so that new entries can be made.

Processing of customers' accounts under the OTHER payment routine is as follows. The employee types in the account number and amount in the preplanned layout. The routine checks all data to ensure that the account number is valid (that is, seven digits and amount have been entered) and that it matches a number in the balance-due file. Errors are noted, and corrections are made in the same way as when processing under FULL. When a match of account numbers is found, the program deducts the payment from the amount due and computes the new balance. If an overpayment is made, the amount of credit is noted for the next bill.

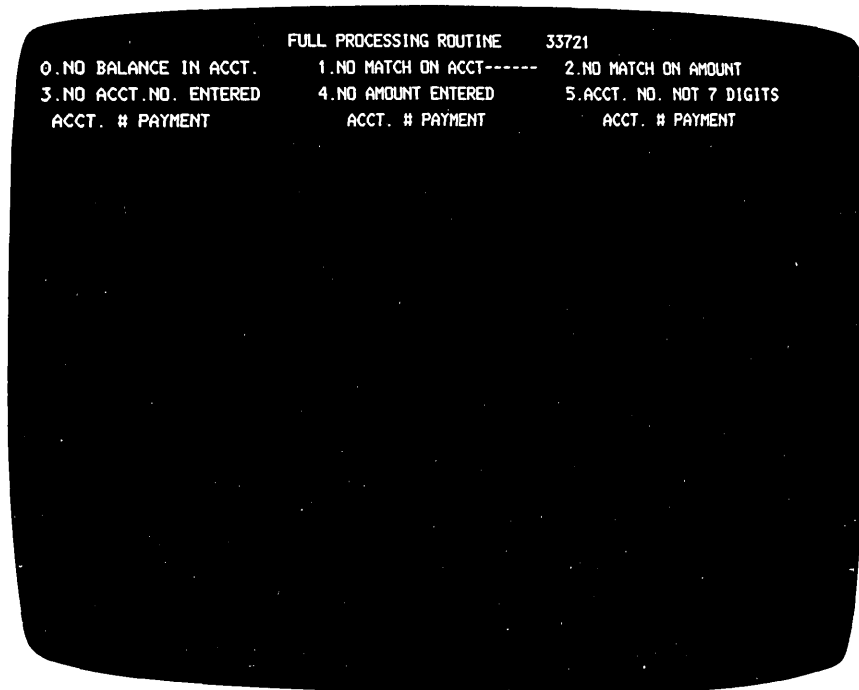
Refer to Figures 4-1 through 4-3 to see what the operator sees as this accounting procedure is being followed.

The application program, which the FULL and OTHER processing routines are part of, performs other accounting work. It totals each day's payments that were applied to the customers' accounts and prepares a bank deposit voucher, which is printed out on a 3286 printer; it also checks the payments-due file at the end of the billing cycle for accounts that were not paid.

When a customer calls in for account information, he is referred to the service representative who handles his file.

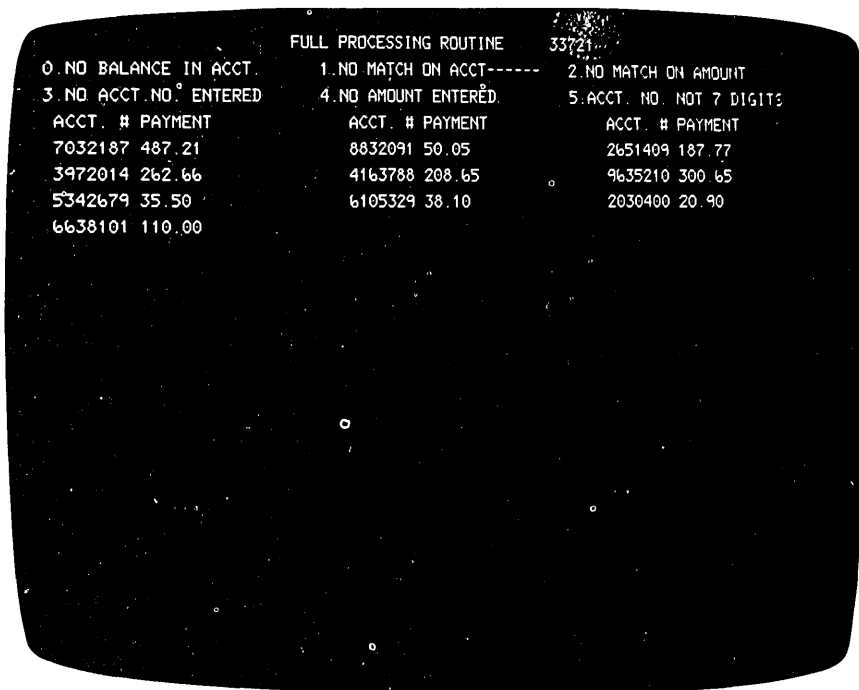
The service representative types in the account number on the keyboard of the display. The system retrieves the account file and presents the most recent transactions on the screen. The representative can cause data from earlier transactions to be displayed. This use of the display system

by the vendor helps the company maintain close contact with its customers. Quick handling of problems gives customers confidence in the vendor's ability to provide the offered goods and services.



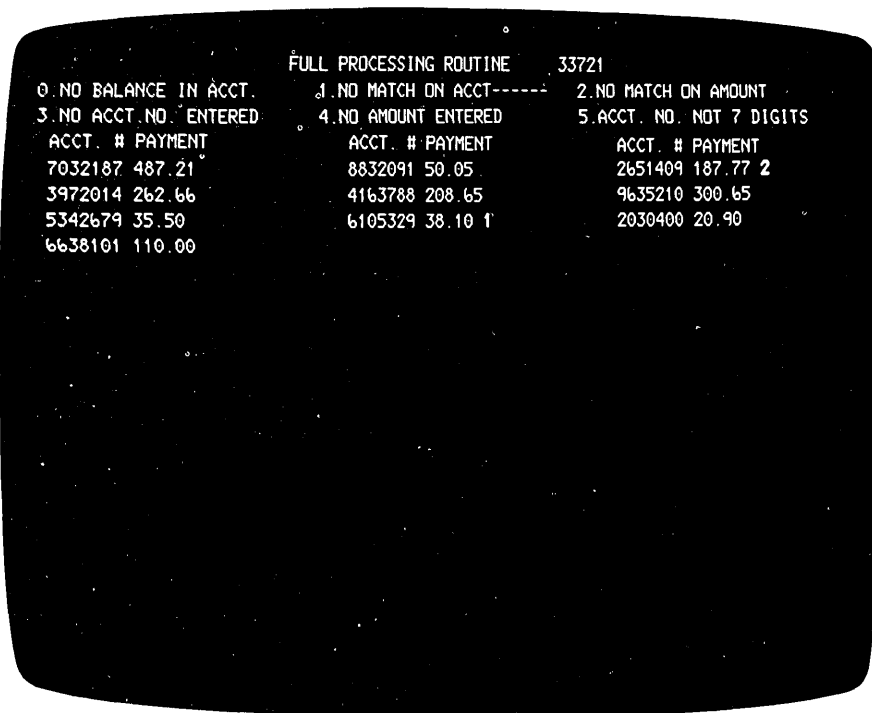
This display appears after the operator has selected the routine that will process a batch of transactions. The first four lines on the screen contain the name of the processing routine (FULL), error codes returned by the system if the information that has been typed in is incorrect, and column headings to help the operator type in data.

Figure 4-1. Displays Appearing during Sample Accounting Procedure (Display 1 of 3)



The operator sees this display as data is being typed in. The next entry can be made at the cursor.

Figure 4-2. Displays Appearing during Sample Accounting Procedure (Display 2 of 3)



If errors are found, a code is displayed next to the data that is incorrect. The error code is in a brighter intensity than the data that has been typed in. Error codes appear on lines 5 and 7.

Figure 4-3. Displays Appearing during Sample Accounting Procedure (Display 3 of 3)

INTRODUCTION

This chapter describes the programming available for the 3270 display system, including telecommunications support (BTAM under DOS and OS) and display console support (DIDOCS and SDS under OS).

Telecommunications support for the 3270 display system is provided by the Basic Telecommunications Access Method (BTAM) under the System/360 Disk Operating System and the System/360 Operating System.

Display console support for local 3270 displays and printers used as operator's consoles is available through Device Independent Display Operator Console Support (DIDOCS) and Status Display Support (SDS) under the System/360 Operating System. DIDOCS provides uniform services for all display operator's consoles on MFT and MVT systems. Status Display Support extends existing system status display services to improve the way information is presented to the operator. The way local 3270 displays and printers are supported is comparable to the way other devices are supported by DIDOCS and SDS.

BTAM under DOS or OS, DIDOCS, and SDS are supplied without additional charge to users of IBM data processing systems.

TELECOMMUNICATIONS ACCESS METHODS

The Basic Telecommunications Access Method (BTAM) is used to control the transfer of data between main storage and local or remote terminals. BTAM provides the application program with macro instructions for using the capabilities of the devices supported. BTAM supports binary synchronous, as well as start-stop, communication.

For a detailed description of BTAM under the System/360 Disk Operating System, see *IBM System/360 Disk Operating System: Basic Telecommunications Access Method*, GC30-5001; for BTAM under the System/360 Operating System, see *IBM System/360 Operating System: Basic Telecommunications Access Method*, GC30-2004.

BTAM Under DOS or OS

Functions and Organization

The primary functions of BTAM under the System/360 Disk Operating System or the System/360 Operating System are channel program generation and, optionally, buffer management.

When the application program (also called the problem program) is assembled, BTAM macro instructions are expanded into (1) BTAM routines; (2) inline instructions, including linkages to executable BTAM routines; and (3) control blocks and tables defining lines, terminals, and options to be used. During execution, the application program communicates with DOS/BTAM or OS/BTAM through BTAM macro instructions and BTAM control blocks and tables in order to request such telecommunications services as preparing lines for use, performing data transmission, and managing buffers.

Environment

BTAM operates under control of the System/360 Disk Operating System or the MFT or MVT versions of the System/360 Operating System.

BTAM under DOS or OS can be used in telecommunications systems that contain many different control units and devices, including those that make up the 3270 display system.

The 3270 Display System and BTAM Under DOS or OS

BTAM under DOS or OS supports the control units, displays, and printers that make up the 3270 display system. DOS/BTAM support for the local 3277 display stations is comparable to DOS/BTAM support for the local 2260. DOS/BTAM and OS/BTAM support for the remote 3277 and 3275 display stations is part of BTAM support for nonswitched multipoint lines that use binary synchronous communication (BSC). Support for the local or remote 3270 display stations or both can be included among the DOS/BTAM or OS/BTAM routines and channel programs.

Functions and Use

BTAM under DOS or OS supports the 3270 display system by:

- Generating channel programs.
- Starting I/O operations.
- Handling attentions.
- Handling line interrupts.
- Performing error recovery procedures, posting, and counting errors.

For local 3270 display systems, capabilities of the display system are used through the "optype" operand of the DOS/BTAM or OS/BTAM READ and WRITE macro

instructions. For remote 3270 display systems, a combination of DOS/BTAM or OS/BTAM READ and WRITE macro instructions for BSC and device control characters included in the data to be transmitted provides access to the display system capabilities.

3270 Display System Capabilities Supported

BTAM under DOS or OS supports the following capabilities of the 3270 display system:

- Write data to display or printer buffer.
- Erase buffer and write data.
- Erase all unprotected fields in buffer.
- Read data from buffer.
- Read buffer from specified location.
- Read modified fields from buffer.
- Read modified fields from buffer from specified location.

3270 Display System Devices Supported

BTAM under DOS or OS supports the following 3270 display system devices:

- 3277 display station, model 1, attached to a 3272 control unit, model 1 or 2, or a 3271 control unit, model 1 or 2.
- 3277 display station, model 2, attached to a 3272 control unit, model 2, or a 3271 control unit, model 2.
- 3275 display station, model 1 or 2.
- 3284 printer, model 1, 2, or 3.
- 3286 printer, model 1 or 2.

Environment

BTAM under DOS operates in any System/360 or System/370 processor that has at least 32K bytes of main storage. BTAM under OS requires a System/360 or System/370 processor that has at least the minimum main storage requirement for MFT or MVT.

In addition to the minimum requirement of 5K bytes for BTAM under DOS, main storage requirements are:

1. Approximately 2K bytes for support of the local 3270 display system.
2. Approximately 7K bytes for support of multipoint lines using BSC, which includes support for the remote 3270 display system.

Support for the local 3270 display system increases the minimum main storage requirements for BTAM under OS

by approximately 4K bytes. There is no increase to BTAM under OS for support of the remote 3270 display system.

DISPLAY CONSOLE SUPPORT

Display consoles are operator's consoles that present the operator's message traffic on the screen of a display instead of printing it on paper. Device Independent Display Operator Console Support (DIDOCS), which is a programming service under the multiple console support (MCS) option of the System/360 Operating System, provides uniform services for all display consoles on MFT and MVT systems. Status Display Support (SDS) improves the existing system status display services under MFT and MVT. Extensions to DIDOCS and SDS provide services for 3270 display stations and printers and also provide several new functions applicable to all devices serviced by the support.

Functions

Basic Display Console Support

DIDOCS provides the linkage between displays and the system to make the displays usable as operator consoles. In conjunction with multiple console support, DIDOCS provides processing and routing of messages from the operating system and problem programs to the consoles, presentation of the messages within the appropriate area of the console screen, and processing of information entered through the console by the operator. The support is device-independent in that it services all devices in a similar manner; on the other hand, it takes advantage of features that are peculiar to a particular console (for example, selector pens and audible alarms).

The additions to DIDOCS for the 3270 display system extend this basic console support to include locally attached 3270 display stations and printers. The 3277 display station, model 2, is made available as a full-capability console or as an output-only console, and the 3277 display station, model 1, is made available as an output-only console. Output-only consoles can be used to display system messages but cannot be used to enter information into the system.

DIDOCS is also extended to include the 3284 and 3286 printers, models 1 and 2, as hard-copy consoles (output-only consoles that produce typed pages instead of screen displays).

Status Display Support is designed to improve system status display services for display and nondisplay consoles. Status displays are formatted, multiple-line displays of system information written to the operator's console in response to certain operands of the DISPLAY and

MONITOR commands. The operator uses status displays to monitor system activity and to determine the status of various system devices.

New Console Support Functions

At the same time that display console support is extended to include the local 3270 display stations and printers, new functions are added to DIDOCS and to existing system status display services to increase the general efficiency of all display consoles.

The new DIDOCS functions are in four areas.

Programmed Function Keyboard Command Entry. The programmed function keyboard (PFK) is made available for rapid entry of operator commands. One or more commands may be associated with each PFK key after initial program load, and the operator can enter commands by pressing the appropriate key or keys.

Selector Pen Command Entry. This service is related to the PFK service described above. Commands are again associated with PFK key numbers after initial program load, but command entry is accomplished by positioning a selector pen over key numbers displayed on the screen. This feature is available on all display consoles equipped with a selector pen (except the 3277 display station, model 1); a program function keyboard is not required.

Transient Display Control Modules. Display control modules (DCMs) can require large amounts of main storage in a system with many display consoles. The transient DCM service added to DIDOCS allows several consoles to be grouped together during system generation, so that one area of main storage may be assigned to the group.

While the system is operating, DIDOCS moves the display control module associated with each console into this main-storage area as it is needed. By means of this feature, the main storage required by a group of consoles can be reduced to just slightly more than the main storage formerly required by a single console (see "Storage Requirements").

Output-Only Mode of Operation. The 2260 display console, the 3277 display station, model 2, and the 3277 display station, model 1, can be put in the output-only mode of operation during system generation or after initial program load. An output-only console can be used to display operator messages but cannot be used to enter information into the system. Removing the input function from a console adds several lines to the message area on the screen (see "Physical Features") and provides a separate display screen that might be used for special purposes, such as presentation of status displays.

The 3277 display station, model 2, and the 2260 display console operate in either the input/output or output-only mode. If they are designated for input/output operation during system generation, they can be varied to output-only mode by the operator. The 3277 display station, model 1, operates only in the output-only mode and can only receive general message traffic; it cannot be designated to receive status displays.

The primary purpose of Status Display Support is to improve system status display services by enhancing the way information is presented to the operator. These improvements are in three areas.

Contiguous Status Displays. The system WTO macro facility (the WTO macro is used to write the lines of the status display to the operator's console) is extended to allow presentation of status displays in contiguous, multiple-line format. This eliminates interleaving of other operator messages with the lines of the status display.

Display Area Designation. A means of separating status displays from normal message traffic and routing them to separate consoles is provided. The operator (or the system programmer during system generation) can designate blocks of lines in the screen's message area as "display areas" for presentation of status displays. The system assigns an alphabetic identifier to the designated display areas and also assigns a numerical identifier to each console in the system. The operator can use these identifiers to specify the precise console and display area in which a status display is to be presented.

Time-Interval-Updated Display. The operator's ability to monitor system activity is enhanced by the addition of time interval updating of the active jobs displays. The A operand of the MONITOR command requests the active jobs display (the same display that is requested by the DISPLAY A command), but also requests that the system update the display each time a pre-set time interval elapses. The time interval can be adjusted by the operator according to his requirements.

Advantages and Limitations

The advantages of the display console are speed, efficiency, and clear presentation of information.

The system can fill a display screen with information almost instantly, expediting the presentation of information to the operator.

Certain display consoles (Table 5-1) allow present command entry by selector pen or PFK. This form of entry, which enables the operator to enter several commands with one action (positioning a selector pen or pressing a PFK key), is faster than command entry on typewriter consoles and is not subject to typing errors.

Table 5-1. A Summary of Display Devices and Features That Are Serviced by DIDOCS and SDS

Feature Device	Input/ Output	Output- Only	Selector Pen Message Deletion*	Selector Pen Command Entry*	PFK Command Entry*	Audible Alarm*	Inten- sified Warning Line
2250 Models 1 and 3	Yes	No	Yes	Yes	Yes	Yes	No
2260 Display Console	Yes	Yes	No	No	No	No	No
Model 85 and Model 165 Operator Consoles	Yes	No	No	No	No	Yes	No
Model 91 and Model 195 Operator Consoles	Yes	No	Yes	Yes	Yes	Yes	No
3277 Display Station, Model 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3277 Display Station, Model 1	No	Yes	No	No	No	No	Yes

*When the required equipment is attached.

Display consoles present different types of information in separate areas of the display screen (see "Physical Features"). Also, the operator may designate a number of contiguous lines of the message area for status displays. When a status display is not present, these lines are used for system message output. When a status display is involved, the information overlays the system messages in the area. When the status information is removed from the screen, the overlaid messages are restored. If the status display contains more lines of information than can be presented in the predefined area, it is dynamically segmented, and the operator can frame through the information.

The operator can classify items as special messages about the console, warning messages, status displays, or general message traffic simply by their location on the screen. Display consoles keep the operator advised of messages requiring action. Unless the operator specifically deletes action messages, they remain on the screen, marked with an asterisk for easy identification. The system also marks messages for which action has been taken and deletes them automatically when the screen becomes full (if the operator has requested automatic deletion). The operator may also control message deletion himself.

In the output-only mode, the display console can provide an effective system monitoring device separate from the main operator console (in a tape or disk library, for example). Most output-only consoles may be designated to receive either general messages or status displays; the 3277 display station, model 1, can be used as an output-only console, but it cannot receive status displays.

A console designated for status displays might be set up close to the master console to provide the operator with

system status information in a convenient location, but away from the normal messages. This arrangement would help the operator by making the status displays easier to read. It could also increase system throughput by freeing space on the master console screen for other messages.

System monitoring with display consoles may also take advantage of the time-interval updating of the display of active jobs. The MONITOR A command can be used to provide the operator with information about the jobs active in the system; the system keeps the information current by updating the display according to a preset time interval.

The 3270 display stations (and other display devices), designated as operator's consoles during system generation, are still available for other display applications. The VARY command is used to reconfigure the consoles for these purposes.

Display consoles involve some limitations and restrictions. They require more control modules and more main storage than typewriter consoles, although this can be eased through the use of transient DCMs (see "Storage Requirements"). The display console screen also requires close operator attention, particularly because of the message deletion requirements, although automatic message deletion and the audible alarm can help in these areas (see "Operating Procedures" and Table 5-1).

Environment

System Requirements

The support (DIDOCS) required to operate the 3270 display stations as display consoles can be used with any central processor in which the MFT and MVT versions of

System/360 Operating System operate. In order to use display consoles, the multiple console support (MCS) option must be included in the system during system generation. Status Display Support is an integral part of System/360 Operating System with MFT and MVT. In order to make use of the display services, other than the multiple-line feature of the write-to-operator macro instruction, the multiple console support option must be specified during system generation.

Devices Supported

Table 5-1 contains a summary of the display consoles that are supported by DIDOCS and the special features of each.

DIDOCS Storage Requirements

The processing modules of DIDOCS operate from the SVC transient area (unless the user specifies otherwise). They will require no additional resident storage in the system. The display control modules (DCMs), which support display consoles, are control blocks that require varying amounts of main storage, depending on the type of console they are supporting. The DCM main-storage requirement for each type of console is provided in Table 5-2 (K equals 1024 bytes of main storage).

Table 5-2. DCM Main Storage Requirements

Console	Storage Required
2250, Models 1 and 3	5.0K
2260, Model 1	1.5K
Display Console for Model 85 and Model 165	3.5K
Display Console for Model 91 and Model 195	5.0K
3277 Display Station, Model 2	3.0K
3277 Display Station, Model 1	1.1K

If the transient display control module feature is not used, separate main-storage areas must be assigned to each console in the system. The total amount of main storage required to support the system consoles therefore equals the sum of the storage requirements for each console plus 36 bytes for each console. For example, a system with a Model 85 display console, a 2260 display console, and a 3277 display station, model 2, needs 8300 (3.5K+1.5K+3.0K+108) bytes of main storage for display consoles.

Transient Display Control Modules. The transient DCM feature allows DCMs to reside in auxiliary storage and to occupy main storage only when they are used. The system assigns to a group of consoles enough main storage to

service the console with the largest individual storage requirement (Table 5-2) plus 8 bytes. The system also requires 50 bytes of main storage for each console in the group and 384 bytes of main storage for the access method (BPAM) that is used to transfer the DCMs between auxiliary storage and main storage. If the three consoles used in the example above were assigned to a transient DCM area, the system would require about 4K (3.5K+8+150+384) bytes of main storage.

PFK Command Entry. The system requires no more than 150 bytes of main storage for each PFK associated with commands. The size of the storage utilization block is not affected by PFK support.

Status Display Support Storage Requirements

Status Display Support requires only a minimal increase in the storage required for the Master Scheduler and Communications Task resident areas. The amount is variable according to the system options that are specified (MFT, MVT, MCS, Non-MCS), but the maximum is not more than 1200 bytes. The system also required some main storage to keep track of time-interval-updated displays, display areas, and console information. The maximum requirement is approximately 100 bytes of main storage for time-interval-updated displays, 32 bytes for each display area, and 30 bytes for each console in the system. The user cannot alter the storage requirements; the system automatically includes the required storage according to the options that are specified.

An increased amount of Write-to-Operator message buffers may be required by systems using display areas and time-interval-updated status displays. The number of buffers required varies according to the number of display areas defined and the number of display areas to be used for time-interval-updated displays.

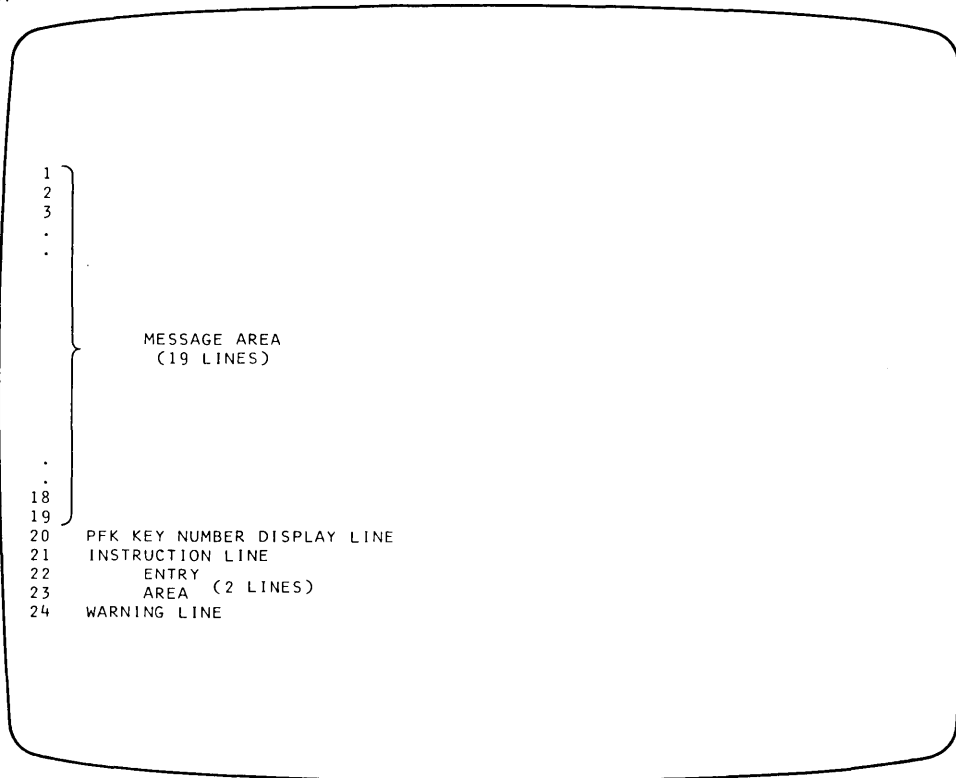
Physical Characteristics of 3270 Display Stations Used as Display Consoles

The device-independent feature of DIDOCS maintains a high degree of similarity among all display consoles. Operators already familiar with other display consoles will find that the 3277 display stations follow the same general format for physical presentation of information. Operators accustomed to typewriter consoles should find the display presentation clear and easy to read.

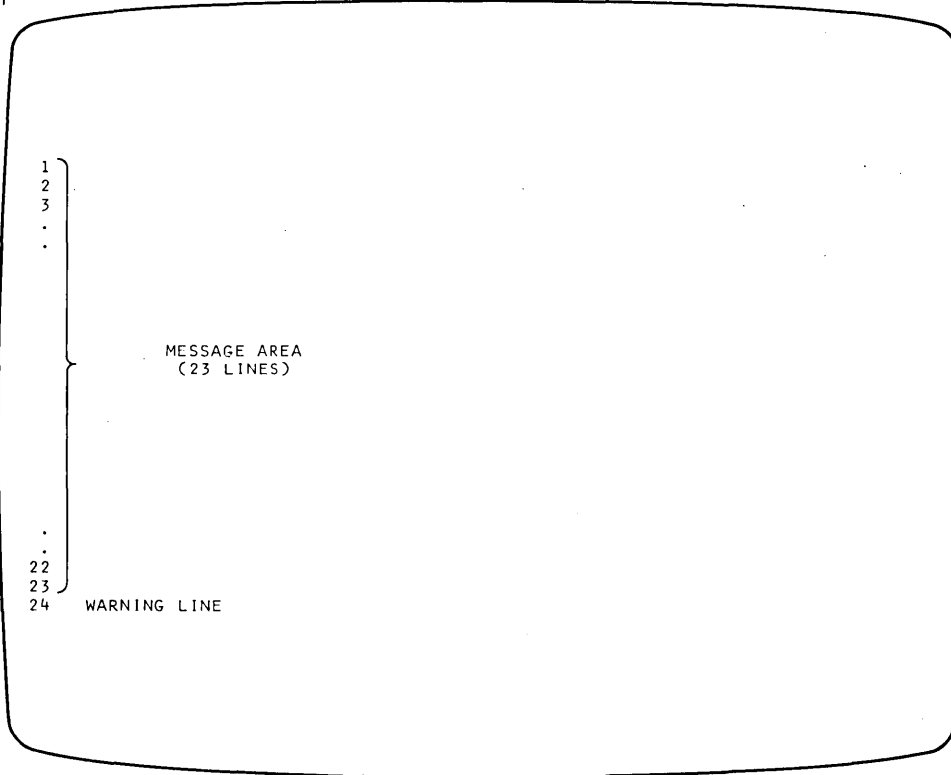
Screen Format for the 3277 Display Station, Model 2

The appearance of the display screen for the 3277 display station, model 2, in the input/output and output-only modes, is shown in Figure 5-1. In the input/output mode of

INPUT/OUTPUT
MODE



OUTPUT-ONLY
MODE



Note: These diagrams indicate how the display-screen lines are used in the two modes of operation; the labels shown do not appear on the screen.

Figure 5-1. Screen Formats for 3277 Display Station, Model 2

operation, the 24 lines of the screen are used as follows:

- Message area — 19 lines for messages.
- PFK display line — one line for display of PFK numbers (for selection using the selector pen).
- Instruction line — one line for display of error or operating instruction messages relating to control of the console.
- Entry area — two lines for entering commands.
- Warning line — one line for warning messages (intensified).

In the output-only mode, the message area is expanded to 23 lines.

Line Format for the 3277 Display Station, Model 2

The lines on the 3277 display station, model 2, are 80 character positions in length. Message area lines have system indicators in the first two positions, which appear blank on the screen. Positions 3 and 4 contain the message line number. Positions 5 and 6 may be blank or may contain indicators noting that action is required or has been taken. The message text is contained in positions 7–78. Messages longer than one line are divided at a blank space or comma after the 71st character position; if no comma or blank is found, the message is written to character position 78. The message is continued at position 7 of the next line.

Entry area lines have a blank in the first screen position; positions 2–80 are used for command entry.

In the output-only mode, lines 1–23 are in the format used for the message area, and the warning line is intensified.

Screen and Line Format for the 3277 Display Station, Model 1

The 3277 display station, model 1, has an 11-line message area and one warning line. Each 40-character line has an asterisk in position 1 when an action is required; otherwise, position 1 is blank. Message text is contained in positions 2–40 of the first 11 lines. Messages longer than one line are continued at character position three of the following line. (Messages longer than two lines are continued on the third line.) Warning messages are printed in positions 1–39 of the warning line; position 40, which contains system information, appears blank on the screen. The warning line is intensified.

System Procedures

Certain specifications must be made during system generation in order to establish the 3270 display consoles in the system. The operator may change these basic specifications after initial program load to arrange the consoles in what he finds to be their most useful configuration. This section outlines the specifications required during system

generation and introduces the basic procedures involved in operating display consoles. Detailed information about system generation is contained in *IBM System/360 Operating System: System Generation*, GC28-6554; display console operating procedures are fully explained in *IBM System/360 Operating System: Operators Guide for Display Consoles*, GC27-6949.

System Generation

Specification is required in the following areas:

- Multiple Console Support: This option under the SCHEDULR macro instruction is required to use display consoles.
- Console Designation: Each console must be specified under the SCHEDULR or SECONSLE macro instruction. This specification, combined with the multiple console support specification, provides the basic DDOCS services for the console.
- Output-Only Consoles: Operands of the SECONSLE macro instruction allow specification of output-only consoles.
- Transient Display Control Modules: This service is selected by means of the OPSTRAN operand of the SCHEDULR and SECONSLE macro instructions. If transient DCMs are used, the DCM library must be included in the system by means of the DCMLIB macro instruction.
- PFK Command Entry: This feature is selected by means of the PFK operand of the SCHEDULR and SECONSLE macro instructions. PFK keys may be associated with commands by the operator after initial program load.
- Selector Pen Command Entry: This function is also selected by means of the PFK operand of the SCHEDULR and SECONSLE macro instructions. Key numbers may be associated with commands by the operator after initial program load.
- Hard-Copy Consoles: The 3284 and 3286 printers may be designated as hard-copy consoles by means of the SECONSLE macro instruction.
- Display Areas: Display areas may be specified by means of the A operand of the SCHEDULR and SECONSLE macro instructions. Display areas may also be specified by the operator after initial program load.

Operating Procedures

The new operator or the operator trained on typewriter consoles should have little difficulty learning to work with display consoles. The procedures the operator is required to perform may involve altering the operating modes of the consoles or controlling the system.

Altering Console Configurations. The basic configuration of consoles is set during system generation. The operator should be aware of this original configuration and of the capabilities of each console in the system. He should know, for example, which consoles have been designated for input/output mode of operation and which have been designated for output-only operation. He can use the **DISPLAY** and **CONTROL** commands to keep informed of the configurations, and he may make alterations in the following areas:

- **Mode of Operation:** The **VARY** command can be used to make a display console available for other display applications; the **CONTROL** command can be used to change a console from input/output mode of operation to output-only mode (for either general messages or status displays) or from output-only to input/output.
- **Message Area Use:** The entire message area of a console screen may be used for messages, status displays, or a combination of both. By means of the **CONTROL** command, the operator may define areas of a console screen for presentation of status displays. Several of these display areas can be defined in one message area.
- **PFK Definitions:** If PFK support is requested during system generation, the operator can use the **CONTROL** command to associate commands with the PFK keys. PFK commands can be redefined by the operator at any time after initial program load.

Controlling the System with Display Consoles. During normal system operation, the operator:

1. Enters commands (1) by typing the command and pressing the **ENTER** key, (2) by typing the command and selecting the word **ENTER** from the display screen with the selector pen, (3) by pressing a PFK key, or (4)

by selecting a displayed PFK number with the selector pen.

2. Requests status displays by means of the **DISPLAY** command. The operator can request a display for his console or he can use the console to request a display for presentation on another console.
3. Deletes messages. If a display console screen becomes full, the operator must delete nonaction messages and messages for which required action has been taken. The operator deletes messages by using the **CONTROL** command, by positioning the cursor and pressing the **ENTER** key, or by using the selector pen. When messages are waiting for screen space, a message appears in the warning line.
4. Replies to Write-to-Operator-with-Reply messages, using the same procedure as for command entry.

Several display console features assist the operator in performing these procedures:

- The **CONTROL** command enables the operator to request automatic deletion of nonaction messages and messages for which required action has been taken.
- The **DISPLAY** command enables the operator to request a display of the commands associated with the PFK keys allocated to his console.
- Routing defaults for status displays can be established, so that the operator need not specify console and display area identifiers each time a display is requested.
- Some consoles have an audible alarm that sounds when an action message is displayed, when a message-waiting warning appears, or when an error is made in entering a **CONTROL** command.

INTRODUCTION

As previous chapters of this publication have indicated, the 3270 display system provides more functional capabilities and has greater flexibility than the 2260/2848 and 2265/2845 display systems. Therefore, many advantages can be realized by replacing 2260 or 2265 display stations with 3270 display stations. Among the advantages are improvements in:

- Transmission efficiency - because of higher local and remote transmission speeds and data compaction features.
- Operator efficiency - because of cursor controls and editing features.
- Simplicity of operation - because of formatting features.

Advantages such as the many possible configurations, the optional features, and the other added functional capabilities also contribute to the superiority of the 3270 display system.

This chapter is based on the assumption that, for expediency, some customers will at first want to use the 3270 display station in the same way as the 2260 display station is used in existing applications. These customers will enjoy the above-mentioned advantages of the 3270 display system, but the impact on their current application programs will be minimal. They can then take advantage of the added functional capabilities and flexibility of the 3270 display system at their own convenience. This chapter is intended primarily for customers who want to replace 2260 or 2265 display stations with 3270 display stations as quickly as possible and who choose not to take immediate advantage of all the added capabilities of the 3270 display system. For such customers, screen formats and display operator procedures for the 3270 display station should remain as much like existing formats and procedures for the 2260 or 2265 display station as possible.

Customers who require more functional capabilities than the 2260/2848 or 2265/2845 display system possesses should consider redesigning and rewriting for the 3270 display system parts or all of their existing application programs. To help them redesign and rewrite, manuals that describe the levels of programming support for the added capabilities of the 3270 display system will be available. To use the full potential of the 3270 display system, these customers are encouraged to complete this step as quickly as possible. All new applications should be developed with the features of the 3270 display system in mind.

Assumptions

For a typical installation, the following assumptions can be made about converting from a 2260/2848 display system to a 3270 display system:

- As little reprogramming as possible is to be done. Therefore, changes should be confined to as few routines as possible.
- The conversion process will occur in steps. Therefore, during the conversion period, 2260 display stations and 3270 display stations will operate simultaneously for most applications. Since simultaneous operation may degrade performance, conversion to 3270 display stations should be completed quickly.
- It may or may not be necessary to change from one access method to another (GAM to BTAM, for example). If the access method must be changed, access method planning guides will be available.
- It should not be necessary to change from one operating system to another (DOS to OS, for example). (If a change is necessary, operating system planning guides will be available.)

Steps in Conversion

If a change of access method is required, it should be done first. During this step, the 2260 display stations and the application program should, for the most part, remain unchanged.

If a change of access method is not required, the first step should be to replace the 2260/2848 display system with a 3270 display system and to use the 3270 display stations like 2260 display stations; that is, in a simple, unformatted, typewriter-like mode of operation. After this step is complete, uses and requirements for functional capabilities not available to the application program with the 2260 display station (but now available with the 3270 display station) will probably become apparent. The next step is to reprogram the applications, as time permits, to take advantage of the additional capabilities of the 3270 display system.

Application Program Structure and Modification

The typical structure of an application program consists of terminal control routines and processing routines. The terminal control routines, which are a distinct part of the application program, are normally responsible for all device

communication or terminal I/O operations. In many cases, all display-device dependencies are handled within the terminal control part, so that these dependencies are transparent to the processing routines. Therefore, in converting the application program, it is the terminal control routines that should be examined for possible modifications. In most cases, modifications to these routines will cause differences in screen format and input procedures that will be apparent to the display operator.

Summary

The programming changes necessary to replace 2260/2848 display systems with 3270 display systems and to use 3270 display stations like 2260 display stations are usually confined to a few parts of the application program. Redesign of application program logic should be minimal. Slight changes in the orientation of display operators will be required. Customers using program products for their applications should be the least affected.

Customers should approach replacement of the 2260/2848 display system with the 3270 display system in a logical, step-by-step procedure. The remainder of this chapter is intended to help do so.

CONFIGURATION CONSIDERATIONS

Table 6-1 is a general summary of configurations of the 3270 display system; Table 6-2 is a summary for the 2260/2848 and 2265/2845 display systems. Table 6-3 summarizes comparable 2260/2848, 2265/2845, and 3270 display system configurations.

There are two different screen sizes of 3270 display stations. The 3277 and 3275 display stations, model 2, have a screen that displays 24 80-character lines. The 3277 and 3275 display stations, model 1, have a screen that displays 12 40-character lines. The 2260 model 1 and 2260 model 2 display stations have the same screen size; screen capacity depends upon the control unit to which these display stations are attached. The 2260 model 1 displays 12 80-character lines when attached to a 2848 model 3. The 2260 model 2 displays 12 40-character lines when attached to a 2848 model 2 or 22, and it displays 6 40-character lines when attached to a 2848 model 1 or 21.

For local and remote groups and for remote standalone, there are 3270 display stations. The 3277 display stations, models 1 and 2, are attached to the 3272 control units, models 1 and 2, to form local groups. They are attached to the 3271 control units, models 1 and 2, to form remote groups. The 3275 model 1 and model 2 are remote standalone control unit/display stations. There are 2260 display stations for local groups and remote groups. The 2260 model 1 is attached to the 2848 model 3 to form local or remote groups. The 2260 model 2 is attached to the 2848 model 1, 2, 21, or 22 to form local or remote groups.

Table 6-1. 3270 Display System Configurations

Control Unit	Display Station or Printer	Number of Devices on Control Unit	Capacity of Display Station (in Characters)
3272 Model 1	3277 Model 1	1-32	480
	3284 Model 1	0-31	-
3272 Model 2	3277 Model 2	1-32	1920
	3286 Model 2	0-31	-
3271 Model 1	3277 Model 1	1-32	480
	3284 Model 1	0-31	-
3271 Model 2	3277 Model 2	1-32	1920
	3286 Model 2	0-31	-
—	3275 Model 1	1	480
	3284 Model 3	0-1	-
—	3275 Model 2	1	1920
	3284 Model 3	0-1	-

Table 6-2. 2260/2848 and 2265/2845 Display System Configurations

Control Unit	Display Station or Printer	Number of Devices on Control Unit	Capacity of Display Station (in Characters)
2848 Model 1	2260 Model 2	1-24	240
	1053 Model 4	0-1	-
2848 Model 2	2260 Model 2	1-16	480
	1053 Model 4	0-1	-
2848 Model 3	2260 Model 1	1-8	960
	1053 Model 4	0-1	-
2848 Model 21	2260 Model 2	1-24	240
	1053 Model 4	0-1	-
2848 Model 22	2260 Model 2	1-16	480
	1053 Model 4	0-1	-
2845	2265 Model 1	1	960
	1053 Model 4	0-1	-

Table 6-3. Comparable 2260/2848, 2265/2845, and 3270 Display System Configurations

Current 2848 or 2845 Control Unit	Current 2260 or 2265 Display Station or 1053 Printer	Comparable 3270 Display Station or Printer	Comparable 3270 Control Units
2848 Model 1	2260 Model 2	3277 Model 1	3272 Model 1
	1053 Model 4	3284 Model 1	3271 Model 1
2848 Model 2	2260 Model 2	3277 Model 1	3272 Model 1
	1053 Model 4	3284 Model 1	3271 Model 1
2848 Model 3	2260 Model 1	3277 Model 2	3272 Model 2
	1053 Model 4	3286 Model 2	3271 Model 2
2848 Model 21	2260 Model 2	3277 Model 1	3272 Model 1
	1053 Model 4	3284 Model 1	3271 Model 1
2848 Model 22	2260 Model 2	3277 Model 1	3272 Model 1
	1053 Model 4	3284 Model 1	3271 Model 1
2845	2265 Model 1	3275 Model 2 3275 Model 1	—
	1053 Model 4	3284 Model 3	

For a more detailed description of 3270 display system configuration considerations, see Chapter 2. For more detailed 2260/2848 or 2265/2845 display system configuration considerations, see *IBM System/360 Component Description: IBM 2260 Display Station - IBM 2848 Display Control, GA27-2700*, or *IBM System/360 Component Description: 2265 Display Station Model 1 - 2845 Display Control, GA27-2731*.

3270 AND 2260/2848 DISPLAY SYSTEM FUNCTIONAL DIFFERENCES

Some of the major functional differences between the 3270 and the 2260/2848 display systems are noted below. For details on these and other functional differences, compare information in the relevant chapters of the manuals mentioned above.

Line Control

Using BTAM support under DOS or OS, differences between the binary synchronous communication line control used for a 3270 display station and the start/stop line control used for a 2260 display station will be apparent to the application program.

Data Stream

Using BTAM support under DOS or OS, differences between a data stream for a 3270 display station and a data stream for a 2260 display station will be apparent to the application program. The 3270 display system has additional buffer and display control information embedded in the data stream.

Commands and Control Characters

Through various control characters and orders in the output data stream, the 3270 display system Write command can be used to perform the same functions as the 2260 Write DS Buffer, Write DS Line Address, and Write 1053 Buffer Commands. The 3270 Write command can also be used to perform the same functions as the 2260 Erase DS Buffer command. The 3270 Read Buffer command can be used to perform the same functions as the 2260 Read Full DS Buffer command.

The start manual input and new line control characters are unique to the 2260 display station. Because these control characters are essential to the operation of the commands, the 2260 Read DS Manual Input and Short Read Manual Input commands have no directly equivalent 3270 display system commands.

DEVICE CONVERSION

Assuming that access method conversion was unnecessary or has been made, there are several ways of introducing 3270 display system devices into the system without completely rewriting application programs. A simple, 2260-like mode of operating the 3270 display station is suggested below. The changes described are merely an example of the impact of conversion on an existing 2260 application program. Each application program must be examined to determine the exact changes that apply. After new line control is established, some editing is needed to convert input and output data streams. The changes suggested below should affect only the I/O module or modules of the application program and will have little impact on the display operator.

Output Considerations

On output, the message text is scanned, and the following substitutions and additions are performed:

- The start manual input (Start MI) character is replaced by a field separator for an unprotected field.
- A cursor positioning (IC) code is inserted in the first position following the field separator that replaces the Start MI character.
- New line (NL) characters are replaced by start field (SF) sequences placed in the last character positions of the lines for unprotected fields (if the NL character may be

entered as data). The first text character following the NL character should be forced to the next line in all cases by using a set buffer address (SBA) sequence.

Input Considerations

On input, the message text is scanned, and the following substitutions and deletions are performed:

- All device control through the first set buffer address (SBA) sequence is deleted, and the message is compacted.
- Each subsequent SBA sequence is deleted, an NL character is substituted (if the NL character may be entered as data), and the message is compacted.

Message Editing

On both output and input, message editing must be done within the application program. One technique for finding the locations that require editing is the use of the Translate-and-Test instruction. The required editing routine should be straightforward if the application program has used Write DS Line Address commands. If the program has used Write DS Buffer commands (so that current cursor position may not be known), but NL characters have not been used, the editing routine remains straightforward. Output conversion is also simple if the data stream is constructed of defined constants with variable areas referenced by symbols; if this is not the case, output conversion may be more complex.

Display Operator Considerations

In conjunction with the changes indicated above, the display operator performs the following operations when entering data:

- Enters data at the cursor location.
- Presses the ERASE EOF key to clear the rest of the field to nulls.
- Presses the ENTER key.

The operator's actions remain essentially unchanged except for the additional requirement of pressing the ERASE EOF key. For most modes of operation, this presents no problem. Even though the "fill-in-the blanks" approach is potentially more difficult, the ERASE EOF key can be

used for each field, thus simplifying the total operation. Caution should be exercised if the entire screen has been defined as one field.

Display Operator Reorientation

When using the 3270 display station, the display operator no longer sees the start manual input, new line, and end of message symbols that appear on the 2260 display station.

For a 2260 display station and a 2260 application program, the display operator enters data in a field (if necessary) and presses the NEW LINE key to move to the next field. After this data has been entered, the operator presses the ENTER key. For a 3270 display station and a modified 2260 application program with a data-stream editing routine, the operator enters data in a field (by overwriting either data or blanks) and presses the ERASE EOF and TAB keys to place the cursor in the first character position of the next unprotected field. If no data is required for a field, the operator enters a "no data" character that is recognized by the editing routine.

Unlike the 2260 display station, for which the new line character serves to end a field for input, the 3270 display station sends the total field (including spaces, but excluding nulls). To allow the message processing routines to scan input correctly and to reduce the logic required in the editing routine, the input data length should always equal the length of the data entered. The operator presses the ERASE EOF key after entering data in a field to guarantee that no other data (such as spaces used to fill out the fields, instead of nulls) is transmitted.

SCREEN FORMAT EXAMPLE

With the device-conversion considerations discussed above in mind, a simple example of the step-by-step transition sequence is described below. To illustrate this sequence from the programmer's and the display operator's points of view, both the screen formats and the input and output data streams are shown.

The screen format example chosen is representative of several different operating modes used in transaction processing, including conversation, data selection, free form, sequence key, and code link.

2260 Display Station - Step 1

When the display is initially written (by means of the Write DS Line Address command), it appears as shown in Figure 6-1. The data stream for this display format is:

2260 Output (command in selection sequence remote)

[STX]

Lineno	TEXT	Start MI
--------	------	----------

 [ETX]

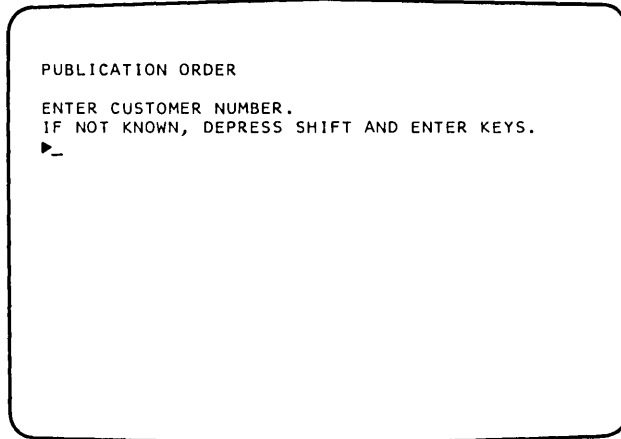


Figure 6-1. 2260 (Step 1)

2260 Display Station - Step 2

After the display operator types a response, the display appears as shown in Figure 6-2. The data stream is:

2260 Input

[STX DVC]

1 2 3 4 5 - 6 7

 [ETX]

Note that the new line character is not used in this example. The required editing is somewhat simplified, since the new line character does not have to be compensated for.

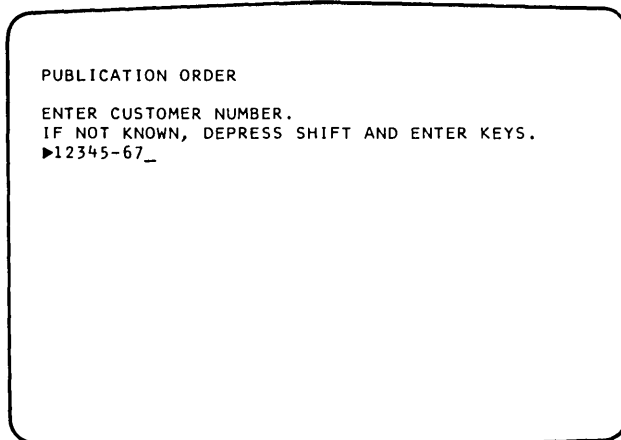


Figure 6-2. 2260 (Step 2)

3277 Display Station - Step 1

After the 2260 output data stream has been edited for the 3277 display station, and the display is initially written, it appears as shown in Figure 6-3. The data stream for this display format is:

3277 Output (command specified by ESC CMD sequence remote)

[STX ESC CMD]

Control Code	SBA seq	SF seq	TEXT
--------------	---------	--------	------

SF seq	IC
--------	----

 [ETX]

Note both the change in text written to the display station and the deletion of the Start MI symbol which has been replaced by a "blank" character. The required changes have been made by the editing routine in the application program. The operator needs to press only the ENTER key (rather than the SHIFT and ENTER keys).

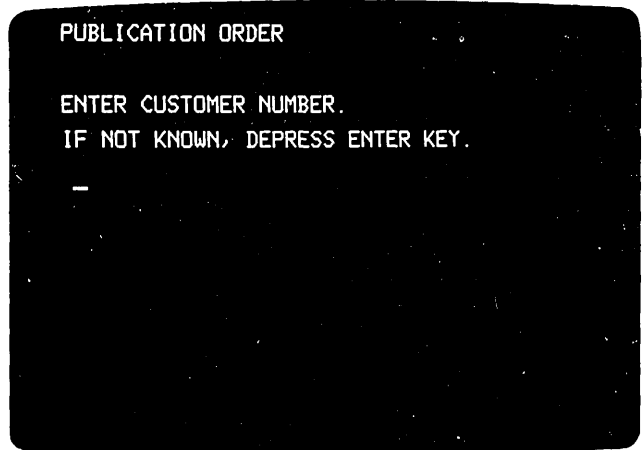


Figure 6-3. 3277 (Step 1)

3277 Display Station - Step 2

After the display operator types in the data requested, the display appears as shown in Figure 6-4.

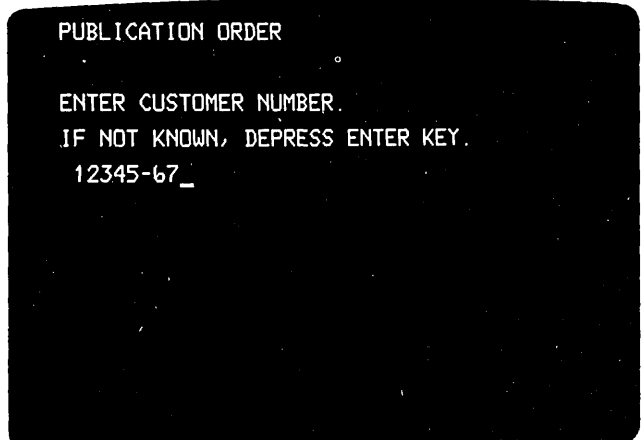
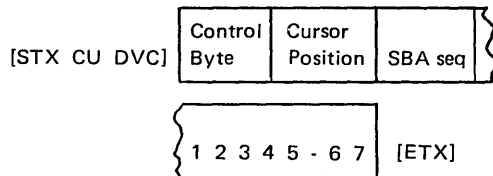


Figure 6-4. 3277 (Step 2)

3277 Display Station - Step 3

After the display operator presses the ERASE EOF and ENTER keys, the display appears as shown in Figure 6-5. The data stream is:

3277 Input



Note that, as compared with the 2260 data streams, additional characters are required in the 3277 data streams preceding and following the text on output and preceding the text on input. Space for the additional characters must be provided by the editing routine in the application program, possibly through expanded input/output work or buffer areas.

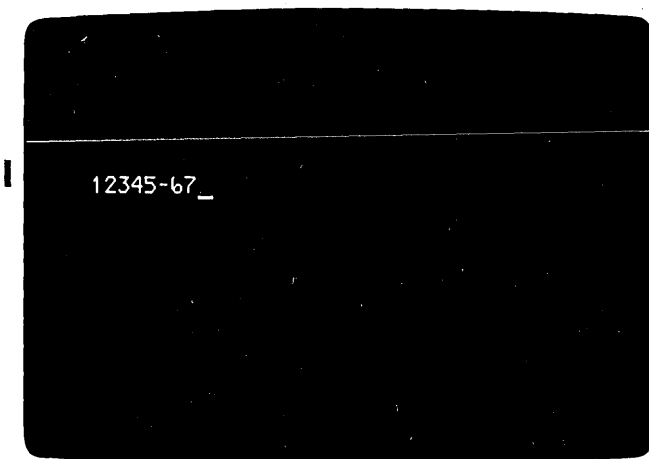


Figure 6-5. 3277 (Step 3)

ESTIMATING THE CONVERSION EFFORT

There is no general "cookbook" for conversion. Every installation has its own special conversion considerations, depending on its particular applications. To gauge the magnitude of a particular conversion effort, these considerations, together with any factors unique to the installation, must be thoroughly understood.

Conversion Segmentation

Typically, key segments of the conversion process can be distinguished, and estimates of the effort involved in each segment can be developed. For example, converting an application program can be segmented as follows:

1. Operating system conversion (if applicable).
2. Access method conversion (if applicable).
3. Minimal modification of application program (to use the 3270 display station in a "2260-like" mode of operation).
4. Maximum modification (redesign and rewrite) of application program (to use additional functional capabilities of the 3270 display system).
5. Reorientation of display operator to new displays and new operations.

Conversion Aids

Planning guides, which can aid in developing estimates, will be available for the first two items listed above. For all items, in addition to documentation, other resources (such as SE services) are available. The list of items is merely intended as a general guideline for assembling the information needed to develop a conversion plan.

CONCLUSION

After the customer has assessed the impact of conversion on his particular applications, a reasonable estimate of the total conversion effort can be assembled. Based on this estimate, the installation can determine the method and schedule for replacing its 2260/2848 display systems with 3270 display systems.

Primary emphasis has been given to the relationship of the equipment to the operator during the development of the IBM 3270 Information Display System. Factors considered include: operator comfort, glare, image legibility, keyboard design, operator efficiency, and operator training costs. This chapter discusses many of these considerations.

DISPLAY IMAGE

All information displayed on the CRT screen must be regenerated periodically for retention of the image. This generation is accomplished automatically by the circuitry in each unit. The speed at which the display image is reproduced is called the "refresh" rate, and, if the displayed image is not refreshed often enough, it can flicker and become difficult to read. The 3270 display system has been designed to refresh the image approximately 50 times per second, creating an easy-to-read display under nominal office conditions.

All characters displayed on the CRT are formed by a pattern of small dots of light on a 7 x 9 dot matrix.

All font designs have been specifically developed for the displays on which they are to appear. Each character has been designed and tested for maximum legibility and minimum ambiguity with similar-appearing symbols.

The operator will find the displayed information easily, rapidly, and accurately readable.

Figure 7-1 shows some characters formed with the 7 x 9 dot pattern. A cursor is shown under the E character.

Glare on the face of the CRT from overhead lighting has been minimized by means of the cover design and proper positioning of the CRT. Selecting this approach to control glare in lieu of an anti-glare treatment on the CRT surface prevents degradation of image clarity. Brightness and contrast of the image with the background are other areas of importance. The brightness is operator-adjustable over a range from an unilluminated screen to full character brightness. Added to this, the green CRT phosphor, in conjunction with a neutral density filter which has been incorporated in the CRT, provides excellent character color and contrast within the normal range of room illumination.

KEYBOARDS

The keyboard is connected to the display station by a 2½-foot cable that allows the operator to place the keyboard in the most comfortable and convenient position. Selection of furniture for use with the 3270 should provide

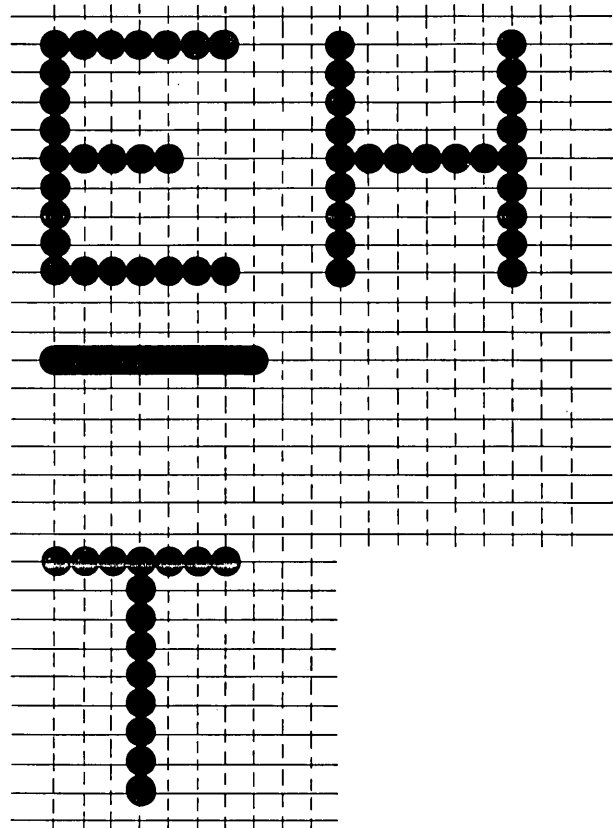


Figure 7-1. Examples of Characters Formed with 7 x 9 Dot Pattern

a supporting surface for the keyboard that is 26 inches above the floor; this will place the home row keys at the optimum operating height from the floor. A dimension of up to 29 inches may be allowed for lower keying throughput requirements. The angle of surface of the keyboard has been carefully selected to provide maximum comfort and efficiency.

Finger Positioning

So they can be easily found by touch, a deeper than normal depression is provided on those keys that establish the home row position for all keyboards. In the case of the typewriter and operator console keyboards, the two keys selected are those for the index fingers (F and J). On the data entry keyboard, the middle three keys in the numeric row are more deeply dished (4, 5, 6). This ability to identify the proper home row keys improves throughput and reduces error rates.

Keyboard Design

The keyboard design has been developed to provide an uncomplicated keyboard layout. This allows an operator to adapt easily and to feel comfortable during operation of the display station.

The keyboard has been divided into three key groups: data keys, special control keys, and erase keys.

The typewriter keyboards retain the basic key layout found on a common office typewriter. Special function keys, such as ENTER and cursor control keys, have been placed where they can be readily reached from the home row of keys. Little training will be required for an operator who is able to type on a typewriter.

Data entry keyboards use the same conventional key layout for alphabetic characters that is used on typewriter keyboards. However, the numeric keys and certain function keys are patterned after the IBM 29. The numeric keys are placed in the same configuration that is found on IBM keypunches, allowing one-hand operation.

Data, special cursor control, and function keys are placed so that they may be operated smoothly from the home row position during a single-hand operation. Key punch operators will have little difficulty in rapidly adapting to this keyboard.

Operator console keyboard layouts are identical with the keyboard layout of the IBM 1052 Model 7 that is presently used with IBM System/360. Here again, the cursor control and special program alert keys have been positioned where they can be used conveniently.

Typamatic Operation

All keyboards in the 3270 system have some typamatic keys, that is, keys that repeat their function as long as they are held down. On the typewriter and operator console keyboards, the TAB, SPACE, HYPHEN/UNDERScore, NEW LINE, BACKSPACE, and cursor control keys have this function. On the data entry keyboard, the TAB, SPACE, NEW LINE, SKIP, BACKSPACE, and cursor control keys are typamatic.

Ease of Operation

All keyboards in the 3270 display system operate swiftly, quietly, and have an electrical lock. Data can be inputted from the keyboard at a rate of up to 25 characters per second. Each depression of a key generates an audible reply that signals the operator that the data has been entered into the display station buffer. The lack of an audible reply signifies that the keyboard input is inhibited. In addition, an indication on the display alerts the operator to the fact that the keyboard is electrically locked.

OPERATOR CONTROLS

All 3270 display stations have the combination OFF-PUSH and contrast control located on the front of the unit. Pulling this control out turns the unit on; pushing in turns it off. When the control is pulled out, the stem of the switch will show red, indicating that the display station is on. Image brightness and dual brightness character contrast can be changed by the operator at any time.

The key lock feature, if installed, is another operator control. This feature provides a key that can be used to control program access to or from a display station (refer to Security Enhancements, Chapter 3); the key receptacle is located on the right side of the unit cover.

INDICATORS

Three indicators are found on all 3277 display stations. These indicators provide the operator with a visual indication of the operational status of the entire display system and particularly that of her own unit. All indicators are located to the right on the CRT screen in a vertical row and are clearly visible. The labels that describe each indicator are located to the right of the CRT screen, parallel with the associated indicator.

3275 display stations have five additional indicators located in line with those described above. 3275 indicators are not located on the CRT screen. Their function is to provide information on the status of the remote communication facilities.

Chapter 8. Installation Planning Data

The physical characteristics and environmental requirements of 3270 units allow a display system installation to be placed in a normal office or computer room environment with a minimum amount of special arrangements. This chapter describes, in general, the reasons why a 3270 display system is easily installed. For more detailed information, contact an IBM installation planning representative or refer to one of the following publications:

1. *IBM System/360 Installation Manual - Physical Planning*, Form GC22-6820
2. *IBM System/360 Installation Manual - Physical Planning*, *IBM World Trade 50-Hertz Requirements*, Form GC19-0001
3. *IBM System/370 Installation Manual - Physical Planning*, Form GC22-7004
4. *IBM System/370 Installation Manual - Physical Planning*, *IBM World Trade 50-Hertz Requirements*, Form GC19-0004

PHYSICAL CHARACTERISTICS

The 3270 display system units are attractively packaged, of small size, and of light weight. Control units and printers are similar in appearance and occupy a volume of space equivalent to that of a standard two-drawer office file cabinet. Access to service these units is gained by means of a removable front cover. Service access to display stations is gained by means of removable side, top and back, and lower front covers.

Approximate unit weights vary from 120 pounds for a printer, downward to 95 pounds for a control unit, 95 to 65 pounds for various display station models, and 20 pounds for a keyboard.

CABLES

A single coaxial cable connects each 3277 display station or 3284 and 3286 printer in the display system to its control unit. This cable is not included with the unit; up to 2000 feet of cabling can be installed. Each device attached to a

control unit requires its own cable; therefore, if a control unit has 16 display stations and 8 printers in a configuration, 24 output cables leave this unit. Two additional control unit cables are used in local configurations to communicate with the system channel. These two cables vary in length; depending upon the central processing system configuration, 200 feet is the maximum length possible. Remote configurations use only one additional control unit cable, which is the connection to the communication data set.

Display stations, in addition to having a cable for connection to the control unit, have other cables that connect to their attached features; that is, selector pen, card reader, or keyboard. 3275 display stations may also accept one additional cable to attach a 3284 printer, model 3. Table 8-1 lists maximum cable lengths.

Table 8-1. 3270 Display System Maximum Cable Lengths

From	To	Length (feet)
3271/2 Control Unit	Display station	2000
3271/2 Control Unit	Printer	2000
3272 Control Unit	Channel (power control) ¹	150
3272 Control Unit	Channel (data signals) ¹	Channel dependent
3271 Control Unit or 3275 Display Station	Data set ²	40
3275/7 Display Station	Keyboard	2½
3275/7 Display Station	Selector light pen	2
3275/7 Display Station	Card reader	10
3275 Display Station	Printer	10
1 — local configurations only		
2 — remote configurations only		

Customers who presently use an IBM 2260/2848 display system can convert to a 3270 display system without replacing the 2848-to-2260 coaxial signal cable. The cables used in the installed display system can easily be adapted for use on the 3270 display system.

Chapter 9. Reliability, Serviceability, and Availability

With the growth of online data processing, the availability of the central processing system and attached devices becomes an essential factor in company operations. The 3270 display system has been provided with many facilities to achieve a high degree of reliability, serviceability, and availability.

The decentralized packaging of critical hardware components highlights the engineering features that make the 3270 more reliable and easier to service. Past display systems were designed with central storage buffer and central controls that were packaged in the control unit. In the 3270 display system, each unit is provided with a separate buffer and separate keyboard controls that are packaged in the device. Thus, the number of components in the control unit are significantly reduced, resulting in a substantial improvement in reliability. Further, decentralization results in a lower cost control unit that permits a customer with a critical application to configure a display system with two control units at a minimal cost increase. With two control units included in a configuration, failure of a critical component in one unit disables only a portion of the display system.

Serviceability improvements include:

- Built-in recovery and retry circuits.

- On-Line Test (OLT) programs*.
- IBM FE Teleprocessing Test Center support for the IBM Customer Engineer.

Unit reliability is improved through the use of a more reliable and more densely packed circuit technology. This improvement reduces the frequency of service calls. Additionally, 3270 control units are provided with the ability to retry any device data transfer operation which fails. The application program is not alerted to a failure unless the retry also fails. If a service call is required, the IBM Customer Engineer (CE) can use OLT programs*, which do not interrupt total system operation, to isolate a failing component. The IBM CE is further supported by a Test Specialist and test programs at the IBM FE Teleprocessing Test Center. This support is provided to minimize service time for remote 3270 display system problems. Service is also made easier by the interchangeability of similar 3270 units. This factor is particularly useful when a keyboard or selector pen problem is being investigated.

Programming error recovery procedures provide additional improvements to supplement the hardware provisions described above.

*This serviceability aid is available only if the customer designs the system with sufficient core space to accommodate a resident OLT facility.

Evaluation of the performance of a 3270 display system is affected by several factors that significantly influence the results. The principal influence is the type of configuration. A display system configured for local (direct) attachment to a system channel will generally provide a response time of 1 second or less for typical transactions. The larger part of this 1-second response period is utilized for processing and file operations within the central processor. A display system configured for remote attachment (by means of communication facilities) to a system channel will generally require more than 1 second to respond to operator inquiries. The added time for a remote operation is caused by the data transmission rates of the communication facilities and is significantly influenced by the number of display stations attached to the same communication line.

Other factors that influence performance are largely dependent upon the application, for example, typical message length, message format, system channel loading, and transaction interaction time.

Because of the many possible display system configurations and the wide variety of applications, it is not practical to provide simple timing formulas, graphs, or performance data that expresses, in exact terms, the system performance capabilities. The data presented in this chapter represents reasonable approximations of 3270 display system performance for a few general applications; and it should be understood that many factors could cause variations in the results.

BASIC CONFIGURATION DIFFERENCES

The reason for a difference in operator response times between a locally attached and a remotely attached display system becomes apparent when the total information transfer path of each configuration is considered (Figure 10-1). Depending upon the line speed, 2400 or 4800 bps, the 300 or 600 character per second data transfer rate is the fundamental factor limiting response time and the number of display stations that can be supported on a single communication line.

Plotting local and remote response times with various numbers of displays in the display system produces a relationship such as that shown in Figure 10-2. The transactions evaluated in Figure 10-2 consist of a 40-character input message and an 800-character output message from the program. The average time between transactions (interval between enter operations) for this case is 22 seconds.

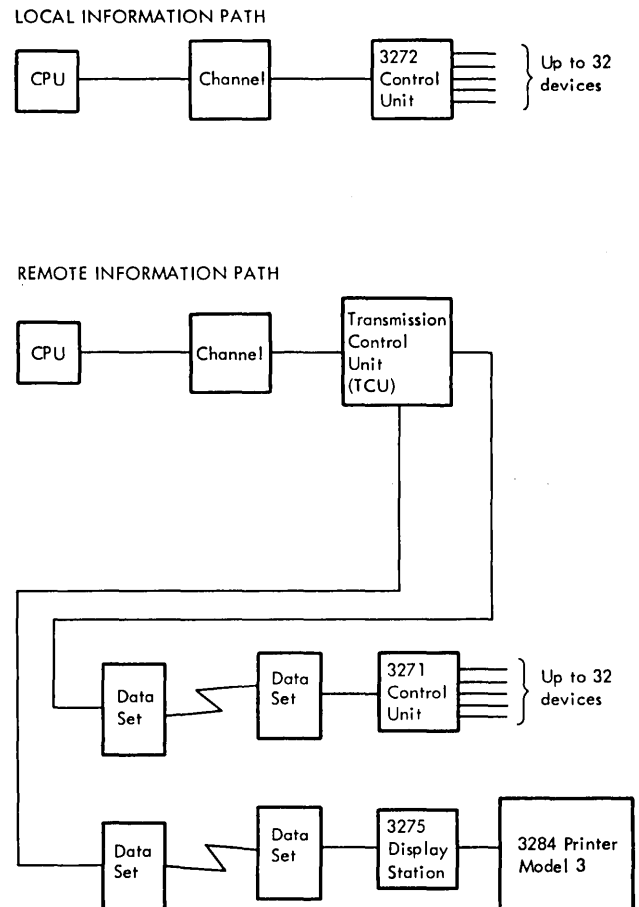


Figure 10-1. Information Path Comparison

DISPLAY SYSTEMS ATTACHED LOCALLY

Locally attached display systems service operator inquiries fast enough to virtually eliminate operator idle-time between the transmission and reception of messages. A local display system that is attached to a heavily loaded system channel may experience response times greater than 1 second because of heavy channel activity. To help rectify this situation, the display system is provided with the ability to prepare for an anticipated system channel instruction without being operationally connected to the system channel. The Select command (Chapter 3) initiates a device to control unit buffer transfer operation that requires up to 70 ms. Upon completion of the buffer load

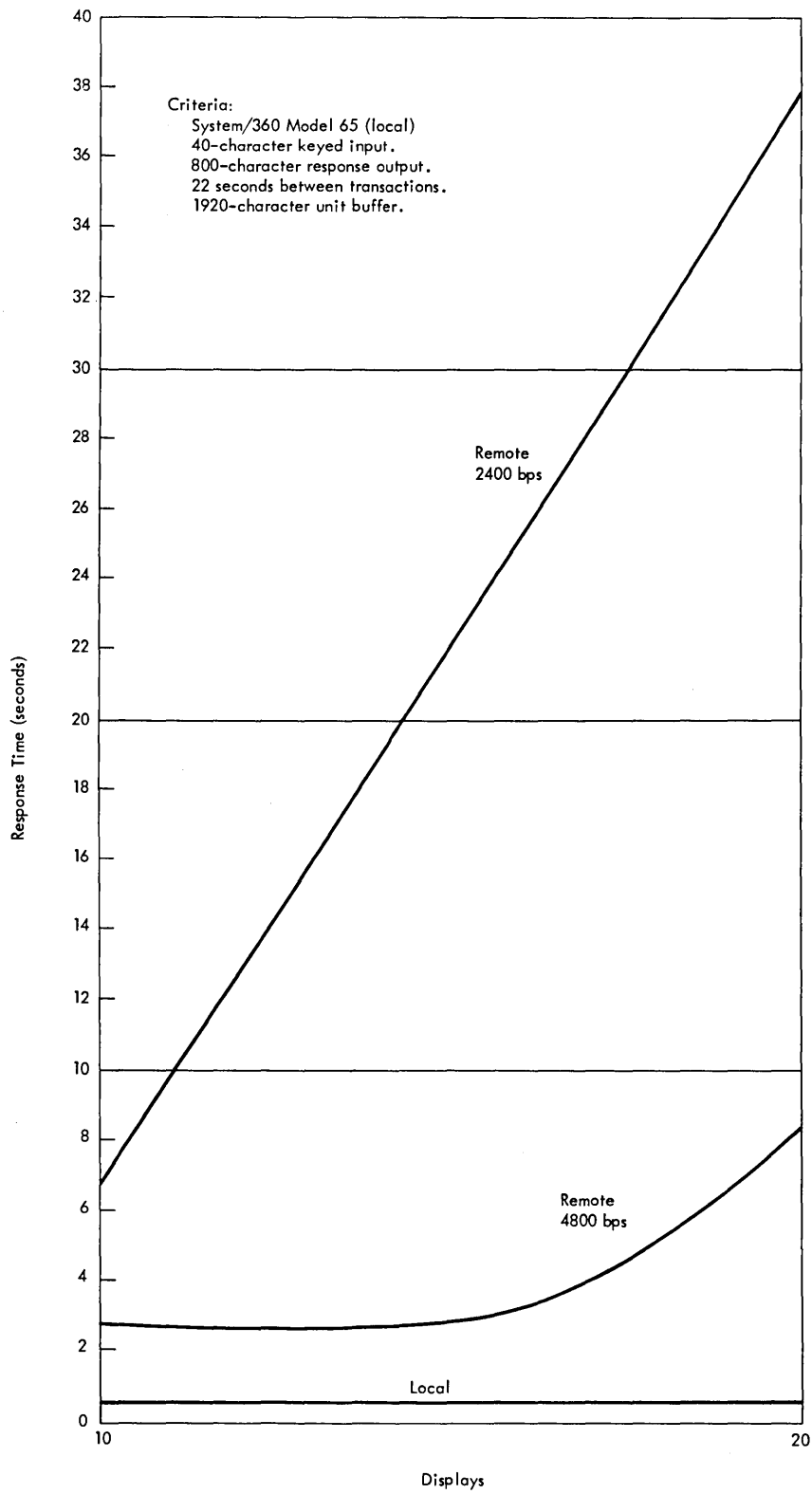


Figure 10-2. Comparison of Local and Remote Response Times

operation, the subsequent program operation is executed with data transfer rates of 14,000 to 650,000 characters per second, depending upon channel characteristics. The select operation is most advantageous when used with a block multiplexer channel.

DISPLAY SYSTEMS ATTACHED REMOTELY

Remote display systems must be designed to satisfy two important system factors: (1) operator idle-time while waiting for a system response and (2) costs of communication facilities. The 3270 display system is provided with many built-in functional control capabilities that are

designed to reduce the number of messages, and the message length and time, thus reducing response times, operator wait time, and the cost of communication facilities.

The importance of careful remote display system planning to incorporate the advantages offered in the 3270 display system cannot be overemphasized. Significant reductions in communication line cost can be realized if the advantages of data compaction are fully employed. Contact your IBM representative for additional information.

A variety of applications have been analyzed, and representative results are shown in the following charts. These charts are provided for general information only.

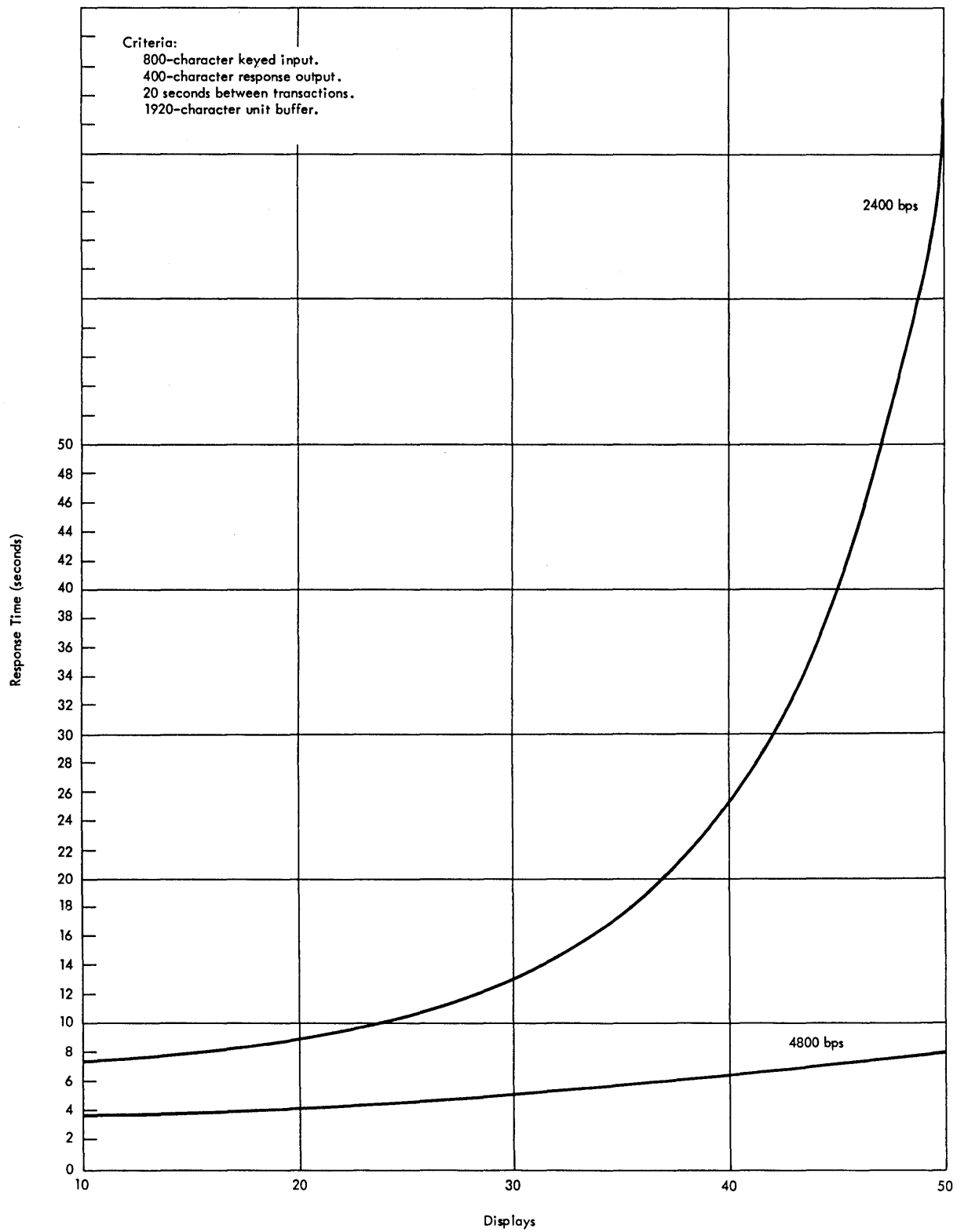


CHART A

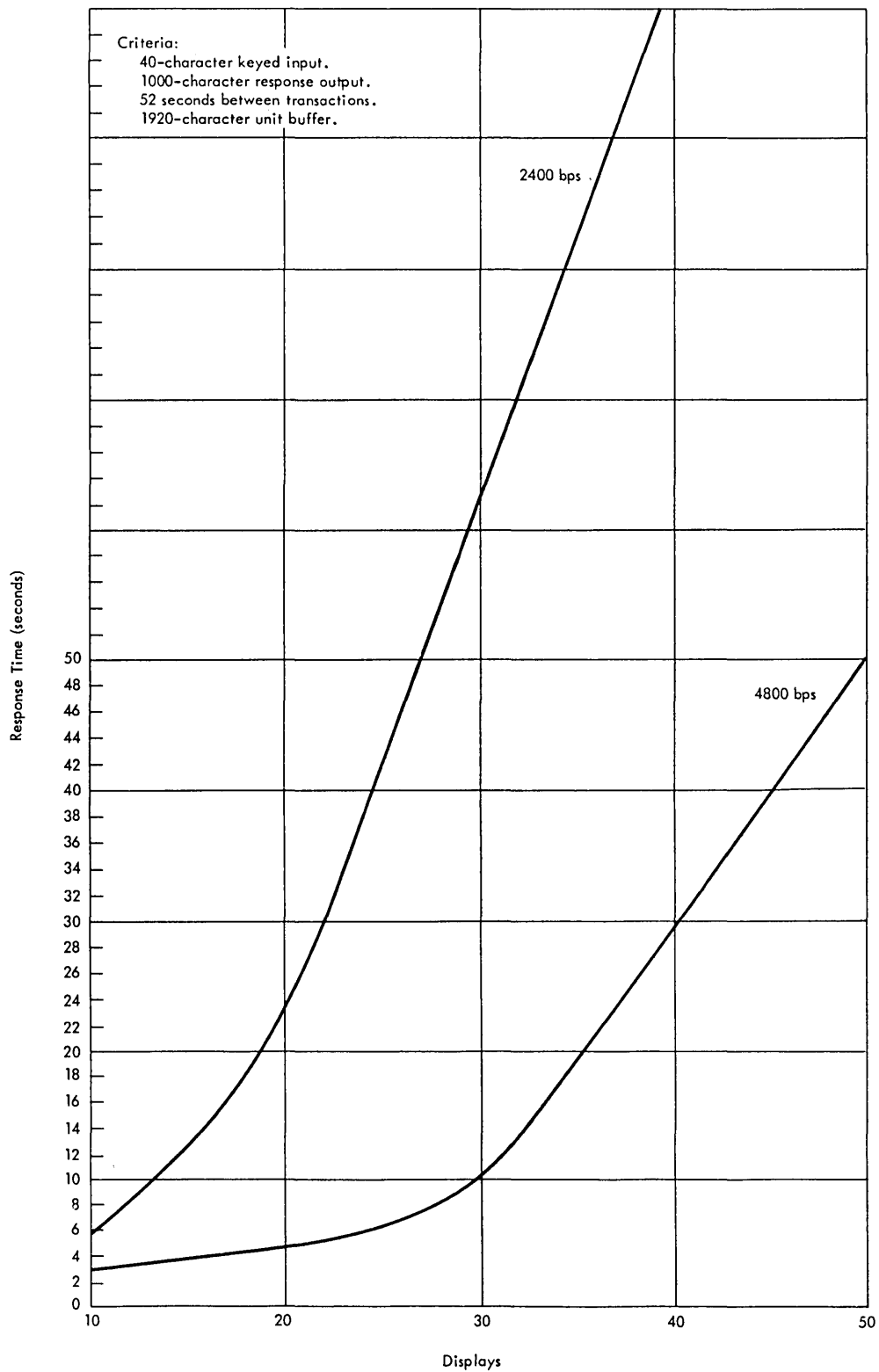


CHART B

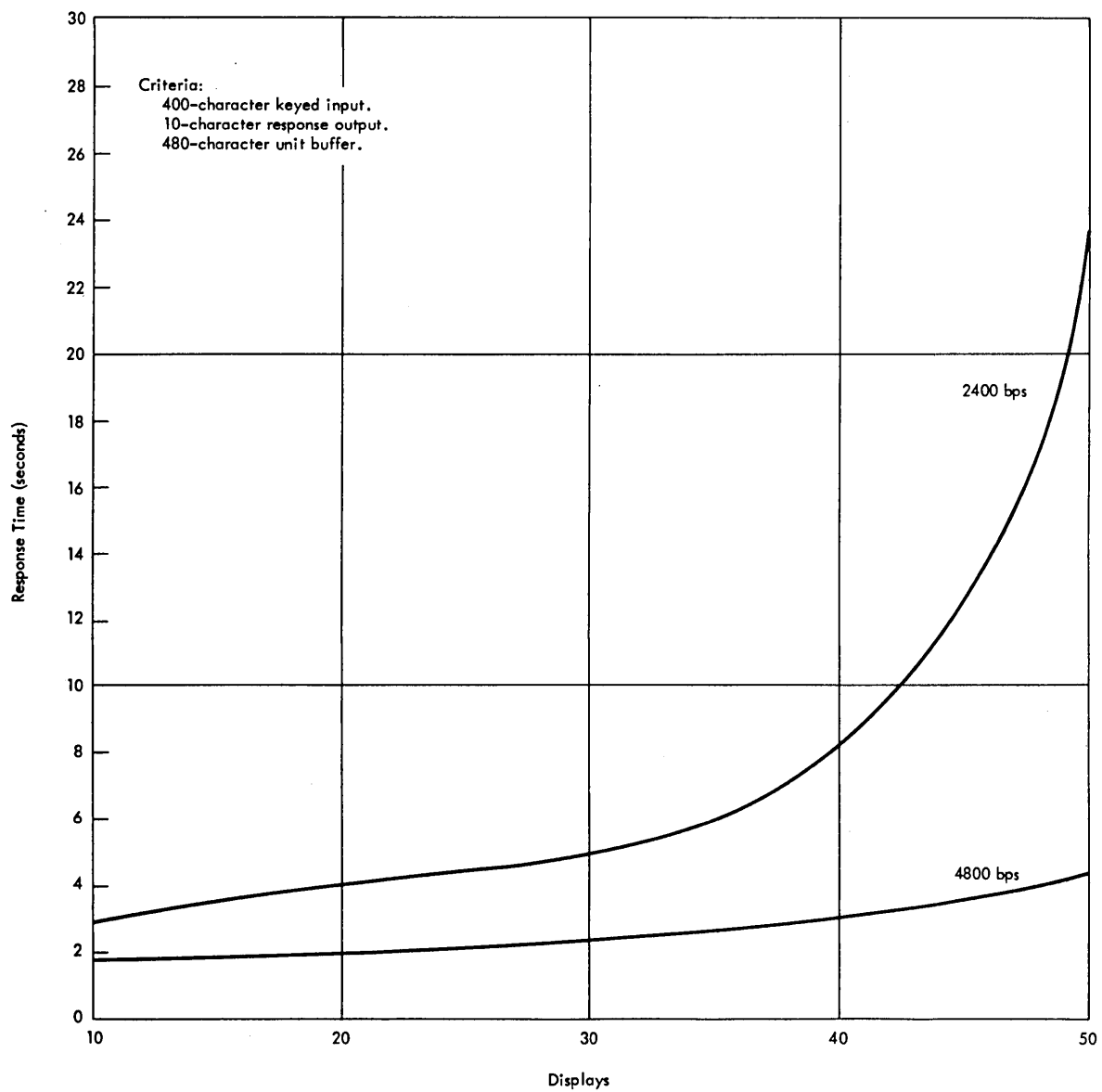


CHART C

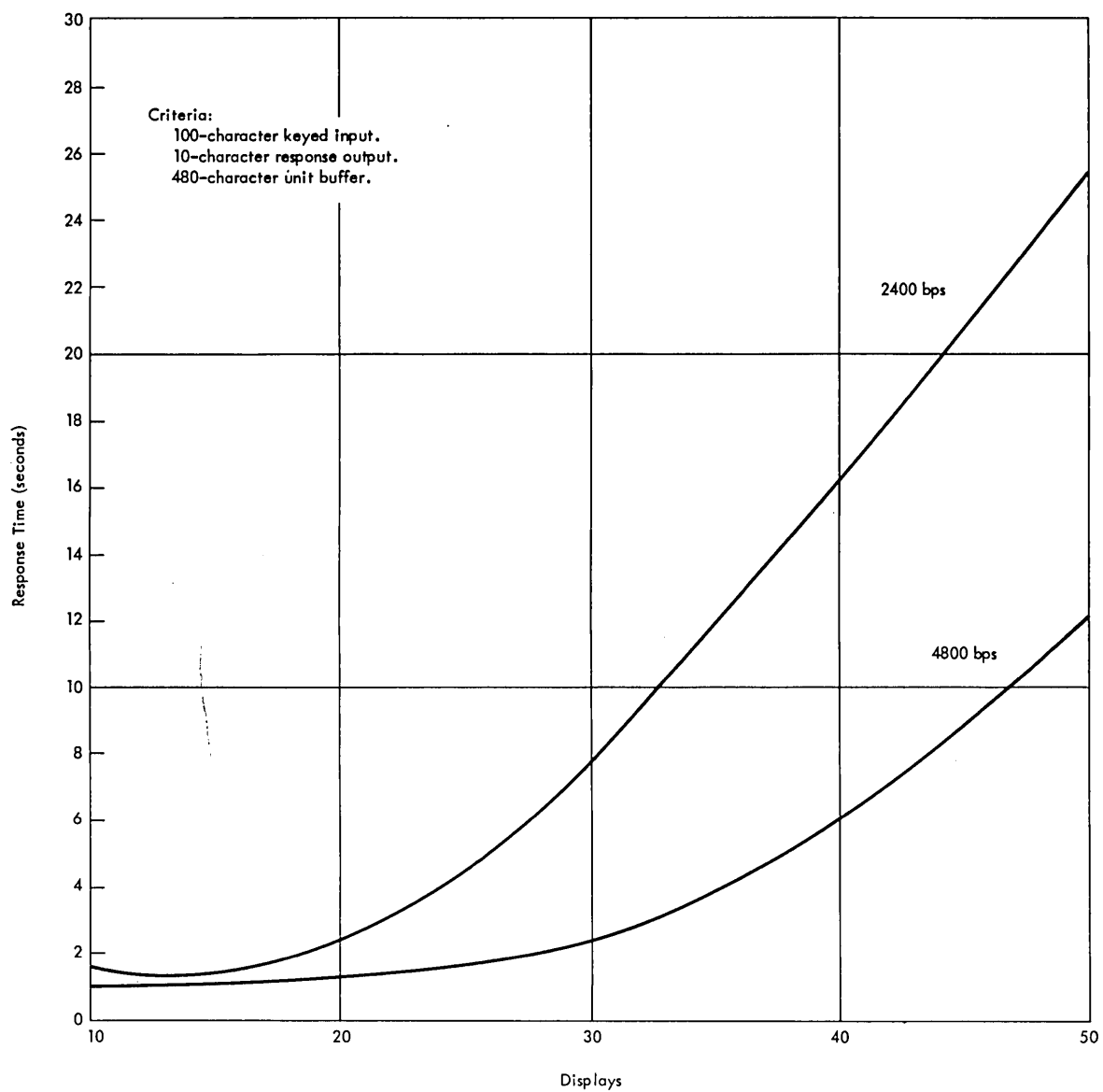


CHART D

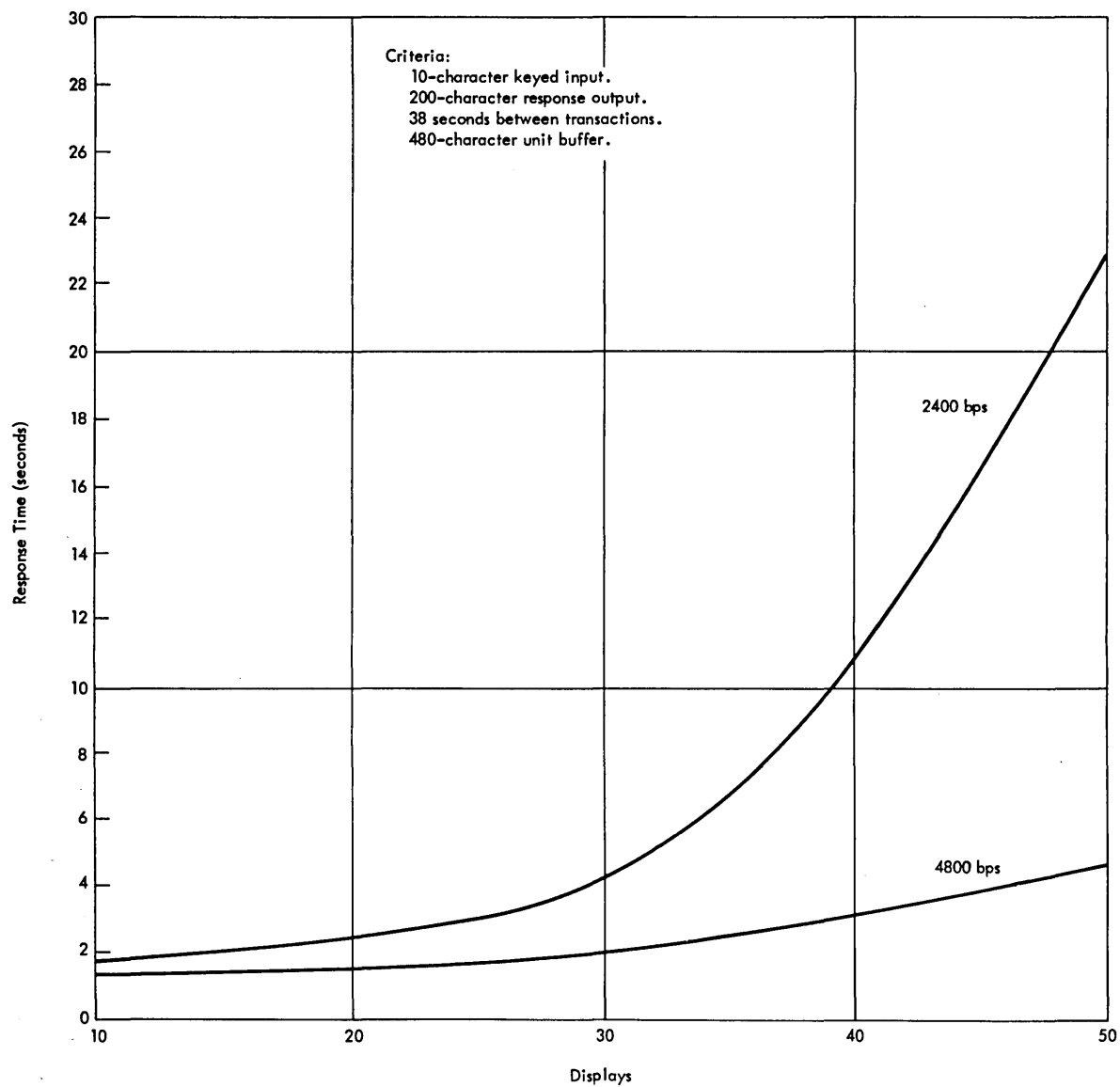


CHART E

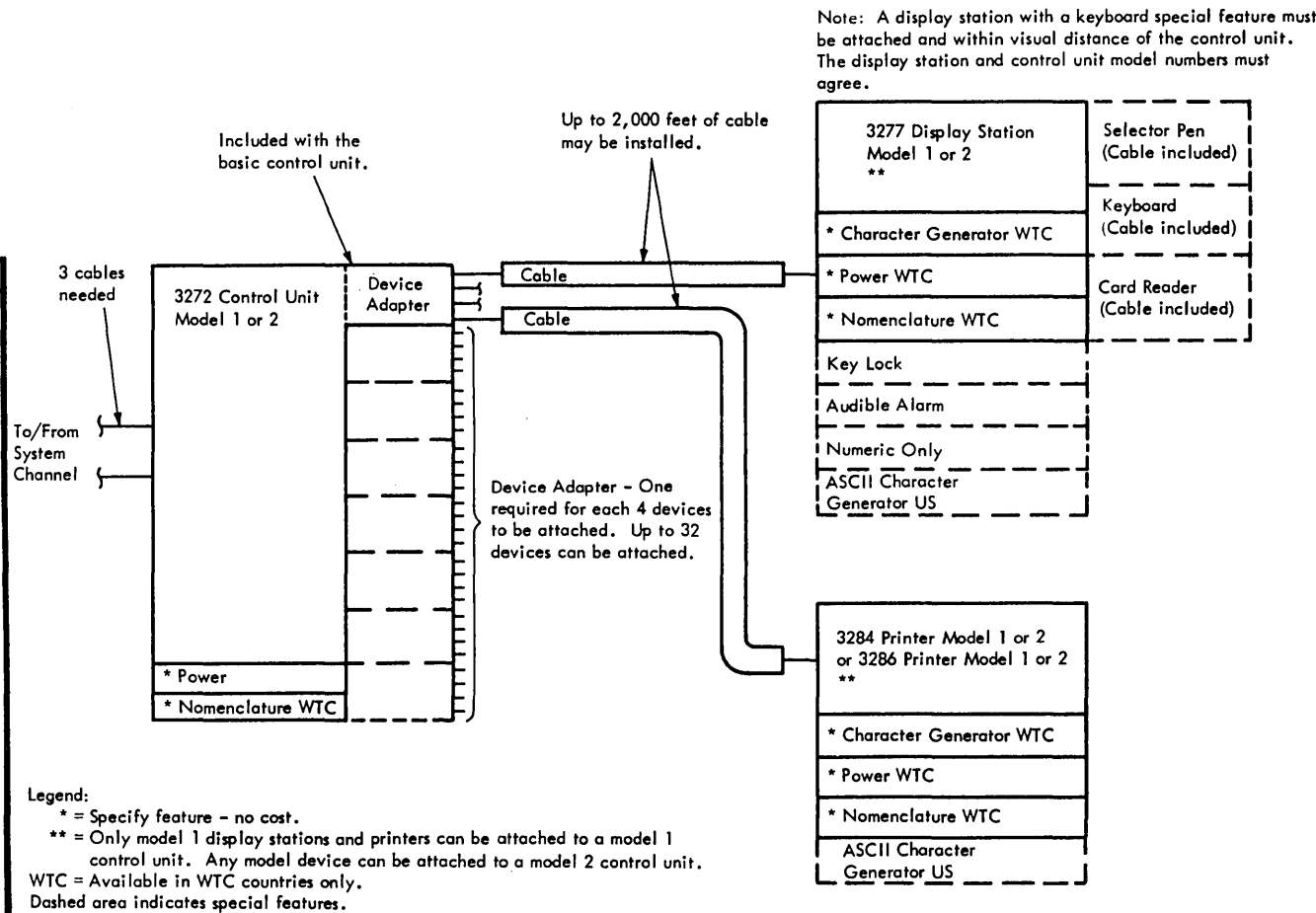


Figure A-1. 3270 Display System - Local

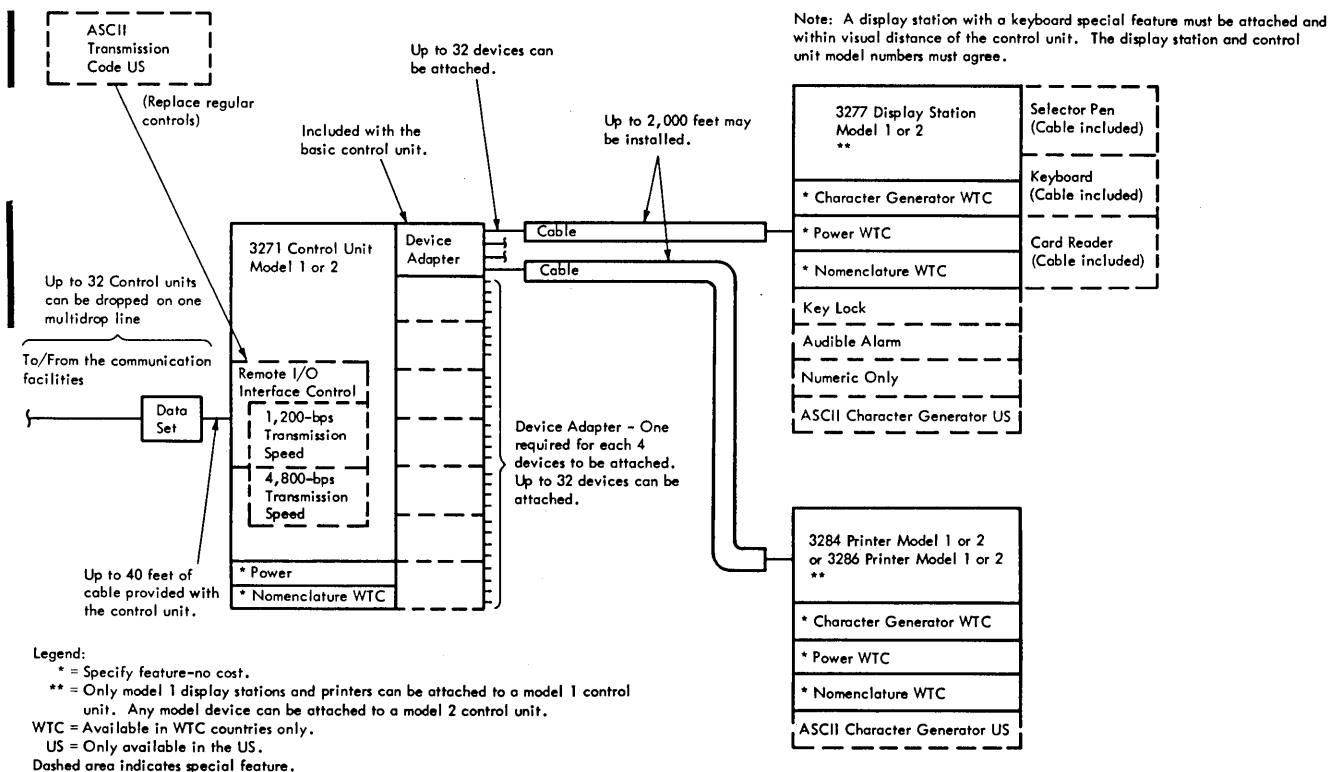


Figure A-2. 3270 Display System - Remote

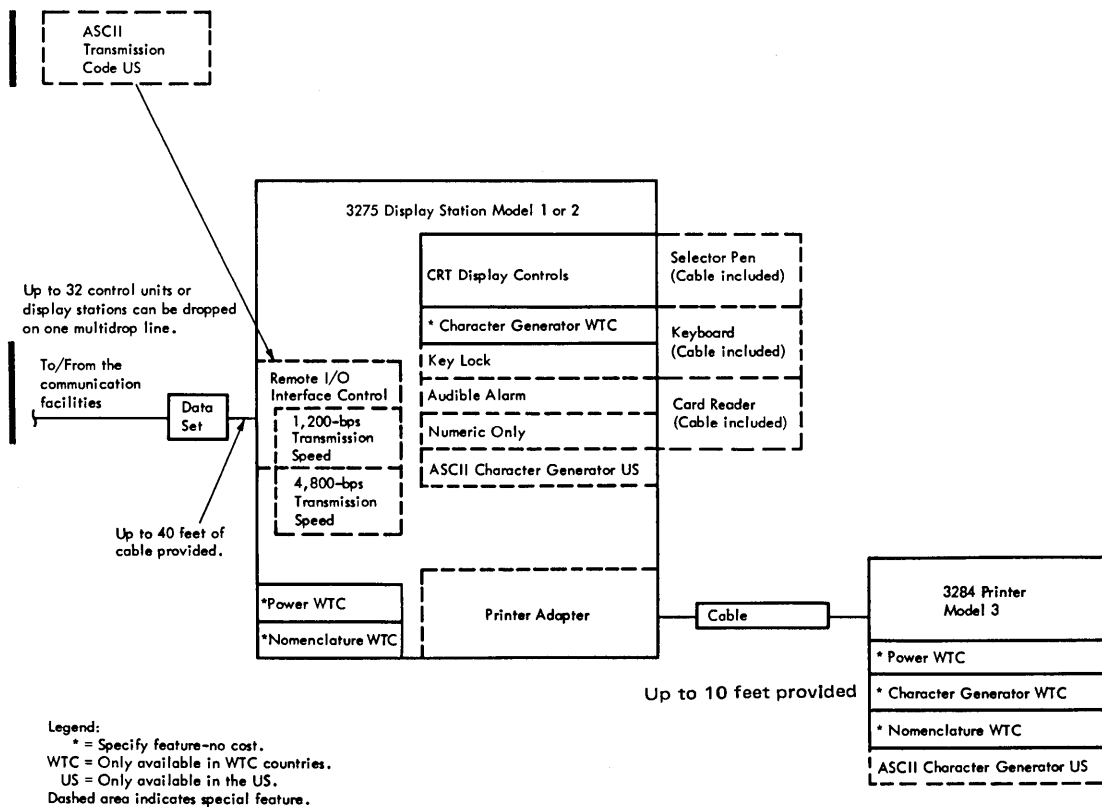


Figure A-3. 3275 Display Station

Appendix B. Features List

Table B-1. Features List

Feature Name	3272 CU	3271 CU	3275 DS	3277 DS	3284 P	3286 P
US Power 115V \pm 10% - 60 Hz	S	S	S	S	S	S
US Power 208V \pm 10% - 60 Hz	S	S				
US Power 230V \pm 10% - 60 Hz	S	S				
Device Adapter*	O	O				
66-Key US EBCDIC Typewriter Keyboard*			O	O		
78-Key US EBCDIC Typewriter Keyboard*			O	O		
66-Key US EBCDIC Data Entry Keyboard*			O	O		
78-Key US Operator Console Keyboard*			O	O		
66-Key US ASCII Typewriter Keyboard			O	O		
78-Key US ASCII Typewriter Keyboard			O	O		
Selector Pen*			O	O		
Printer Adapter*			O			
Operator Identification Card Reader*			O	O		
1,200-bps Transmission Speed*		O	O			
4,800-bps Transmission Speed*		O	O			
ASCII Transmission Code		O	O			
ASCII Character Generator - Character Set A			O	O	O	O
ASCII Character Generator - Character Set B			O	O	O	O
Audible Alarm*			O	O		
Key Lock*			O	O		
Numeric Lock*			O	O		

Legend:

S - Specify Features

O - Special Features

* - Features available to World Trade and US customers.

Table B-1. Features List (cont)

Feature Name	3272 CU	3271 CU	3275 DS	3277 DS	3284 P	3286 P
World Trade Power 100V \pm 10% - 60 Hz**	S	S	S	S	S	S
World Trade Power 100V \pm 10% - 60 Hz**	S	S	S	S	S	S
World Trade Power 110V \pm 10% - 50 Hz**	S	S	S	S	S	S
World Trade Power 123.5V \pm 10% - 50 Hz**	S	S	S	S	S	S
World Trade Power 200V \pm 10% - 50 Hz**	S	S				
World Trade Power 200V \pm 10% - 60 Hz**	S	S				
World Trade Power 220V \pm 10% - 50 Hz**	S	S	S	S	S	S
World Trade Power 235V \pm 10% - 50 Hz**	S	S	S	S	S	S
66-Key United Kingdom Typewriter Keyboard**			O	O		
78-Key United Kingdom Typewriter Keyboard**			O	O		
66-Key United Kingdom Data Entry Keyboard**			O	O		
66-Key French Typewriter Keyboard**			O	O		
78-Key French Typewriter Keyboard**			O	O		
66-Key French Data Entry Keyboard**			O	O		
66-Key German Typewriter Keyboard**			O	O		
78-Key German Typewriter Keyboard**			O	O		
66-Key German Data Entry Keyboard**			O	O		
American English Character Generator*			S	S	S	S
United Kingdom Character Generator**			S	S	S	S
German Character Generator**			S	S	S	S
English Nomenclature**	S	S	S	S	S	S
French Nomenclature**	S	S	S	S	S	S
German Nomenclature**	S	S	S	S	S	S
Italian Nomenclature**	S	S	S	S	S	S
Spanish Nomenclature**	S	S	S	S	S	S
Japanese Nomenclature**	S	S	S	S	S	S

Legend:

S - Specify Features

O - Special Features

* - Features available to World Trade and US customers.

** - Features available to World Trade customers only.

Appendix C. Functional Capabilities (Detailed)

Display system operations in response to program commands depend on the functional capabilities of the display system hardware, the facilities available to the display operator, and the means of communication between the system channel and the display system. The following paragraphs describe some of the basic or built-in capabilities of the display system hardware and some of the optional feature capabilities and relate them to the programmed operations and the operator's needs.

BASIC FUNCTIONS

Each unit in the display system (except the 3284 printer, model 3) is provided with a buffer to store display or print data (Figure C-1). Model 1 unit buffers are capable of storing 480 characters; model 2 unit buffers, 1920 characters. Display data, print data, or control data that is sent from the system channel to a 3277 display station or a 3284 or 3286 printer is received and formatted at a control unit buffer and is then transferred to the device buffer. Conversely, display or print data that originates at a device is first sent to the control unit buffer, is prepared for transmission, and is then sent to the system.

Display data that is stored in a display station buffer is presented to the operator on a CRT screen in the form of alphanumeric characters and symbols. The display image on a 480-character unit is presented on 12 horizontal lines of 40 characters each. The display image on a 1920-character unit consists of 80 characters on each of 24 horizontal lines. Printed data appears in the same alphanumeric characters and symbols that appear on a display image. Printout line length can be program-defined up to 132 characters per line, depending upon the needs of the application.

Unformatted and Formatted Display Images

An application program can communicate with a display operator using one of two basic methods. In one method, the display screen is left unformatted, similar to the IBM 2260. The display operator uses the screen in a free-form manner. In the second method, the display image is completely or partially formatted by the application program. This method helps define the operator's tasks and provides capabilities that assist in performing the tasks.

Formatting a Display Image on the 3275 or 3277 Display Station

Since all 3270 display stations employ a fixed relationship between each buffer storage location and its related character position on the display image (Figure C-2), a program can load a display station buffer with many combinations of control and data characters to present to the operator a display image that exactly fits the application.

To illustrate the flexibility available in 3270 display image formatting, consider the display image shown in Figure C-3. The visible characters represent display data stored by the program in the unit buffer; character positions indicated by dotted squares represent buffer locations where attribute control code information is stored; and dotted characters represent display data that is defined by the program as not displayable, that is, not visible to the operator. Attribute control code stored in a unit buffer is not displayed; data characters may or may not be displayed, depending upon program definition.

A field starts at an attribute control code and extends through succeeding locations up to the next attribute control code. Eight fields are shown in Figure C-3. Attribute control codes, in addition to defining the start of a field, define the following field characteristics:

- Protected (from modification by a display operator) or unprotected (available for the operator to modify or to input data). The unprotected definition classifies a field as an input field.
- Alphanumeric (an input field in which an operator can enter alphabetic, numeric, or symbol character data) or numeric (implementing certain data entry functions such as auto shift and numeric lock).
- Character brightness (off, normal, bright).
- Selectable or not selectable (by means of the selector pen).
- Tab stop positions (first position of input fields).

Formatting a Printout from the 3284 and 3286 Printer, Models 1 and 2

Printouts can be formatted in the same manner as a display image. Fields can be defined as printable or not printable.

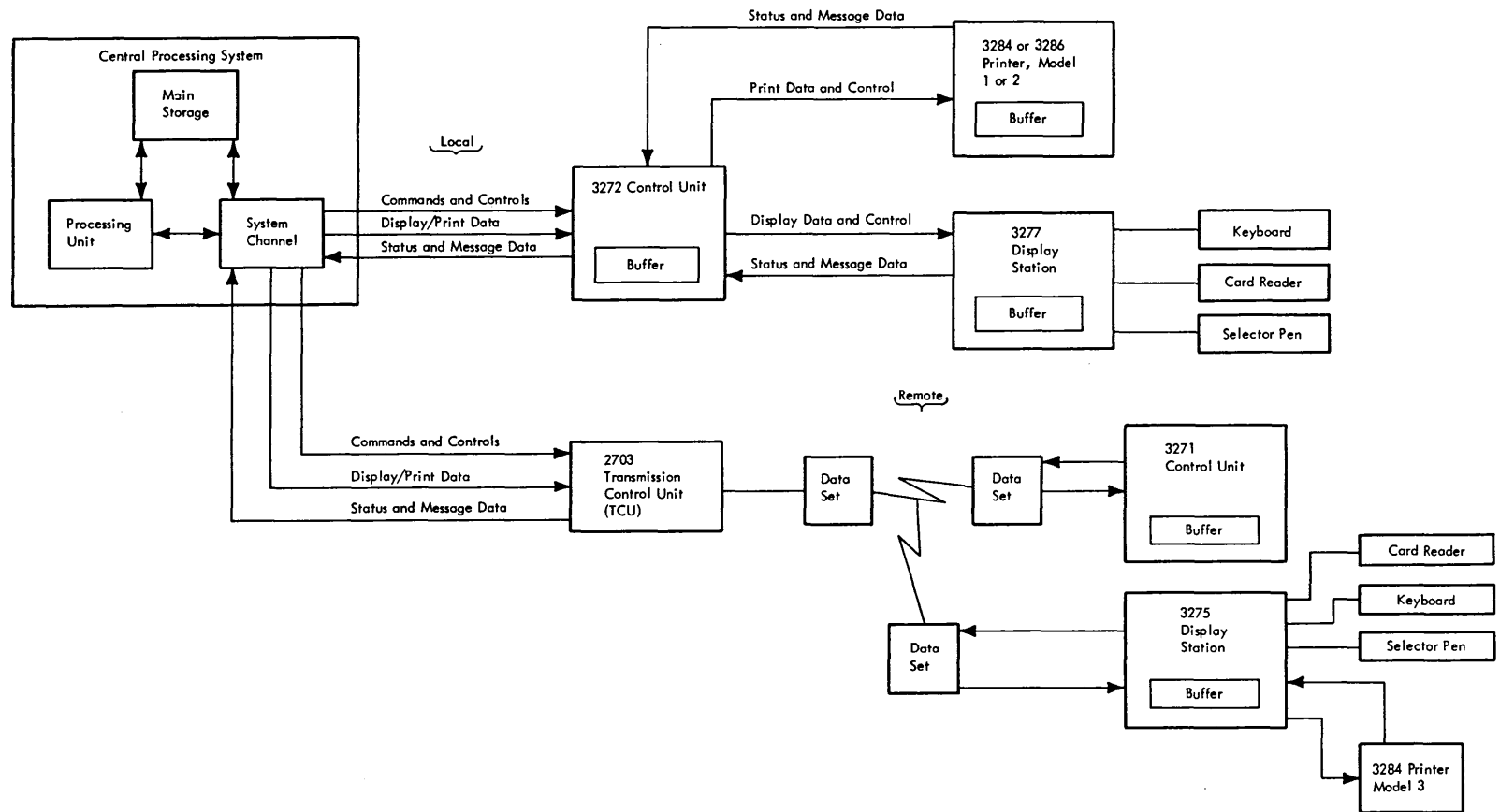


Figure C-1. Information Exchange between a Central Processing System and a Display System

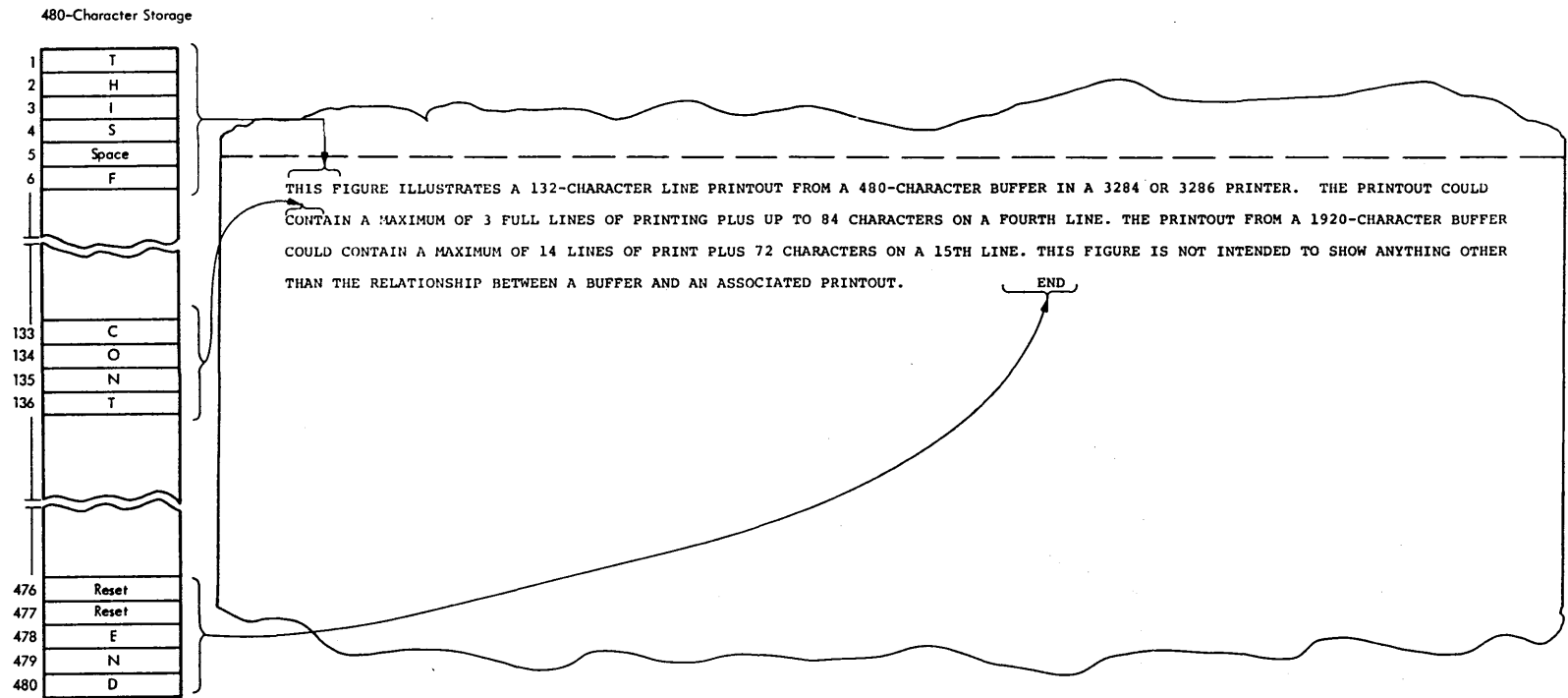


Figure C-4. Printer Buffer and Printout Character Position Relationship

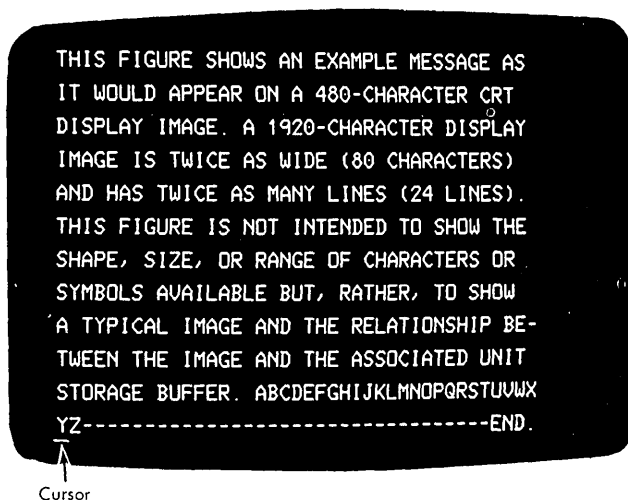


Figure C-5. Example of a Display Image Showing a Cursor

rapid positioning of the cursor to any character position on the display image. Included in these cursor controls are the UP (↑), DOWN (↓), LEFT (←), and RIGHT (→) keys. These keys are used to move the cursor either one character step to the left or right or one line step up or down. If the key is held depressed, cursor movement continues step by step until the key is released.

The BACKSPACE (←) key is also used for cursor control. This key functions exactly as the LEFT key, except that movement of the cursor is restricted to one character position per key depression.

The TAB (→) and BACKTAB (←) keys function much like the RIGHT and LEFT keys except that they cause cursor movement that is related to program-defined input fields rather than successive display image character positions. For example, when the TAB key is depressed while the operator is working on a formatted display image, the cursor does not stop until it reaches the first character location of the next input field encountered in the cursor movement. The BACKTAB key functions in the same manner as the TAB key except that cursor movement is to the left. If either of these keys is depressed when no input field has been defined, the cursor will scan the complete display image once and then be repositioned to the upper left corner of the display image.

Note: Data entry keyboards are provided with a SKIP key. This key works the same as the TAB key; it is provided to maintain the efficiency of data entry applications.

The NEW LINE key (↵) functions as the TAB key except that the cursor moves to the start of the next lower line before beginning a search for an input field.

Inputting Data

Before inputting data, the cursor is positioned to the desired location on the display image. The display operator can depress any alphabetic key. The character associated with the key appears on the display image in the character position marked by the cursor, and the cursor moves one character position to the right. If the display operator attempts to key data into a control character position or a protected field, or to key alphabetic or symbol data into a numeric field (see "Numeric Lock Operation", below), the keyboard will electrically lock, no audible feedback will be provided, and the INPUT INHIBITED indicator (located on the front of the display station) will light. The RESET key allows the display operator to recover from the electrical lock condition.

Insert Mode and Delete

Two keyboard keys, INSERT MODE and DELETE, enable a display operator to perform unique text-editing functions. To illustrate the DELETE key function, assume the display operator has completed an input message and discovers the name "JONES" was mistakenly inputted as "JONNES". To correct this mistake, the operator positions the cursor under either N in the name and depresses the DELETE key. The N over the cursor will disappear and all characters to the right of the character position occupied by the N, within the same field and on the same line, will shift one character position to the left.

The INSERT MODE key function is comparable to that of the DELETE key except that characters are inserted into a field and field characters shift to the right. For example, consider a situation where the display operator has neglected to key a word into the field. If "NOW IS TIME" was inputted, and "NOW IS THE TIME" is correct, the display operator must position the cursor under the T in "TIME" to prepare to insert "THE". Once the cursor is positioned, the INSERT MODE key is depressed. This causes the INSERT MODE indicator on the front of the display station to light. The display operator then keys T, H, E, and SPACE. Once the T is inputted, the message changes to "NOW IS TTIME". The inputted T appears in the cursor position, and the word TIME, plus all other characters to the right in the field, shift to the right one character position. The cursor also shifts to the right with the T in "TIME". Provisions have been made to avoid discarding meaningful data characters.

Program Function and Program Attention Keys

Twelve program function keys (PF1–PF12) are provided on some keyboard options. Two or three program attention keys (PA1–PA3) are provided as standard equipment. These keys, when depressed, provide a uniquely coded input to the application program.

Numeric Lock Operation

The numeric lock special feature provides a means of alerting a display operator to certain keying errors. Although this special feature may be installed on any style keyboard, its primary purpose is to support data entry applications.

Whenever the cursor moves under a character position within a numeric input field, the display station upshifts the data entry keyboard. Without the numeric lock special feature, the display operator can input any upshift character into the field. With the numeric lock feature, the keyboard is electrically locked if any character other than minus (-), period (.), the numerals 0 through 9, or the DUP (duplicate) key is keyed.

Duplicate and Field Mark Keys

These keys, when depressed, cause a (*) and a (;), respectively, to appear on the display image. The application program, however, defines the unique codes inputted by these keys. Thus, the duplicate and field mark functions, common to IBM keypunch applications, may be duplicated by the application program.

Erase Keys

Erase keys reset character positions on the display image.

The CLEAR key resets the buffer to nulls, moves the cursor to the upper left corner of the screen, and alerts the program that this action has been taken. The ERASE EOF key is used by the display operator to reset the remainder of a field which has been modified. This key also repositions the cursor to the next input field, just as the TAB key. The ERASE INPUT key is used to reset all input fields on the display image and to reposition the cursor to the first character position of the first input field on the display image.

Test Request

An online test (OLT) program is available to help determine the source of display system troubles. A TEST REQUEST key is provided on each keyboard to permit initiation of the OLT program. Diagnostic tests included in the program can be individually initiated or the entire program of tests can be initiated by inputting the proper test request message from the keyboard and depressing the TEST REQUEST key. Documentation will be provided to allow a customer to initiate the test request message and to help him interpret the test results.

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