OCT 17 1984

GA33-3035-3
File No. S370-06

Systems

An Introduction to the IBM 3250 Graphics Display System

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Third Edition, July 1983

This major revision obsoletes GA33-3035-1, GA33-3035-2, and Technical Newsletters GN33-3052, GN33-3063, GN33-3064, GN33-3093, GN33-3101, GN33-3139, and GN33-3182. The revision incorporates changes brought about by the introduction of the IBM 3255 Display Control Unit Model 2. Changes or additions to the text are indicated by a vertical line to the left of the change.

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems or equipment, refer to the latest *IBM System/370 and 4300 Processors Bibliography,* GC20-0001, for the editions that are applicable and current.

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In addition to the above FCC statement, the user should be aware that:

- The statement applies only to the machines of an IBM 3250 Graphics Display System used in the United States.
- The phrase "instruction manual" means:

  For installation information:

  - *IBM 3250 Graphics Display System: Installation Manual - Physical Planning,* GA33-3036
  - *IBM 3251 Display Station/IBM 3255 Display Control: Maintenance Information,* SY33-0055
  - *IBM 3251 Display Station Model 1/IBM 3255 Display Control Unit Model2: Maintenance Information,* SY33-0109
  - *IBM 3258 Control Unit: Maintenance Information,* SY33-0054

  For user information:

  - *An Introduction to the IBM 3250 Graphics Display System,* GA33-3035
  - *IBM 3250 Graphics Display System: Component Description,* GA33-3037

Preface

This publication provides customer executives, data processing managers, system analysts, system programmers, and programmers of graphics applications with introductory information about the IBM 3250 Graphics Display System. The system, which is connected to a host system, comprises the following units:

- IBM 3258 Channel Control Unit
- IBM 3255 Display Control Unit Model 1 or IBM 3255 Display Control Unit Model 2
- IBM 3251 Display Station Model 1

The 3251 Display Station Model 1 presents graphic and alphanumeric information on a cathode-ray tube (CRT) and, through optional keyboards and a light pen, enables a user to interact with the displayed image and with data stored in the host system.

The publication contains the following chapters and appendixes:

- Chapter 1 outlines the environment for interactive computer graphics and describes briefly the graphics functions offered a user by the 3250 Graphics Display System. The chapter also both defines the channels and IBM processors for which programming support is provided by IBM, and outlines this support.
- Chapter 2 discusses briefly the various functions that contribute to graphics applications.
- Chapter 3 describes the units of the 3250 system, their intercommunication, and the various features provided or available.
- Chapter 4 expands the information given in Chapter 1 on host-system channels, describing device addressing and introducing the instructions, commands, and interruptions associated with operations over the channels.
- Chapter 5 gives details of the performance of both the 3251 and the 3250 system and includes considerations relevant to configuring a system with many 3251s.
- Chapter 6 discusses the programming support provided by IBM for the 3250 system; this support is substantially similar to that provided for the IBM 2250 Display Unit Model 3, and includes the IBM OS/VS

Graphic Programming Services (GPS) and the IBM OS/VS Graphics Subroutine Package (GSP). The chapter also gives details of system generation.

- Chapter 7 assists users of the 2250 Display Unit Model 3 who may wish to convert their installations wholly or partly to the 3250 system. Besides giving aspects of system generation, the chapter discusses how functions of the 2250 Model 3 that have been extended or changed by the 3250 system affect application programs, the use of GPS and GSP, and operator actions.
- Chapter 8 gives information needed for planning an installation.
- Appendixes A and B summarize, respectively, the channel commands and buffer orders used by the 3250 system.
- Appendix C gives the configurator for the system.
- Appendix D lists the features that need specifying for a particular system and the special (optional) features.

The publication also contains a glossary of the terms and abbreviations used.

Compatibility with IBM 5080 Graphics System

Compatibility between the IBM 5080 Graphics System and the IBM 3250 Graphics Display System is described in Chapter 1, "Introduction."

Contents

Figures

Chapter 1. Introduction

The IBM 3250 Graphics Display System provides interactive graphics capabilities for a host system such as the IBM System/370 (including the IBM 303X and 308X Processors), and the IBM 4300 series Processors. The 3250 Graphics Display System uses a cathode-ray tube (CRT) to display graphic and alphanumeric information, and has optional keyboards and light pen for interaction with the displayed image and stored data.

The Graphics Environment

Interactive computer graphics are used in a large and still growing variety of applications. Some of the most complex and highly developed applications are found in the automotive and aerospace industries; here, complete geometric definitions of products are specified through interactive graphic displays linked to powerful processors. Other industries using interactive computer graphics include shipbuilding, electronics, architecture, and general mechanical engineering.

A key characteristic of these applications is a high rate of operator-initiated interactions with the system through the input devices and the displayed graphic information. Rapid interaction with large quantities of graphic and alphanumeric data is the normal mode of operation.

Typical applications of interactive computer graphics are:

- Computer aided design and drafting
- Geometric definitions and vehicle studying
- Numerical control
- Architectural composition
- Circuit layout
- Simulation
- Mapping and utilities layout
- Computer aided manufacturing.

The benefits that can result from the use of interactive graphic displays are:

- Improved productivity
- Increased flexibility
- Reduced design schedule
- Better control.

These benefits are increasing rapidly in value in the present highly competitive and cost conscious business world.

IBM 3250 Graphics Display System

The 3250 Graphics Display System offers a user the following functional capabilities:

- A directed-beam, buffer-refreshed display technology allowing an image to be displayed at a steady intensity level.
- A 305 millimeter square (12 inch) display area with 1024 x 1024 addressable positions.
- User interaction provided by a light pen, an alphanumeric keyboard, and a program function keyboard (optional features).
- Intensification of the image in the light pen field of view, to assist the operator positioning the light pen on the display screen.
- The display of straight lines of programmable length, orientation, and position specified in absolute or incremental (relative to the current beam position) coordinates.
- Four types of displayable line: solid, dotted, dashed, and dot-dashed.
- The display of characters and symbols with choices of four sizes, uppercase or lowercase, and horizontal or vertical orientation.
- Eight programmable intensity levels including blank (intensity level 0).
- The optional blinking of defined image entities.
- Attachment to the input/output (I/O) channel of a host system.

The 3250 system is well suited to the current and future environment of interactive graphics. Upwards compatibility from the IBM 2250 Display Unit Model 3 provides continuity and simple migration for those who already have well-developed graphic display systems and who want to expand them. The 3250 system provides also an opportunity for entering the field of graphics applications.

Users of graphics applications based on the 2250 Display Unit Model 3 must note that there are differences between the 2250 and the 3250. Chapter 7 discusses these differences.

For flexibility of configuration, the 3250 Graphics Display System comprises three basic units: the IBM 3258 Channel Control Unit, the IBM 3255 Display Control Unit Model 1 or 2, and the IBM 3251 Display Station Model 1 (Figure 1-1 on page 1-4). The special features available on the 3251 Display Station are an alphanumeric keyboard, a program function keyboard, and a light pen.

The 3255 Model 2, although compatible with the 2250 Display Unit Model 3, differs from both the 2250 and the 3255 Model 1 by virtue of its enhanced graphic capabilities. The enhancements to the 3255 Model 2 are:

- Attachment of up to three 3251 Display Stations Model 1.

- Optional single-element-intensification (SEI) of a vector, character, or point when detected by a light pen without intervention from the host system. The enhancement is available when SEI is enabled.
- Two 32 768 byte refresh buffers.
- A four-level-intensity function that provides (1) downward compatibility with programs written for an IBM 2250 Display Unit Model 3, and (2) enhancement of level 7 (bright) intensity.
- An Engineering Character Set with special engineering symbols.
- Improved internal performance.

A maximum of sixteen 3251 Display Stations Model 1 may be connected, through 3255 Display Control Units, to a 3258 Control Unit (Figure 1-2 on page 1-5). Each 3255 may control one or more 3251s; thus a configuration of sixteen 3251s may contain up to sixteen 3255s.

Inter-unit connection between the 3258 and 3255 (potentially the longest connection in the system) is by a coaxial cable supplied by the customer. Use of this type of cable facilitates the optimum siting of the individual units, while minimizing the cost of cable installation.

For further information on the units of the system, see Chapter 3.

Figure 1-1. IBM 3251 Display Station Model 1

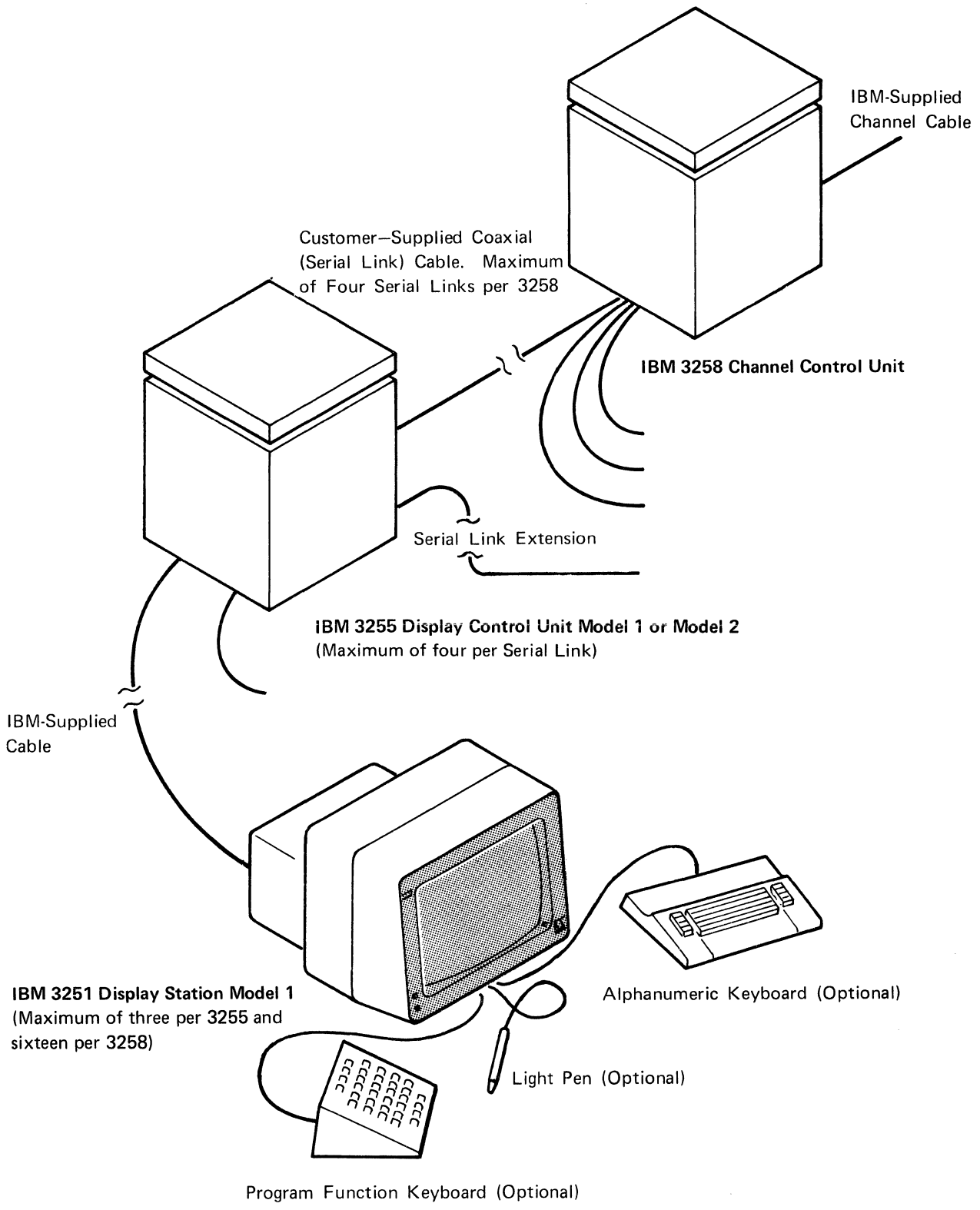

Figure 1-2. Relationship of Devices in a 3250 System

Compatibility with 2250 Model 3

If the 3250 system is attached to a System/370 I/O channel, it appears to the host system to be an IBM 2840 Display Control Model 2 with associated 2250 Display Units Model 3. Chapter 7 of this publication describes the incompatibilities between the 3250 and 2250.

Compatibility with IBM 5080 Graphics System

The following paragraphs address compatibility between the IBM 5080 Graphics System and the 3250 Graphics Display System.

Channel Control Units

The 3258 Channel Control Unit and the IBM 5088 Graphics Channel Controller are compatible, and both can attach to the I/O channels of any host processor that supports either the 3250 system or the 5080 system.

Note: The 3258 and the 5088 Model 1 support a maximum of 16 displays; the 5088 Model 2 supports a maximum of 32 displays.

Display Control Units

The 3255 Display Control Unit Models 1 or 2 and the IBM 5085 Graphics Processor can attach to either a 3258 or to a 5088.

Note: The 3255 Model 2 must be at Engineering Change (EC) level 384549 to attach to a 5088.

Display Stations

The 3251 Display Station Model 1 can attach only to a 3255 Model 1 or 2. The IBM 5081 Display can attach only to a 5085.

Constraints

1. If a 3255 or 3258 is included in a graphics subsystem, all coaxial cables in the subsystem must have an impedance of 75 ohms.

2. Pay due regard to the permissible configurations for each individual system. For details of the 5080 system refer to *IBM 5080 Graphics System: Principles of Operation*, GA23-0134, and *IBM 5080 Graphics System: Customer Setup Instructions*, GA23-0130.

Host System

The 3250 system attaches, with programming support, to a block-multiplexer channel, a selector subchannel, or a selector channel of the following processing units of IBM System/370, including multiprocessor (MP) and attached-processor (AP) versions:

IBM 303X Processors
IBM 308X Processors
IBM 3135 Processing Unit
IBM 3135-3 Processing Unit
IBM 3138 Processing Unit
IBM 3145 Processing Unit
IBM 3145-3 Processing Unit
IBM 3148-Processing Unit
IBM 3158-3 Processing Unit
IBM 3165-II Processing Unit
IBM 3168 Processing Unit
IBM 3168-3 Processing Unit
IBM 4331 Processing Unit
IBM 4341 Processing Unit

In addition to the above, but without IBM programming support, the 3250 can be attached to the I/O channels of System/370 Models 115 and 125.

Programming Support for 3250 System

Operating Systems

The 3250 system is supported by the current versions of the operating systems that support the 2250 Model 3, namely:

- IBM Operating System/Virtual Storage 1 (OS/VS1)
- IBM Operating System/Virtual Storage 2 (OS/VS2) Release 1
- IBM Operating System/Virtual Storage 2 (OS/VS2) Release 3 (MVS)
- IBM Virtual Machine/System Product (Conversational Monitor System)
- IBM Multiple Virtual Storage/System Product (MVS/SP V1)
- IBM MVS Extended Architecture System (MVS/XA).

The execution of a 3250 graphic application on any of these operating systems is also supported by the IBM Virtual Machine Facility/370 (VM/370).

Chapter 6 describes the programming support for the 3250 system and the system generation. Chapter 7 describes those differences that may affect program conversion. Other IBM publications that describe the programming support for the system are listed in the bibliography of this manual.

Control Programs - GPS and GSP

The components of OS/VS that govern 3250 graphic display operations are IBM OS/VS Graphic Programming Services (GPS), which includes Graphics Access Method (GAM), and the IBM OS/VS Graphic Subroutine Package (GSP) for FORTRAN IV, COBOL, and PL/I languages. These components were originally developed for the 2250. However, because the 2250 Model 3 and the 3250 system are generally compatible, the 3250 is supported without change to the software.

GAM/SP

Originally, Graphics Access Method (GAM) was an integral part of Graphics Programming Services that was supplied with the operating systems OS/VS1 and MVS. GAM/SP is now available as a program product, Graphics Access Method/System Product (GAM/SP), for use with IBM Virtual Machine/System Product (CMS).

Further details of GAM/SP are given in Chapter 6.

Chapter 2. Typical Applications

Several logically distinct and important functions contribute to the value of an application:

- Data entry and editing
- Updating and change control
- Geometric modeling Figure 2-1 on page 2-2
- Output to other functions.

The emphasis in these functions varies from one application to another. In some applications, such as integrated circuit layout or precision mapping, data entry and editing are important because large quantities of precise data must be accurately generated. In other applications, such as computer-aided design engineering, change control may be important.

Data Entry and Editing

The IBM 3250 Graphics Display System can be used, with appropriate application programs, to construct and enter data into a geometric model data base. The entered data may be point data or interpolated curves or surfaces, and the data base could define a vehicle or mechanical part, an architectural construction, or other representation.

Updating and Change Control

In some applications, and particularly those in engineering, change control and modification are the most important and productive use of interactive computer graphics. A single model enables a common data base to be used by many functions, thereby reducing the possibility of errors and confusion over the currency of the data.

Geometric Modeling

Once a geometric model has been created, it can serve as input to a wide variety of other tasks, for example, structural analysis, circuit simulation, and other simulations.

An associated use is to assist in simulating the interaction of complex shapes, for instance, checking parts for interference and proper fit in a dynamic system such as a retracting undercarriage. Examples of this use in static systems are checking in the fit of luggage into a proposed car trunk, or checking the layout of furniture in a building.

Output to Other Functions

Frequently, the end product of an interactive graphics application is a set of drawings. Many instances occur, however, where the output of an application may be used with other data processing programs to generate numerical control tapes, test data, or assembly instructions.

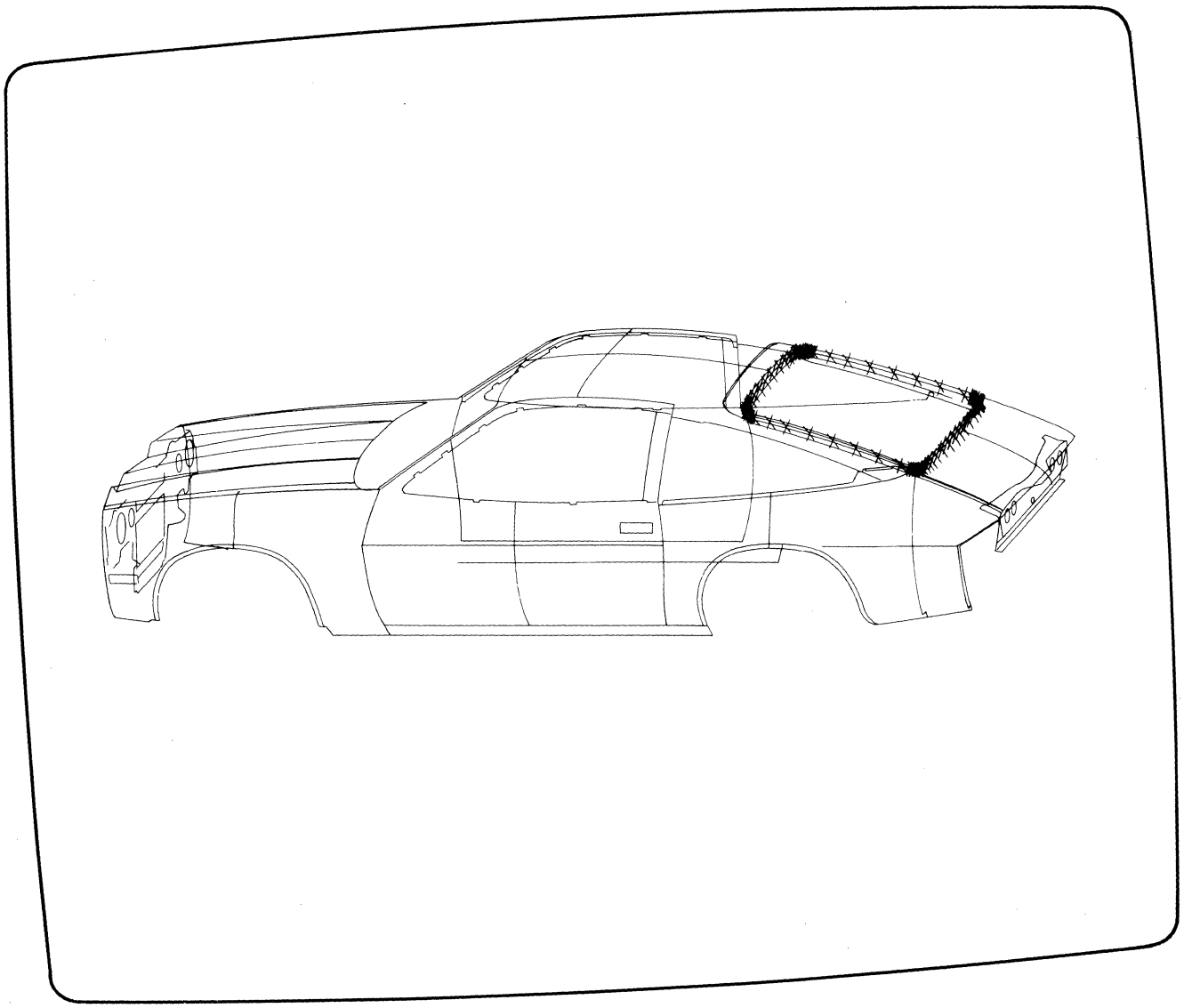

Figure 2-1. Example of a Geometric Model

Chapter 3. Units and Features of the System

The IBM 3250 Graphics Display System contains the following units:

- IBM 3258 Channel Control Unit
- IBM 3255 Display Control Unit Model 1 and/or Model 2
- IBM 3251 Display Station Model 1.

This chapter describes the functions and features of each unit.

IBM 3258 Channel Control Unit

The 3258 Channel Control Unit attaches to an I/O channel of the host system. All data, including control and interrupt signals, that is transferred between the host system and the 3250 system passes through the 3258.

Primarily, the functions performed by the 3258 are:

- To accept data from, and pass data to, the I/O channel interface
- To accept data from, and pass data to, the serial link between the 3258 and an attached 3255.

I/O Channel Interface

The format of data and the sequence of control signals on the I/O channel interface conform to the requirements of an IBM System/370 channel to control unit I/O interface. The interface is defined in *IBM System 360 and System/370 I/O Interface Channel to Control Unit, Original Equipment Manufacturers' Information*, GA22-6974.

Logically, the channel interface carries the data between the host system and the 3250 system connected to the interface. The graphics system may be based on a single 3258 or on multiple 3258s.

Serial Link

A serial link consists of link adapters (one in the 3258 and one in each 3255) and coaxial cable up to 2000 meters (6500 feet) in length from the 3258 to the terminating 3255. The total length may be increased by the use of lower-loss cable.

The link transfers data, at an effective rate of 100 000 bytes per second, between the 3258 and attached 3255s, each 3255 acting for the display stations attached to it. All data transfers over the serial link are initiated and controlled by the 3258.

A 3258 has four serial link adapters, allowing it to interface between the channel and a maximum of sixteen 3255s. When the 3258 is not busy with one 3255, it interrogates the links to see if other attached 3255s require service.

IBM 3255 Display Control Unit Model 1 and Model 2

The 3255 Display Control Unit contains the logic circuits and storage needed:

- To accept data from, and pass data to, the serial link to the 3258.
- To maintain and execute a buffer program for each attached 3251
- To generate the beam deflection and intensity signals for producing the required image on the screen of each 3251
- To provide a light pen interface for each attached 3251
- To provide a keyboard interface for each attached 3251.

Serial Link

A maximum of four 3255s may be connected to a serial link. Data transfers are always initiated by the 3258; the 3258 either requests a 3255 to accept data or asks a 3255 if it wishes to respond by sending data or outstanding control information.

Display Buffer

Buffer programs are created and updated by the application program in the host system. The programs are then sent to the 3255 by way of the 3258 and the high-speed link. The functions of the buffer program are (a) to generate the displayed image, and (b) to monitor the keyboards and light pen to accept operator actions.

The 3255 Model 1 has a 32 768 byte buffer available to the buffer programs controlling the attached 3251s. The 3255 Model 2 has two 32 768 byte buffers available to the buffer programs controlling attached 3251s.

The buffer programs consist of graphic orders, graphic and alphanumeric data, and control orders. In its execution, a buffer program controls:

- Regeneration of the displayed image
- The sensitivity of the displayed image to a light pen operation
- Data entry from the alphanumeric keyboard.

Character Generator

Alphanumeric characters that are to be displayed are defined in EBCDIC form by the buffer program. The character generator converts from the binary code to a series of beam deflections to write the defined character on the screen. (The average number of beam deflections per character is 14.)

Controlled by character mode orders supplied by the buffer program, the full character set can be produced in four sizes with two possible character orientations. The nominal character sizes are:

Small	3.05 x 2.03 mm	(0.12 x 0.08 in.)
Basic	4.06 x 2.79 mm	(0.16 x 0.11 in.)
Medium	5.08 x 3.30 mm	(0.20 x 0.13 in.)
Large	6.10 x 4.06 mm	(0.24 x 0.16 in.)

The character orientation can be either upright (that is, on the horizontal axis) or rotated 90^0 counterclockwise.

Line Generator

The line generator, controlled by line type attributes and addresses supplied by the buffer program, generates the beam deflection and intensity signals to display lines on the screen. Four line types can be programmed: solid, dotted, dashed, and dot-dashed.

Display Adapter

The display adapter contains the circuits that transfer analog and digital signals to the 3255/3251 cable and accept digital signals from the cable. A display adapter is used for each 3251 connected to the 3255. The interfaces provided by the display adapter are:

- Screen interface
- Light pen interface
- Keyboard interface

Screen Interface

Logic and analog circuits in the 3255 convert the output of the line and character generators to the analog signals that deflect the electron beam in the CRT. Two analog deflection signals are passed to the 3251: an X signal controlling horizontal deflection and a Y signal controlling vertical deflection.

Beam intensity is controlled by a Z analog signal. Intensity is a function of the blink and intensity attributes set by the buffer program and either the line type or the character generator.

Light Pen Interface

The light pen interface accepts two discrete signals from the 3251. One signal is activated by the light pen tip switch and the other is generated when the electron beam passes the tip of the pen.

When the light pen is enabled by the buffer program, the 3255 accepts the beam-generated signal as input from the operator.

Keyboard Interface

The display adapter provides one keyboard interface for the attached 3251. If both keyboards, alphanumeric and program function, are installed, they share the keyboard interface.

Data is carried in both directions by the keyboard interface. Control data is sent by the 3255 to the keyboards; input and control data is received by the 3255 when the operator presses a key on either keyboard.

IBM 3251 Display Station Model 1

The 3251 Display Station Model 1 displays graphic and alphanumeric images. A fully configured 3251 Model 1 has four separate units:

- Display unit (with an audible alarm)
- Light pen (optional)
- Program function keyboard (optional)
- Alphanumeric keyboard (optional), or as an alternative with the 3255 Model 2 only,
- Alphanumeric keyboard with numeric keypad (optional).

Display Unit

The display unit contains the circuits needed (1) to generate an image on the cathode-ray tube, (2) to sound the audible alarm, (3) to return light pen signals to the 3255, and (4) to switch the keyboard interface between the alphanumeric keyboard and the program function keyboard.

The 533-millimeter (21-inch) diagonal CRT presents a display area of 305 mm by 305 mm (12 in. by 12 in.). The necessary power supplies and video amplifiers, accepting deflection and intensity information from the X, Y, and Z cables, are packaged in the display unit.

An audible alarm in the 3251 sounds whenever called for by a host application program.

Data from the alphanumeric keyboard and the program function keyboard is passed to the 3255 by a common switching unit in the 3251; similarly, control data to light the back-lit keys of the program function keyboard or to sound the clicker on the alphanumeric keyboard is received and distributed by the switching unit.

Character Translate

Character-translate logic in the 3251 converts the basic alphanumeric keyboard codes to a form suitable for the keyboard interface to the 3255. During the conversion, the character-translate logic compares the keyboard code with a table of valid codes for the specified language group. Invalid keyboard codes are rejected.

In countries other than the United States, a character set must be specified for the character-translate logic (see "Features"), whether or not an alphanumeric keyboard is to be attached. If, at a later time, a keyboard is fitted, the keyboard language must match the character translate character set. If no character set is specified, English (U.S.) is provided.

Features

The features available for the 3250 system units are described below. A system configurator in Appendix C and a features list in Appendix D summarize this information.

Features are categorized as **specify** or **special.** A specify feature is one that must be chosen (at no extra cost) to make a 3250 system functional. A special feature is one that may involve extra cost but is not required to make the system functional; special features provide additional operational capability.

Specify Features

Power

All units can operate from one of several power supply voltages (see Appendix D). In Canada and the Unites States there is a choice of locking or non-locking plugs for connection to the power source.

All units available through the IBM World Trade Corporation can operate from one of several different power sources.

The same power must be specified for the 3255 as is specified for 3251s attaching to that 3255.

Power Cable Length

The standard power cable length is 4.27 meters (14 feet). Units for use in the United States may be specified with a power cable 1.8 meters (6 feet) long.

Signal Cable Length

The signal cable between the 3255 and an attached 3251 is supplied with the 3251. Three lengths are available: 4.6 meters (15 feet), 9.1 meters (30 feet), and 15.2 meters (50 feet). One 3251 on each 3255 must have a cable of length 4.6 meters (15 feet).

Character Set

The following character sets are available as specify features of the 3250 system:

- English (U.S.)
- English (U.K.)
- French
- German
- Italian
- Katakana
- Swedish.

The same character set must be specified for each of the following:

- Character generator in the 3255
- Character-translate feature in the 3251
- Keyboard language of the 3251.

Special Features

Light Pen

The light pen is a separate assembly, relying upon the 3251 for its power supplies and its signal interface with the 3255. The pen contains a switch and a light sensitive device that operate as follows:

- The switch is activated when the operator presses the pen against a hard surface such as the screen.
- The light sensitive device generates a signal when the electron beam illuminates the position on the screen at which the pen is pointing.

The intensity of the image increases at the point selected by the light pen, thus enabling the operator to see if the intended point was selected. If the programmed intensity level is 0 through 4, then light pen interruption is suppressed.

Alphanumeric Keyboard

The alphanumeric keyboard is a separate assembly, relying upon the 3251 for power supplies and interface to the 3250 system. Using the keyboard as a typewriter-like input device, the operator can compose and update alphanumeric text on the screen. The buffer program in the 3255 determines which areas of the screen can receive alphanumeric data, and identifies the current area with a cursor. Acceptance of a key depression is confirmed by the keyboard clicker sounding.

Two types of alphanumeric keyboard are available for the 3255 Model 1, and three types of keyboard are available for the 3255 Model 2:

3255 Model 1 or Model 2.

- A 76-key keyboard, using four levels of keyboard shift to support the Katakana character set
- A 75-key keyboard, with uppercase and lowercase shift to support the remaining character sets listed previously.

3255 Model 2 only. An additional type of alphanumeric keyboard is available only with the 3255 Model 2. This is an 87-key numeric keypad keyboard similar to the 75-key engineering symbols keyboard. It differs only in that it has a numeric keypad, and provides extended special engineering symbols. Both these and the keys in the numeric keypad provide the same character code in both upper case and lower case shift.

Notes:

1. The 87-key numeric keypad keyboard with engineering symbols is the only one available in the Swedish language).
2. Extended engineering symbols are not available with the Italian language character set.
3. Extended engineering symbols are shown under "Character Set" in Chapter 7.

Program Function Keyboard

The program function keyboard is a separate assembly with 32 back-lit keys; it relies upon the 3251 for its power supplies and interface to the 3250 system. The keyboard provides two-way communication between the operator and the host application program. The program can communicate with the operator by lighting or extinguishing the lamps behind the keys. When the operator presses one of the program function keys, a unique code is transmitted to the host system.

The program function keyboard is designed to accept keyboard overlays. This feature allows the user to create overlays showing the function provided by particular keys in an application. Key functions are defined by the application, and each application may have its own overlay. Overlays are not available from IBM.

Special Functions (3255 Model 2 Only)

The following special functions can be enabled at installation time for the 3255 Display Control Unit Model 2:

- Enhanced Level 7 Intensity
- Single-Element Intensification

Enhanced Brightness Level 7

A 3255 Display Control Unit Model 2 can be set to enhance vectors, points, or characters that are drawn at intensity level 7; or "bright." This capability improves operator discrimination between intensity level 5 (normal), and intensity level 7 (bright).

Single-Element Intensification

A 3255 Display Control Unit Model 2 can have a single-element intensification function enabled that identifies a vector, point, or character detected by a light pen without intervention from the host system. The whole of the identified element is brightened by the 3255 at the moment of light-pen detection.

Chapter 4. Channel Operations

Channel Attachment

The IBM 3250 Graphics Display System attaches to a host system by way of an I/O channel. This attachment provides two-way communication between the units of the 3250 system and the graphics application program.

Types of Channel

The 3250 system can be attached to any of the following types of I/O channel:

- Byte-multiplexer channel, IBM System/370 Models 115 and 125, operating in burst mode
- Block-multiplexer channel (see Note)
- Selector channel.

Note: When attached to a block-multiplexer channel, shared unit control words (UCWs) should be used if the channel implementation allows block-multiplex operation with shared UCWs.

Addressing

At installation, each IBM 3258 Channel Control Unit is allocated a control unit address and each IBM 3255 Display Control Unit is allocated a block of device addresses for the attached IBM 3251 Display Stations. To establish a data path between the host system and a 3251, the channel program presents the relevant address byte (a 5-bit control unit address and a 3-bit device address *or* a 4-bit control unit address and a 4-bit device address) to the channel interface.

The allocated control unit address (bits 0 through 3 or 4 of the address byte) can be in the range 0 through 31.

Bits 4 or 5 through 7 of the address byte contain the device address, thus there are either sixteen or eight device addresses available for each control unit address. A 3255 can be allocated a single device address where only one 3251 is attached, or a block of device addresses from the available range (0 through 7 or 15). The addresses within a block are contiguous and, where two or more 3255s are attached to a single 3258, there must be no duplication of device addresses.

Channel I/O Operations

This section introduces the instructions, commands, and interruptions associated with channel input/output operations. The I/O operations are described in more detail in *IBM System/370 Principles of Operation*, GA22-7000.

Instructions

Communication with the 3250 system is initiated from the host system by the execution of an I/O instruction. Such communication may be in response to interrupts raised by the program or by an operator action made at the 3251.

The following I/O instructions are valid for the system:

- Clear I/O
- Halt Device
- Halt I/O
- Start I/O
- Start I/O Fast Release
- Test I/O.

Commands

The channel uses four types of command to control and communicate with the 3250 system:

- *Write*, which is used to send data to the addressed device
- *Read*, which is used to fetch data from the addressed device
- *Control*, which is used to set-up specific conditions in the device
- *Sense*, which is used to fetch sense data from an addressed device

Appendix A lists the commands that are valid for a 3250 system.

Interruptions

Operator actions such as light pen operation (unless disabled or deferred), pressing a Program Function key, or pressing the END or CANCEL key on the alphanumeric keyboard, result in an interruption being raised at the host system; also the buffer program can raise an interruption by executing an End Order Sequence (GEOS) or Permit Detect Interrupt (GPDI) order. The response to such interruptions is dependent on the application program in the host system.

Block Multiplexing

On a block-multiplexer channel, multiplexing may take place between 3258 Channel Control Units, and between 3258 Channel Control Units and other Control Units on the same channel. For a description of block multiplexing, see "Input/Output operations" *IBM System/370 Principles for Operation*, GA22-7000). Multiplexing will not be performed between devices attached to the same 3258 Channel Control Unit.

When 3251 devices are assigned to a shared subchannel, the implementation of the channel in the host system determines whether block multiplexing occurs.

Chapter 5. Performance

To the user of an IBM 3250 Graphics Display System, performance has two elements:

- The complexity of the displayed image
- The speed at which the display reacts to an operator action

Performance considerations regarding the complexity of the displayed image are discussed in "Display Station Performance" (below).

Certain operations, such as the entry of alphanumeric data from the keyboard to the displayed image, are executed locally; there is no interaction with the program in the host system until a complete field, or fields, has been entered. The 3250 buffer orders also allow certain light pen functions, such as moving a tracking symbol, to be programmed without interaction with the host system. However, most operator actions require interaction between the graphics system and the host system, and this is discussed later in this chapter in "System Performance."

Display Station Performance

The displayed image is the result of execution of a program in the buffer of the IBM 3255 Display Control Unit. This program executes repeatedly in order to regenerate the displayed image. Regeneration is normally at the rate of 46 cycles per second (cps); however, the complexity of the displayed image may cause the regeneration rate to fall below this nominal rate.

Buffer Capacity

A 3255 Model 1 has 32 768 bytes of buffer storage. If one IBM 3251 Display Station is attached to the 3255, the buffer program can occupy all of the available storage. If two 3251s are attached, each is allocated a share of the storage. Allocation is dynamically controlled by the program in the host system, within constraints determined at system generation.

A 3255 Model 2 has the following characteristics:

- Two 32 768-byte buffers as separate entities. A buffer program contained in one buffer cannot branch to, or access data in, the second buffer.
- The allocation of buffers to particular 3251s is determined by the number of attached 3251s and their device addresses:

  One 3251: Only one buffer is used.

  Two 3251s: The 3251 with the low address uses one buffer, and the high address 3251 uses the other buffer. Alternatively, if it is envisaged that an additional 3251 is to be added at a future date, then the two 3251s can share the same buffer, leaving the other buffer unused.

  Three 3251s: The 3251s with the low and medium addresses share the one buffer. The high address 3251 has exclusive use of the other buffer.

Buffer allocation for the 3255 Model 2 is shown in Figure 5-1 on page 5-2.

Number of attached 3251s	Buffer 1	Buffer 2
One 3251	3251	Not used
Two 3251s	First 3251	Second 3251
	OR	
	Both 3251s	Not used
Three 3251s	First and second 3251	Third 3251

Figure 5-1. Table of Buffer Allocations (3255 Model 2)

The complexity of displayable data that can be generated by 16K bytes of buffer program is equivalent to more than either (a) four thousand lines specified in absolute screen coordinates; or (b) eight thousand lines specified in relative screen coordinates; or (c) sixteen thousand characters. This capacity is reduced by the size and number of buffer orders and data needed to control the displayed image; the orders are 2, 4, and 6 bytes long and the number of them varies greatly, depending on the required characteristics of the image (for example, sensitivity to light pen interruptions, or grouping of data in identifiable fields).

Display Capacity

The 3251 image is regenerated at a maximum rate of 46 cps, under the control of a regeneration timer. Regeneration results from the repeated execution of the buffer program. If program execution time exceeds 21.7 milliseconds, the regeneration rate becomes proportionally less than 46 cps. At a regeneration rate of 40 cps, the picture quality of the 3251 is better than that of the 2250 Model 3; at this regeneration rate, the buffer program execution time is 25 milliseconds. The point at which a reduced regeneration rate results in an unacceptable image depends upon the intensity level and the operator.

If more than one 3251 is attached to the 3255, the buffer programs are executed sequentially; and if total execution time exceeds 21.7 milliseconds, the regeneration rate for all attached 3251s becomes less than 46 cps. The execution time of the buffer program depends on the amount of data displayed, the beam movements made without displaying data, and the number of control mode buffer orders. There is an overhead for switching between buffer programs when more than one 3251 Display Station is in operation.

Basic Performance Characteristics with 3255 Model 1

The 3251 Model 1 when attached to a 3255 Display Control Unit Model 1, has the following basic performance characteristics:

- Vector draw: 34 microseconds for a full screen deflection of 305 millimeters (12 inches), about 8 890 meters (350 000 inches) per second.
- Vector move (that is, repositioning the beam): 22 microseconds for a full screen deflection.
- Average time to draw a basic-size character, that is, a character height of 4.1 millimeters (0.16 inch), and move the beam to the next character position: 4.2 microseconds.

Consequent on this performance, with one 3251 attached to a 3255 and with a regeneration rate of 40 cps, the buffer program is capable of drawing either:

- More than 9500 incremental, connected vectors of 9.53 millimeters (0.375 inch); *or*
- More than 2150 absolute, connected vectors of 76.2 millimeters (3 inches) each; *or*
- More than 5250 basic size characters as generated by the character generator in the 3255, with an average of 14 strokes per character. The number of strokes per character for the standard character set varies between 2 and 23; most fall in the range of 10 to 18. Therefore, the number of characters that can be drawn depends on the proportion of few-stroke characters to many-stroke characters.

Basic Performance Characteristics with 3255 Model 2

The 3251 Model 1 when attached to a 3255 Display Control Unit Model 2 has the following basic performance characteristics:

- Vector draw: 20 microseconds for a full screen deflection of 305 millimeters (12 inches). That is, 1524 meters (600 000 inches) per second.
- Vector Move: (that is, repositioning the beam) for a full screen deflection: 20 microseconds.
- Average time to draw a basic-size character, that is, a character height of 4.1 millimeters (0.16 inch), and move the beam to the next character position: 4.0 microseconds.

Consequent on this performance, with one 3251 Model 1 attached to a 3255 Model 2, and at a regeneration rate of 40 cps, the buffer program is capable of drawing either:

- 12500 incremental vectors of 9.5 millimeters (0.375 inch); *or*
- 3500 absolute vectors of 76 millimeters (3 inches); *or*
- 5750 basic size characters of an average character-mix as generated by the character generator.

Note: With more than one 3251 Display Station Model 1 attached to a 3255 Model 1 or Model 2, the performance may be slightly less than that stated above because of the overhead incurred in switching between buffer programs.

System Performance

The performance of a 3250 system is affected by several factors, including graphics system configuration, channel performance, 3258 Channel Control Unit/3255 Display Control Unit address ranges, processing power of the host system, and the characteristics of the application programs.

In many interactive graphics applications, a high interaction rate is desired, an interaction being the sequence of events initiated by the display station operator and terminated by a display change or other program response.

Take, as a typical interaction, the operator making a selection with a light pen to modify the displayed image; here a peak rate of two interactions every second is not abnormal. To provide this interaction rate, the system response times (between operation of the light pen and display of the new image) are usually required to be a fraction of a second. Two of the factors in response time are the processing time and storage access time for the application program in the host system; this includes waiting for the processing and storage access facilities to be made available to the application program. Other factors include the transmission of data between the host system and the 3255 and delays resulting from contention for channel availability.

Application Programs

The graphics application program is a critical factor in determining the number of 3251s that can be supported by a given host system and yet maintain a desired interaction rate and response time.

Important program characteristics relative to the processing power of the host system and its configuration of direct-access storage devices are:

- The amount of processing and storage accessing required to manage a typical interruption from the 3250 system in relation to the speed of the host system and its attached devices.
- The degree to which the managing of multiple interactions can be overlapped.
- The amount of data returned to the 3250 system in response to an interruption. (Some applications return the whole new image, others return only that part of the image changed as a result of the interaction.)

Because, in general, any application program developed for the 2250 Model 3 can be used compatibly with the 3250 system, such a program in the same host system can support the same number of 3251s as 2250 Model 3s. This requires that a suitable 3250 system configuration and channel attachment should be used.

Graphics System Configuration

System with a 3255 Model 1

The following performance considerations are relevant in determining how to configure a 3250 system that is required to support many 3251s.

Multiple 3258 Channel Control Units can be attached to a single I/O channel; up to sixteen 3255s can be attached to each 3258; two 3251s can be attached to each 3255. But there is a maximum of sixteen 3251s that can be attached to a single 3258 via a variable number of 3255s Model 1s.

System with a 3255 Model 2

The following performance considerations are relevant in determining how to configure a 3250 system using a 3255 Display Control Unit Model 2 that supports multiple 3251s.

Multiple 3258 Channel Control Units can be attached to a single I/O channel; up to sixteen 3255s (Model 1 or Model 2, or a mixture of both models) can be attached to each 3258; up to three 3251s can be attached to each 3255 Model 2. But there is a maximum of sixteen 3251s that can attach to a 3258 via a variable number of 3255 Model 2s.

Effect of Configuration on Response Time

When optimizing the response time one should consider the number of 3251s allocated to each 3258, and the number of 3258s and other devices on each channel. Response time is improved by spreading the 3251s across multiple 3258s, thereby taking advantage of the block-multiplex capability. The number of 3255s per 3258 does not affect response time and should be determined by considering the picture content required by the application.

Chapter 6. Programming Support

The IBM 3250 Graphics Display System operates with the following programming support:

- Operating System/Virtual Storage 1 (OS/VS1)
- Operating System/Virtual Storage 2 - Multiple Virtual Storage (MVS)
- IBM Virtual Machine/System Product (VM/SP) with Conversational Monitor System (CMS), using GAM/SP.

These operating systems and access methods are described below.

Operating With OS/VS and VM/370

The IBM 3250 Graphics Display System is supported by the current versions of the OS/VS operating systems that support the IBM 2250 Display Unit Model 3, namely:

- OS/VS1
- OS/VS2 Release 3 (MVS).

"Host System" in Chapter 1 specifies the IBM systems and channels for which programming support is provided.

The execution of a 3250 graphics application on any of these operating systems is also supported by the IBM Virtual Machine Facility/370 (VM/370).

The OS/VS products that govern 2250 and 3250 graphic display operations are IBM Graphic Programming Services (GPS), which includes Graphics Access Method (GAM) (Program numbers 5741-GA1 and 5752-GA1), and the IBM Graphic Subroutine Package (GSP) for FORTRAN IV, COBOL, and PL/I languages (Program numbers 5741-GS1 and 5752-GS1). These were originally developed for the 2250, but the compatibility of the 3250 system with the 2250 Model 3 makes them applicable, unchanged, to the 3250.

This chapter briefly describes the facilities of GPS and GSP; a full description of GPS and GSP is given in their publications (see the bibliography for titles), where "2250 Model 3" may be considered as a synonym for "3251." Details of the minor differences that exist in the way GPS and GSP apply to the 3250 are described in Chapter 7.

System generation for the 3250 is addressed in more detail in this chapter. Although the support is identical with that for the 2250 Model 3 (because no software change has been made), the differences in subsystem configuration make it appropriate to describe I/O device generation directly in terms of the 3250 system units.

The user should be aware that the OS/VS operating systems have no special recognition of graphic application programs and their response time requirements, treating such programs as ordinary batch jobs.

This situation may be alleviated by using suitable values of system parameters for graphic application jobs. Examples of such parameters are:

- For VS1: partition number, use of partition time-slicing
- For MVS: domain, domain multiprogramming levels, automatic priority group, interval service value, performance objectives, performance group, performance group periods.

For a full discussion of these and other parameters, refer to *OS/VS1 Planning and Use Guide*, GC24-5090, or *OS/VS2 System Programming Library: Initialization and Tuning Guide*, GC28-0681. Due to the large variety of possible installation job mixes, specific recommendations for these parameter values cannot be made.

To summarize: no OS/VS or VM/370 system software changes have been made to support the 3250 system; an IBM 3251 Display Station is treated as if it is a 2250 Model 3. Thus:

- In most instances, references to 2250 Model 3 in software publications may be read as references to 3251.
- Storage requirements in the host system for the 3250 system are the same as those for 2250 Model 3.
- Job control language A 3251 is specified in OS/VS Job Control Language as:

  ```
  UNIT=2250-3
  ```

- GPS and GSP do not explicitly support the following capabilities of the 3250 system:
  - Dotted, dashed, and dot-dash line types
  - Small-size and medium-size characters
  - Character string rotation
  - Programmable intensity levels
  - Blinking of defined image entities.

Graphic Programming Services (GPS)

Graphic Programming Services provides support under OS/VS for developing and executing graphics application programs and provides support for the operator-machine interactive facilities of the 3251. GPS provides a basic level of programming support, and the interface to GPS function is defined at the assembler language level.

GPS can be regarded as providing three facilities:

- Buffer Program Generation Facilities. These can be used to generate the orders and data that are executed by the 3250 system for producing an image on the screen.

- Problem Oriented Routines (PORs). These are generalized routines that generate buffer orders and data to display grids, plots, arcs, and alphanumeric characters on the screen. In addition, a POR is provided to move a tracking symbol on the screen using the light pen.

- Graphics Access Method (GAM). This is a set of routines and associated macro instructions that control the interface between the host system and the 3250 system. The functions provided include:

  - Data transmission between the host system and the 3250 system, to display images from previously generated buffer programs

  - Attention handling facilities for operator interaction with the host program through the light pen or keyboards of the display station

  - Storage allocation of the display buffer in the IBM 3255 Display Control Unit.

To display the images provided by either the Buffer Program generation facilities or the PORs, the Graphics Access Method must be used to transmit the generated orders and data to the 3250 system, and to initiate the display. GAM may also be used to transmit buffer programs created by other techniques utilized within an application program.

The facilities of GPS are described in *OS/VS Graphics Programming Services (GPS) for IBM 2250 Display Unit and IBM 3250 Graphics Display System*, GC27-6971. Although written for the 2250, in general all the facilities that apply to the 2250 Model 3 apply equally to the 3251. However, some minor differences between the display stations have implications on the use of GPS; these differences are discussed in Chapter 7.

Graphic Subroutine Package (GSP)

The Graphic Subroutine Package provides support under OS/VS for graphic applications programs written in Assembler language or for the following Compilers: COBOL (F), FORTRAN IV E, G or H, PL/I (F), FORTRAN IV H-Extended or GI (licensed programs), PL/I Optimizing or Checkout Compilers (licensed programs).

GSP is a set of subroutines that are invoked using either the CALL statement or a Function reference. These subroutines support the creation and modification of image data within the host program, transmission of the image data between the host system and the 3250 system, storage allocation within the display buffer, and the communication between the 3251 operator and the host program.

The transmission and communication facilities of GSP utilize the Graphics Access Method, although the use of GAM is not apparent at the application program interface to GSP.

The facilities of GSP are described in *OS/VS Graphic Subroutine Package (GSP) for FORTRAN IV, COBOL and PL/I*, GC27-6973. Although written for the 2250, it applies equally to the 3251, because any GSP function supported for the 2250 Model 3 is identically supported for the 3251. However, minor differences between 2250 Model 3 and 3251 have implications on the use of GSP; these differences are discussed in Chapter 7.

Graphics Access Method/System Product (GAM/SP)

Graphics Access Method is an integral part of Graphic Programming Services contained in Operating Systems OS/VS1 (CMS) and OS/VS2 (MVS).

Graphics Access Method/System Product (GAM/SP), on the other hand, is a program product (Program number 5668-978) for use with the VM/SP CMS operating system.

GAM/SP provides almost all the facilities available with GPS, allowing most application programs developed for GPS to be run under GAM/SP. The exceptions are:

- The 2250 Display Unit Model 1 is not supported.
- Other than GSTOR module support, GAM/SP does not include the facilities provided by the problem-oriented routines (PORs) of GPS. However, existing users of POR functions can retain the functions and continue using them.
- Programs that rely on specific timing or performance characteristics of a system may need modification if a change is made to the system.

Further information about GAM/SP is contained in *IBM Graphics Access Method/System Product: General Information*, GC33-0125.

System Generation

A 3251 Display Station is defined to the host system as if it is a 2250 Display Unit Model 3 attached by way of an IBM 2840 Display Control Model 2. A slightly different interpretation of certain parameters applies for a 3251, arising from the difference in configuration of the two systems. In the 3250 system, the 2840 Model 2 is replaced by a 3258 Channel Control Unit and one or more 3255 Display Controls Units. Although the method of defining a 3251 for the system generation process is described fully in the following paragraphs, reference must also be made to the relevant OS/VS or VM/370 system generation manual quoted in the bibliography. This action is necessary both for a full appreciation of the total system generation process and for an explanation of the terminology used.

OS/VS System Generation

During OS/VS system generation, it is necessary to specify which 3251s are to be configured, and whether or not the programming support packages GSP and GPS are to be included in the system. Specification of the 3251s is performed by the IODEVICE macro instruction, which is described here in detail; this macro instruction is applicable to OS/VS1, OS/VS2 Release 1, and OS/VS2 Release 3 (MVS). The inclusion of the GSP and GPS subroutines is not affected by the 3250 system; for information, see the OS/VS system generation manuals.

An IODEVICE macro instruction is required for each 3251, and the applicable parameters (for both 3251 and 2250 Model 3) are as follows:

```
IODEVICE  ADDRESS={address                  }
                  {(address,number of units)}
          UNIT=2250
          MODEL=3
          PCU=number

          [IOREQUE={PRIORITY}]
                   {FIFO    }

          [EXPBFR={number}]
                  {4096  }

          [NUMSECT={number}]
                   {16    }

          [FEATURE=(feature[,feature])]
```

ADDRESS=address
specifies the unit address of the device. A unit control block (UCB) is created for each device address specified.

The unit address consists of three hexadecimal digits from 000 through FFF. The high-order digit is the number of the channel (specified in the CHANNEL macro instruction) to which the device is attached. The 3250 is a burst device and so cannot be specified at system generation on a byte-multiplexer channel. The low-order two digits represent the control unit and device address.

ADDRESS=(address,number of units)
specifies the first unit address of a series and the number of units in the series of sequential addresses. The value for the number of units can be from 1 through 255. For example, if ADDRESS=(190,4) is specified, the unit addresses 190, 191, 192, and 193 will be assembled.

All 3250 device-address configurations permitted by the hardware can be accommodated, provided the range of addresses on any given physical control unit (see "PCU=number" below) does not overlap that on any other.

UNIT=2250,MODEL=3
specifies that the device is a 3251 Display Unit or a 2250 Model 3. It must be coded as shown. In addition to defining the device type to the system, it also provides a unit name by which Job Control Language can refer to devices of this type. In this case, the unit name is 2250-3.

PCU=number
specifies the number identifying the physical control unit (which contains the display-control buffer) to which this display unit is attached. The number must be in the range 1 through 99, but its value is not inherently significant; the parameter merely serves to tell the system which devices have a common physical control unit and, therefore, share a display control buffer. For a 3251, the physical control unit is the 3255; for a 2250 Model 3, it is the 2840 Model 2. Note that the presence and configuration of the 3258 Channel Control Unit is not apparent to system generation.

IOREQUE=parameter
specifies the type of I/O request queuing to be provided by the supervisor for the device. Code the parameter:

IOREQUE=PRIORITY
to specify queuing according to the requesting task's priority

IOREQUE=FIFO
to specify first-in-first-out queuing

The default is FIFO.

EXPBFR=number
specifies, in bytes, the amount of space in the display buffer that should be allocated when an OPEN request is issued for the device and the device is opened for access by GAM with EXPRESS attention-handling subroutines. The requested buffer space may be any number of bytes from 1 through 8192.

If this parameter is omitted, 4096 bytes are allocated.

NUMSECT=number
16
specifies the number of 256-byte buffer sections in the display-control buffer to be **guaranteed** to the display station. These buffer sections can be used only by the device being specified.

For the purposes of GAM buffer management, the display-control buffer may be thought of as divided into 256-byte sections. Buffer storage can be assigned, released, or guaranteed only in multiples of 256 bytes, starting on a buffer address that is a multiple of 256.

An operating system may, for the purposes of certain system functions, require that each graphics device always has a specified minimum of buffer storage available, or it may simply require that no device ever be completely deprived of buffer storage. In either case, the installation may specify, during system generation, an amount of buffer storage that is to be reserved exclusively for each display station. The guaranteed storage is always a multiple of 256 contiguous bytes.

The buffer storage of each display control is divided into zones, one zone for each associated display station. Each zone contains a number of whole 256-byte buffer sections. Some of these sections may be "guaranteed" to the display station to whose zone they belong, and can never be assigned to any other display station.

The zone and guarantee status of each buffer section is recorded in a buffer table (one table per display control), constructed during system generation. These buffer tables also contain entries showing the current assignment status of each of the buffer sections; the entries are made and updated by the GAM buffer management facilities during program execution.

The following rules govern the mapping, during system generation, of each display control buffer:

1. The number of buffer sections in the zone assigned to each display station is equal (normally) to the total number of buffer sections divided by the number of display stations, with any remainder included in the zone of the last display station. (Rule 3 gives the exception to this.)

2. The guaranteed buffer sections for each device are contiguous and occupy the low-address portion of that display-station zone. These sections can be assigned only to that particular device. Sections not specified as guaranteed may be assigned to any of the display stations attached on a first-come, first-served basis.

3. The exception to rule 1 occurs if the number of sections to be guaranteed to any display station is greater than its zone. In that case, that display station's zone is made exactly equal to the number of guaranteed sections.

4. Each display station must have a zone consisting of at least one buffer section.

5. The sum of the guaranteed sections may not exceed the total amount of buffer storage.

6. If the NUMSECT parameter is omitted, 16 sections are guaranteed.

FEATURE=(feature[,feature])
specifies the keyboard special feature(s) that are attached to the display station. Code as follows:

ALKYB2250
for alphanumeric keyboard

PRGMKYBD
for program function keyboard

An RDEVICE macro instruction is required for each 3251 Display Station. The applicable parameters (for both 3251 and 2250 Model 3) are:

```
RDEVICE   ADDRESS={cuu     }
                  {(cuu,nn)}
          DEVTYPE=2250
```

ADDRESS={**cuu** / **(cuu,nn)**}

specifies the real I/O device address (or addresses).

The address, **cuu**, is three hexadecimal digits from 000 through FFF. The high-order digit is the address of the channel to which the device is attached; the two low-order digits represent the control unit and device address.

The value, **nn**, is the number of RDEVBLOK entries to be generated; it may be any number from 1 through 256. For example, if ADDRESS=(110,4) is specified, RDEVBLOK entries with device addresses 110, 111, 112, and 113 are generated. If **nn** is omitted, a value of 1 is assumed.

DEVTYPE=2250

specifies that the device is a 3251 or a 2250 Model 3. The MODEL parameter is not required and should not be specified. VM/370 considers 3251 and 2250 Model 3 to be unsupported devices whose device subclass is known; no CLASS parameter should therefore be specified.

An RCTLUNIT macro instruction is required for each 3258 Channel Control Unit. The applicable parameters (for both 3258 and 2840 Model 2) are:

```
RCTLUNIT  ADDRESS=address
          CUTYPE=2840
```

ADDRESS=address

specifies the real address of the control unit. The address consists of three hexadecimal digits; the high-order digit is the channel address of this control unit and the two low-order digits represent the 5-bit control unit address with a device address of binary 000. (Details of control unit and device addresses are given in Chapter 4 under "Addressing".) The first low-order digit may be any hexadecimal number from 0 through F, the second must be either 0 or 8.

CUTYPE=2840

specifies that the control unit is a 3258 or a 2840 Model 2. VM/370 considers 3258 and 2840 Model 2 to be unsupported control units.

The association of 3251 Display Stations with particular 3255 Display Control Units and their buffers is not relevant to VM/370 and, consequently, there is no way of specifying this information. Note especially that the way in which the control units are specified by a RCTLUNIT macro instruction has no effect on this association. As is the case for the 2840 Model 2 and 2250 Model 3, the association between the 3255 and 3251 is of interest only to the various virtual machines that run under VM/370 and use the 3251s, and this association is

typically specified in the system generation of the virtual machines. Because of this, device usage conventions may be required in any circumstances where the 3255-3251 associations of the real devices differ from those of the virtual devices that are mapped onto them, whether in one virtual machine or several.

A common case is where a user allocates 3251s attached to the same real 3255 to different virtual machines. The user must ensure that the same part of the real display-control buffer is not allocated concurrently to more than one of the machines. Because VM/370 does not know of the 3255-3251 association, this condition must be met by the user imposing conventions on these virtual machines in their use of the 3251s. For instance, if the virtual machines are all running OS/VS systems and using GAM to access the display stations, the following conventions are recommended to meet the condition:

- Each virtual machine must be configured with a set of virtual devices equivalent to the total set of **real** 3251s on the **real** shared 3255s.
- Virtual machines should not be allowed to dynamically allocate space in the display-control buffer, that is, all the 3255 buffer sections must be guaranteed to the associated 3251s.

Operating System Considerations for the IBM 3255 Model 2

The 3255 Display Control Unit Model 2 differs from the 3255 Model 1 in that the Model 2 has two buffers. Both buffers are seen by the operating system as separate buffers. Therefore it is necessary to define each buffer separately to the operating system.

Under VS1 and MVS

When the 3255 Model 2 is operating under VS1 or MVS, graphics applications are supported by the *IBM Graphic Programming Services* (GPS) component of the operating system. In this instance, each buffer is seen as a separate physical control unit (PCU). In order to use the additional buffers, the IODEVICE macro instruction that describes the devices for system generation must specify different PCU operands for the devices that use different buffers.

Under VM/CMS

When the 3255 Model 2 is operating under VM/CMS, graphics applications are supported by the *IBM Graphics Access Method/System Product* (GAM/SP). To obtain support for the buffers, the GABDEV macro instructions that define the devices should be associated with different GABBUF macro instructions. Refer to *GAM/SP Installation, Resource Definition, and Customization,* SC33-0141.

Chapter 7. Conversion from 2250 Model 3

The IBM 3250 Graphics Display System is generally compatible with the IBM 2250 Display Unit Model 3/IBM 2840 Display Control Model 2, so that most graphic application programs for a 2250 Model 3 execute unchanged with a 3250 system. This compatibility applies whether the application programs were written using GPS, GSP, or any other programming tool. However, some minor differences occur in configuration aspects, and some modifications or extensions in function occur for installations being converted partly or wholly from 2250 Model 3 to the 3250 system.

In this chapter, these conversion considerations are discussed. In particular, any effect on existing valid programs using GSP or GPS is addressed.

System Generation Aspects

The 3250 hardware and system generation specification is compatible with that for a 2250 Model 3/2840 Model 2. For installations that are being converted from 2250 Model 3, therefore, replacement can be made without need for any I/O-device generation. In certain cases, however, it may be advisable to do an I/O-device generation in order to take full advantage of the additional flexibility provided by a 3250 system.

OS/VS Considerations

Where 2840 Model 2s with 2250 Model 3s are replaced by equivalent 3250 systems (having IBM 3251 Display Stations with the same device addresses as the 2250 Model 3s, and IBM 3255 Display Control Units in one-to-one correspondence with the 2840 Model 2s), no change to any IODEVICE macro instruction is required, and so a new I/O-device generation is not needed.

If 2250 Model 3s are replaced by a 3250 system where the grouping of 3251s attached to a 3255 does not correspond exactly with that of the 2250 Model 3s attached to the 2840 Model 2s, then the following considerations apply:

- User software incompatibilities can occur if the software depends on the precise configuration, for example, in the use of absolute display-buffer addresses or in the use of display-buffer subroutines shared between multiple display stations.

- Provided that the 3251 device addresses correspond to those of the replaced 2250 Model 3s, an I/O-device generation is not essential, even though the 2840 Model 2s and 3255s are not in one-to-one correspondence. The PCU parameter that formerly identified a 2840 Model 2 and its 32K-byte display-control buffer then applies to more than one 3255, each of which has a 32K-byte buffer. In this case, the system does not differentiate between the 3255s, so that only one buffer table describing one hundred and twenty-eight 256-byte buffer sections (total of 32K bytes) is built in main storage to control the multiple 3255 buffers. As a result, if GAM is used to access the 3250 system, only 32K bytes of the combined 3255 Display Control Unit buffers are used at any time, to give a buffer allocation compatible with the replaced 2840 Model 2. To be able to use all the available display-control buffer storage, and thus increase the possible maximum size of buffer order programs, a new I/O-device generation using 3250 system specifications and identifying multiple PCUs must be done.

VM/370 Considerations

Where 2840 Model 2s with 2250 Model 3s are replaced by equivalent 3250 systems (having 3251s with the same real device addresses as the 2250 Model 3s, and 3255s in one-to-one correspondence with the 2840 Model 2s), no change to any RDEVICE or RCTLUNIT macro instruction is required, and so a new VM/370 system generation is not needed.

Even where the replacement is such that the 3255s are not in one-to-one correspondence with the 2840 Model 2s, it is unlikely that a new VM/370 system generation is required (because display control units are, in effect, transparent to VM/370). However, consideration must be given to whether the special situations described in Chapter 6 under "VM/370 System Generation" apply as a result of the replacement; that is:

- Real 3255-3251 associations differing from those of the virtual devices mapped onto them
- An OS/VS system running under VM/370 having multiple virtual 3255s where it previously had one 2840 Model 2.

If such a situation exists, refer to Chapter 6 to determine what action, if any, is necessary.

Effect of 3250 System Extensions and Variations

This section considers the effect of the extended 3250 system function, and some of the minor variations from the 2250 Model 3 function with respect to:

- Existing 2250 Model 3 application programs to be used with the 3250 system
- The use of GPS or GSP to develop new applications for the 3250 system
- Use of the display station by an operator.

Configuration Differences

It is possible to replace any configuration of 2840 Model 2/2250 Model 3s by a 3250 system as follows:

1. Replace each 2250 Model 3 by a 3251 Display Station.
2. Replace each 2840 Model 2, or pair of 2840 Model 2s if they share a common control unit address (via the Address Expansion RPQ), by one 3258 Channel Control Unit and the configuration of 3255 Display Control Units needed to attach the 3251s.

With such a replacement, the same device addresses can be retained for the display stations, and there is little likelihood that a new I/O-device generation is required for OS/VS or VM/370.

Because each 3258 can support up to sixteen 3251s using up to sixteen 3255s, replacement of a configuration containing multiple 2250 Model 3s can be done in many ways. Considerations for determining the appropriate 3250 configuration include the required geographic distribution of the workstations relative to the 3250 system cable lengths, and system performance factors. In addition, "System

Generation Aspects" (above) discusses the cases when a new I/O-device generation may be needed and the possible effect on application program compatibility.

Buffer Orders

The 3250 system provides additional functions by extensions to the buffer order set. These extended orders are not generated by GSP or by GPS macro instructions. On the 2250 Model 3, these orders would be treated as a 2-byte NO-OP; any existing application program that generates these orders produces a different image on a 3251. The new order codes (hexadecimal) are: 2A10, 2A42, 2A43, 2A46, 2A47, 2A48, 2A49, 2A4A, 2A4B, 2A4C, 2A4D, 2A4E, 2A4F, 2AD1, 2AD2, and 2AF5.

These buffer orders provide the following additional functions:

- Small-size characters
- Medium-size characters
- Character string rotation
- Variable intensity levels
- Blinking
- Broken line types
- Status of the light-pen tip-switch.

Buffer programs that support the above functions can be transmitted by GAM.

The order X'2A52' produces small-size characters when executed on a 3250 system whereas it produces basic-size characters when executed on a 2250 Model 3.

In addition to the order codes specified in the preceding paragraph, the 3255 Display Control Unit Model 2 uses the following additional codes to support the four level intensity function: hexadecimal 2A90, 2A91, 2A92, and 2A93.

Character Set

Alphanumeric Characters

The 3250 system supports both uppercase and lowercase characters, whereas the 2250 Model 3 supports uppercase only. A 2250 Model 3 program could define characters with the lowercase code, but the characters would be folded to uppercase by the 2250 and they would be displayed as uppercase character; this does not occur if the same program is used with a 3250 system. The GXTX macro instruction of GPS and the PTEXT subroutine of GSP can be used for either uppercase or lowercase characters.

Special Characters

In addition to the character set supported by the 2250 Model 3, the 3250 supports the character codes for backspace, left and right braces ({}), vertical broken bar (¦), and backward solidus (\). The character displayed in response to an undefined code may not be the same character on the 3250 system as on the 2250 Model 3.

Engineering Symbols

The 3255 Display Control Unit Model 2 supports additional character codes for the following engineering symbols:

Centerline ℄	Omega Ω
Degree °	Micro μ
Plus/minus ±	Raised period
Diameter Ø	Depth ↧
Less than or equal to ≤	Countersink ⌵
Greater than or equal to ≥	Counterbore ⌴

The special engineering symbols are available with all language groups except the Italian language. The "depth" symbol is not supported by the Katakana keyboard.

An 87-key Numeric Keypad Alphanumeric keyboard is available as an optional feature for the 3255 Model 2. It differs from the standard 75-key keyboard by having a numeric keypad added to the right-hand side of the key bank, and keys for the 12 engineering symbols listed above.

The numeric keypad and the engineering symbols provide the same character codes in both uppercase and lowercase shift.

Notes:

1. The numeric keypad keyboard is compatible with the standard 75-key keyboard.
2. For the Swedish language, the numeric keypad keyboard is the only keyboard that is supported.

Null and New-Line Characters

The 3250 system permits null and new-line characters to appear anywhere in a displayed character string; this removes a restriction of the 2250 Model 3. The GCNL macro instruction of GPS and the PTEXT subroutine of GSP allow this facility.

Sharing a Display Buffer

Both the 3250 system and the 2250 Model 3 permit display stations to share a display buffer; however, the methods differ for interleaving the execution of a buffer program. A resulting effect on the 3250 system is that should a Start Regeneration Timer (GSRT) order be omitted from the regeneration loop for one display station, it is possible to blank the image on the other display stations that share the same 3255 Model 1 or Model 2.

The LOCPN routine of GSP, which floods the display screen with characters to allow a light pen detect on an "empty" screen, has this blanking effect during the interval between starting the image and the light pen detect. Apart from the LOCPN routine, all buffer order programs generated by GSP include a GSRT order in the loop. If GPS is used, it is the responsibility of the application program to ensure that a GSRT order is included.

Sharing Two Display Buffers (3255 Model 2 Only)

The 3255 Display Control Unit Model 2 has two separate 32 768 byte buffers. Buffer programs cannot branch to, or transfer data between, the two buffers. Each buffer is addressed from 0 through 32 767 bytes. Bit 0 of the first byte of the address word used in the Set Buffer Address Register and Start command, and the Set Buffer Address Register and Stop command, is not required to address up to 32 767 bytes. Bit 0 is reserved, and should be set to zero.

Single Cursor

The 2250 Model 3 permits multiple cursors to be used whereas the 3255 permits only one. Thus, inserting a cursor removes any previous cursor. Application programs that relied on retaining multiple cursors therefore need modification. GSP only supports a single cursor; on the other hand, it is possible with **GPS** to generate multiple cursors on the 2250 Model 3, although no explicit support is given.

Overlay Sensing

The 3250 system does not support the function provided by the 2250 Model 3 overlay sense switches. The overlay sense information associated with program function key interruptions normally contains hexadecimal FF; this setting of the overlay sense information affects the GREADR MIP macro instruction of GPS and the RQATN routine of GSP.

Buffer Program Interruption and Restart

If the execution of a buffer program is interrupted through either a light pen detect or a Set Buffer Register Address and Stop command, and is then restarted by a Set Buffer Address Register and Start command that specifies a buffer location not containing a GSRT order, differences can occur between the 3250 system and the 2250 Model 3. On the 2250 Model 3, the light pen modes are remembered across the interruption; on the 3250 system, however, the buffer order program is continued with light pen modes reset as though a GSRT order had been executed. By using GSP, this situation cannot occur. However, GPS/GAM permits buffer programs to be started at any point, although the GPS publication[1] explains that a GSRT order should always be the first order to be executed.

Normally any effect would not be noticeable, because the difference in modes would apply only to the remainder of the current regeneration cycle. The next GSRT order executed would restore compatibility. Thus, only buffer programs that do **not** contain a GSRT order in their regeneration cycle, and that depend on multiple light pen detects, would be affected. Such programs should be modified to include a GSRT order in their regeneration cycle for this and other reasons given earlier in this chapter under "Sharing a Display Buffer."

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1 *OS VS Graphic Programming Services (GPS) for IBM 2250 Display Unit and IBM 3250 Graphics Display System,* GC27-6971.

Time Dependent Programs

Time dependencies in channel programs or buffer programs written for the 2250 Model 3 are not guaranteed if the same programs are transferred to a 3250 system.

Buffer Storage Validity

Programs that depend upon the validity of data in buffer storage after the 2250 system power supply has been turned off and restored are not guaranteed if the same programs are transferred to a 3250 system.

Keyboard Functions

The 3251 has an alphanumeric keyboard improved over that of the 2250 Model 3 by a modified layout and extended function. Major improvements are:

- The 3251 permits lowercase characters to be entered from the keyboard.
- Separate keys are provided for CANCEL and END. Unlike the 2250 Model 3, there is no ALTN Coding key.
- The action resulting from pressing the JUMP key when the cursor is in a protected field, and there is no unprotected field, has been improved from the 2250 Model 3. The cursor is not moved, and further keyboard action is inhibited until RESET is pressed.
- There is no physical keyboard locking; successful key entry is indicated by a clicker mechanism, which can be enabled or disabled by the operator as required.
- An 87-key Numeric Keypad Alphanumeric Keyboard with an extended Engineering Symbols character set is available as a special feature with the 3255 Model 2. This keyboard is compatible with the standard 75-key keyboard.

The 3255 Model 2 requires both the CANCEL and CONTINUOUS keys to be pressed to produce the CANCEL function, as a safeguard against accidental use of the CANCEL key.

The 3251 has a program function keyboard special feature with different dimensions from those for the 2250 Model 3; it requires a different overlay and does not support overlay sensing.

Keyboard Operation (3255 Model 2 Only)

Polling

If an active picture is being displayed, the program function keyboard and the alphanumeric keyboard are polled sequentially for data/interrupts at Start Regeneration Timer (GSRT) time. If there is no GSRT order present in the buffer program, neither keyboard is polled until the program stops.

If no active picture is being displayed, the keyboards are polled sequentially at the real-time clock rate of 46 cycles per second until a picture is displayed when GSRT polling is resumed.

Program Function Keyboard Operation

When a program function keyboard (PFK) key is pressed, the key number is passed via a PFK keyboard response to the 3255 Display Control Unit Model 2. The 3255 generates an Attention interrupt and sets data in the read manual input (RMI) register. If the RMI register is already set, or there is an outstanding Attention (or Attention with Unit Check), the PFK is ignored. That is, the PFK is logically locked out and the interrupt will not be generated. A PFK operation cannot overwrite an outstanding PFK, END, or CANCEL condition.

Alphanumeric Keyboard Operation

All keystrokes, with the exception of END and CANCEL, are taken and processed provided that there is an unprotected data field and a cursor available. An END or a CANCEL key causes an Attention interrupt to be generated and the Read Manual Input (RMI) register to be set, unless there is already a previous Attention, (or Attention with Unit Check) outstanding. In which case, the later input is locked out.

Note: If a light-pen strike is received, and the Attention with Unit Check interrupt is outstanding, the RMI register cannot be set. Also, if the light-pen tip-switch is closed, the PFK interrupts are locked out.

3251 Display Station Model 1: With simultaneous interrupts from the keyboards, the first response to a keyboard poll that is received will lock out the other interrupt.

3255 Display Control Unit Model 2: With the 3255 Model 2, if an END or CANCEL interrupt is received after a Program Function Keyboard (PFK) interrupt has been raised, but before a Read Manual Input (RMI) command has been received, the END or CANCEL will set a new value into the RMI register and generate a new Attention interrupt.

Light Pen

The light pen of a 3251 Display Station Model 1 differs from the light pen of a 2250 Model 3. The 3251 light pen identifies a displayed element at which it is pointed, by locally intensifying that element, whereas the light pen of a 2250 Model 3 emits twin beams of light to indicate where the pen is pointing.

Single-Element Intensification (3255 Model 2 Only)

The 3255 Display Control Unit Model 2 can be set to allow a vector, character, or point to have its brightness intensified when detected by a light pen without intervention from the host system. This facility differs from the 3255 Model 1, which does require intervention from the host system.

Read Manual Input Command

If a Read Manual Input command specifies a length of less than 3 bytes, any remaining unread bytes are lost. (On the 2250 Model 3, the whole block of 3 bytes could be re-read if a shorter length was specified.) This change does not affect GPS or GSP which always read all 3 bytes.

Cable Replacement

The cables used between the 2840 Model 2 and the 2250 Model 3 cannot be used to link the 3255 and 3258.

Block Multiplexing and IOS

Applications written using GPS or GSP are unaffected. Other applications that replace some of the functions of GPS or GSP may require changes to accommodate a 3250 on a block-multiplexer channel. For example, programs which access 3250 systems via EXCP rather than GAM and which examine internal system control blocks or provide private I/O appendage routines should be checked to ensure independence of concurrent Channel End and Device End flag settings. For details of sense and status conditions, see *IBM 3250 Graphics Display System: Component Description,* GA33-3037.

Four-Level Intensity (3255 Model 2 Only)

The four level intensity function modifies the 3255 Model 2 to allow the additional buffer orders available with the 2250 Model 3 to be used with a 3250 system.

The function is a subset of the eight intensity levels that are controlled by the Attribute Register. With the four level intensity function, a specific buffer order can be executed to change the intensity level.

Each of the following buffer orders sets a specific intensity level:

GSBL BUFFER ORDER	3250 INTENSITY ATTRIBUTE
GSBL(B) 2A90	Blank (Intensity level 0)
GSBL(D) 2A91	Dim (Intensity level 3)
GSBL(N) 2A92	Normal (Intensity level 5)
GSBL(B) 2A93	Bright (Intensity level 7)

These orders can be used in addition to, or in conjunction with, the intensity level controlled by the attribute register.

Notes:

1. When a Start Regeneration Timer (GSRT) order is executed, the intensity attribute is set to Normal as a default.

2. A displayed entity that is valid for light pen selection must be displayed at Normal or Bright intensity.

3. The Load Immediate Attribute Register (GLAR) buffer order is not removed or changed.

4. The Bright intensity level is level 7, or level 7 enhanced.

Enhanced Level 7 Intensity (3255 Model 2 Only)

On the 3255 Display Control Unit Model 2, intensity level 7 (Bright) can be enhanced to improve differentiation between it and intensity level 5 (Normal).

Chapter 8. Installation Planning Data

The physical characteristics and environmental requirements of an IBM 3250 Graphics Display System allow the units of a graphics system installation to be placed in normal offices or computer rooms with few special arrangements. This chapter gives briefly the data needed for planning an installation; for more detailed information, consult an IBM installation planning representative.

Physical Characteristics

Units of the 3250 system are attractively packaged and of a size suitable to their working environment. The 3258 Channel Control Unit and the 3255 Display Control Unit are similar in appearance; access for customer engineers to service these units is gained by means of hinged front and rear covers. Service access to the 3251 Display Station is gained by means of a removable rear section.

The 3258 and 3255 are floor-standing units whereas the 3251 and its optional keyboards stand on a desk or table.

Dimensions of Units

The units of the 3250 system have the following dimensions:

- 3258 Channel Control Unit: 762 mm (30 in.) high, 585 mm (23 in.) wide, 762 mm (30 in.) deep
- 3255 Display Control Unit Model 1 and Model 2: 762 mm (30 in.) high, 585 mm (23 in.) wide, 762 mm (30 in.) deep
- 3251 Display Station Model 1:
  - Display unit: 508 mm (20 in.) high, 585 mm (23 in.) wide, 737 mm (29 in.) deep
  - Alphanumeric keyboard: 89 mm (3.5 in.) high, 432 mm (17 in.) wide, 254 mm (10 in.) deep
  - Numeric keypad alphanumeric keyboard: 65 mm (2.50 in.) high, 477 mm (18.75 in.) wide, 240 mm (9.50 in.) deep
  - Program function keyboard: 153 mm (6 in.) high, 185 mm (7.25 in.) wide, 216 mm (8.5 in.) deep.

Weight of Units

The units of the 3250 system have the following approximate weights:

- 3258 Channel Control Unit: 125 kilograms (275 pounds)
- 3255 Display Control Unit Model 1 and Model 2: 125 kilograms (275 pounds)
- 3251 Display Station Model 1:
  - Display unit: 63.5 kilograms (140 pounds)
  - Keyboards: Less than 5 kilograms (11 pounds) each.

Cables

Each 3255 needs a coaxial cable connection to the 3258; this cable is not provided with the 3250 system, but must be supplied and installed by the customer. For further information, see *IBM 3250 Graphics Display System: Installation Manual - Physical Planning,* GA33-3036.

In addition to the cables to attached 3255s, a 3258 requires two signal cables for communications between the 3258 and the I/O channel. These two cables vary in length, depending on the host system configuration; 61 meters (200 feet) is the maximum length.

The 3251s each have a cable for connection to the 3255. One 3251 on each 3255 must have a cable of length 4.6 meters (15 feet) and must be located adjacent to its 3255. Extra 3251s, if present, have a choice of three cable lengths: 4.6 meters (15 feet), 9.1 meters (30 feet), and 15.2 meters (50 feet). Cables that connect the light pen, alphanumeric keyboard, and program function keyboard are supplied as part of these features. The 3251s also have a keyboard connector at both sides; each connector accepts the cable from either keyboard, thus allowing a display station to be personalized for use by right-handed or left-handed operators.

Appendix A. Summary of Channel Commands

The IBM 3250 Graphics Display System uses four types of channel command: write, read, control, and sense. The write command initiates the transfer of data from the host system into the refresh buffer. Read commands cause a transfer of data from either the refresh buffer or from a register (for example, X and Y position registers) in a selected IBM 3251 Display Station. Control commands initiate the setting of program function indicators or activate the audible alarm for operator attention at a selected 3251, and control display regeneration and cursor insertion. The Sense command transfers data to the channel, the transferred data indicating various control and/or check conditions in the graphics system. (These commands are the same as the channel commands used with the 2250 Model 3.)

The channel commands and command codes are shown in Figure A-1:

Type of Command	Channel Command	Command Code	See Note
Write	Write Buffer	X'01'	
Read	Read Buffer	X'02'	
	Read Manual Input	X'0E'	1 or 2
	Read Cursor	X'06'	1
	Read X Y Position Registers	X'12'	
Control	Control No-Operation	X'03'	
	Set Buffer Address Register and Start	X'27'	
	Set Buffer Address Register and Stop	X'07'	
	insert Cursor	X'0F'	1
	Remove Cursor	X'1F'	1
	Set Program Function Indicators	X'1B'	2
	Set Audible Alarm	X'0B'	
Sense	Sense	X'04'	

Figure A-1. Channel Commands and Command Codes

Notes:

1. Needs the attachment of an alphanumeric keyboard for operation of the command.

2. Needs the attachment of a program function keyboard for operation of the command.

Appendix B. Summary of Buffer Orders

This appendix summarizes the buffer orders supported by the IBM 3250 Graphics Display System. These orders include all those supported by the 2250 Display Unit Model 3.

Graphic-Mode Orders

The graphic-mode orders Figure B-1 control the display of points and lines on the screen, and also the repositioning of the beam to a new position on the screen. The display is affected by the current Intensity, Blink, and Line Type attributes set by the control-mode orders.

Each graphic-mode order is followed by a data list that determines the coordinates of the points, or end-points of the lines to be displayed. Each data list field is either a pair of 2-byte absolute coordinates (position relative to the screen axes) or a pair of 1-byte incremental coordinates (positions relative to last item displayed).

Mnemonic (See Note)	Graphic-Mode Order	Code
GEPM	Enter Graphic Mode Absolute Point	X'2A00'
GEVM	Enter Graphic Mode Absolute Vector	X'2A02'
GEPI2	Enter Graphic Mode Incremental Point	X'2A04'
GEVI2	Enter Graphic Mode Incremental Vector	X'2A05'

Figure B-1. Graphic-Mode Orders

Note: The mnemonics shown are those used by Graphic Programming Services.

Character-Mode Orders

The character-mode orders Figure B-2 on page B-2 control the display of alphanumeric information on the screen. There are sixteen different orders, each 2 bytes in length, to permit control of the character size and the rotation of the character string, and to specify whether the contents of the string may be sent from the keyboard (unprotected) or not (protected). Each character-mode order is followed by a data list containing the characters that are displayed. Each 2-byte field in the list contains two characters.

The display of the characters is affected by the current Intensity and Blink attributes set by the control-mode orders.

Rotated character strings are displayed at 90° counterclockwise from normal, that is, for reading from the bottom of the screen to the top.

Mnemonic	Graphic-Mode Order	Code	See Note
GECF (B)	Enter Graphic Mode Basic	X'2A40' or X'2A50'	1
GECF (L)	Enter Character Mode Large	X'2A41' or X'2A51'	1
GECF (S)	Enter Character Mode Small	X'2A42' or X'2A52'	2
GECF (M)	Enter Character Mode Medium	X'2A43'	2
GECP (B)	Enter Character Mode Basic Protected	X'2A44'	1
GECP (L)	Enter Character Mode Large Protected	X'2A45'	1
GECP (S)	Enter Character Mode Small Protected	X'2A46'	2
GECP (M)	Enter Character Mode Medium Protected	X'2A47'	2
GECF (B,R)	Enter Character Mode Basic Rotated	X'2A48'	2
GECF (L,R)	Enter Character Mode Large Rotated	X'2A49'	2
GECF (S,R)	Enter Character Mode Small Protected	X'2A4A'	2
GECF (M,R)	Enter Character Mode Medium Rotated	X'2A4B'	2
GECP (B,R)	Enter Character Mode Basic Protected Rotated	X'2A4C'	2
GECP (L,R)	Enter Character Mode Large Protected Rotated	X'2A4D'	2
GECP (S,R)	Enter Character Mode Small Protected Rotated	X'2A4E'	2
GECP (M,R)	Enter Character Mode Medium Protected Rotated	X'2A4F'	2

Figure B-2. Character-Mode Orders

Notes:

1. The mnemonics shown are those used by Graphic Programming Services.
2. This order is an extension to the 2250 Model 3 order set.

Control-Mode Orders

The control-mode orders Figure B-3 on page B-3 provide a variety of functions that give flexibility to the overall flow of control and logic of the buffer program. The Start Regeneration Timer (GSRT) order synchronizes the display, keyboard, and light-pen actions with the standard 46 cps regeneration rate. The Load Immediate Attribute Register (GLAR) and Store Attribute Register (GSAR) orders set and access the attributes that control the intensity, line-type, and blinking of the displayed image. These attributes are set to standard (2250-compatible) values that is, solid, no-blink, and intensity 5, by the GSRT order.

Mnemonic	Graphic-Mode Order		Code	See Note
GNOP2	No-Op 2-Byte	2-byte class	X'2A80'	1
GEOS	End Order Sequence		X'2A81'	1
GSRT	Start Regeneration Timer		X'2A82'	1
GNOP4 (ADDR)	No-Op 4-Byte	4-byte class	X'2AC0'	1
GTRU (ADDR)	Transfer Unconditional		X'2AFF'	1
GSXY (ADDR)	Store X, Y Deflection Registers		X'2AEA'	1
GLAR (VALUE)	Load Immediate Attribute Register		X'2AD1'	2 & 3
GSAR (ADDR)	Store Attribute Register		X'2AD2'	2 & 4
GSBL(B)	Blank (Intensity Level 0)	2-byte class	X'2A90'	1,2,6
GSBL(D)	Dim (Intensity Level 3)		X'2A91'	1,2,6
GSBL(N)	Normal (Intensity Level 5)		X'2A92'	1,2,6
GSBL(B)	Bright (Intensity Level 7)		X'2A93	1,2,6
GTDD (ADDR)	Transfer on Deferred Detect	4-byte class	X'2AFC'	1
GTND (ADDR)	Transfer on No Detect		X'2AFD'	1
GTSO (ADDR)	Transfer on Switch Open		X'2AF5'	2 & 5
GMVA (ADDR, DATA)	Move Immediate Address	6-byte class	X'2AEB'	1
GMVD (ADDR, DATA)	Move Immediate Data		X'2AEC'	1

Figure B-3. Control-Mode Orders

Notes:

1. The mnemonics shown are those used by Graphic Programming Services.

2. This order is an extension to the 2250 Model 3 order set.

3. The GLAR order causes the Blink, Intensity, and Line Type attribute to be set according to values held in the second 2 bytes of the order. These attributes affect subsequent graphic-mode or character-mode orders until reset by a GSRT or another GLAR order. The format of the second 2 bytes (in bits) is:

   0000 vaaa vbbb vccc

   If v = 1, then the following 3 bits contain a new attribute value:

   aaa - Blink attribute, 000 = normal, 001 = blink

   bbb - Line Type attribute, 000 = solid, 001 = dotted

   010 = dashed, 011 = dot-dashed

   ccc - Intensity attribute, 000 = zero intensity, 111 = brightest

   101 = normal, all values allowed

   If v = 0, the corresponding attributes remain unchanged.

4. The GSAR order causes the current Blink, Intensity, and Line Type attributes to be stored at the location addressed by its second 2 bytes. It does not alter the attributes. The attributes are stored (in bits) in the following forms:

   0000 100a 10bb 1ccc

   where the attribute fields a, bb, and ccc are as described for the order GLAR.

5. The GTSO order causes a transfer to the specified address if the light pen tip switch was open when the preceding GSRT order was executed.

6. The GSBL buffer orders are supported only by the 3255 Model 2 Display Control Unit.

Light-Pen-Mode Orders

The light-pen-mode orders Figure B-4 determine whether or not the displayed data is sensitive to light pen detects with or without depression of the light-pen tip-switch; the orders determine also the reaction of the buffer program to light pen usage. These orders permit an interruption to be raised at the host system as the result of a light-pen detection, either immediately or following additional logic in the buffer program.

Mnemonic	Light Pen Mode Order		Code	See Note
GDRD	Defer Response to Detects	2-byte class	X'2A83'	1
GESD	Enable Switch Detect		X'2A84'	1
GDPD	Disable Pen Detects		X'2A85'	1
GENSD	Enable No-Switch Detect		X'2A86'	1
GPDI	Permit Detect Interrupt		X'2A87'	1

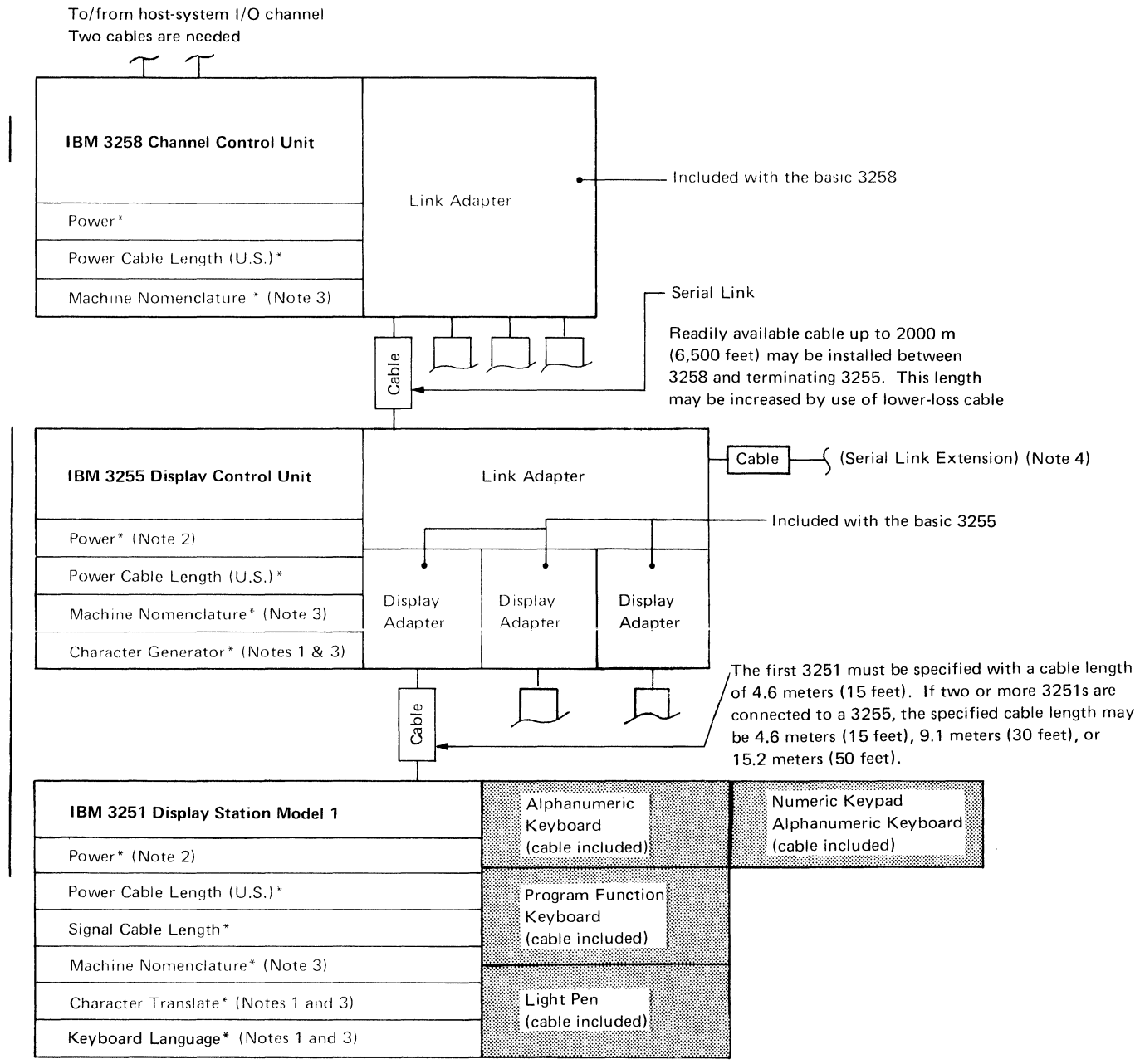
Figure B-4. Light-Pen-Mode Orders

Note: The mnemonics shown are those used by Graphic Programming Services.

Diagnostic Order

The order code X'2A10' is reserved for diagnostic use.

Appendix C. System Configurator



Legend:

* = Specify feature
▒ = Special feature

See Appendix D for other details.

Notes:

1. If an Alphanumeric Keyboard is stipulated, the 3255 and 3251 must be specified with the same character set for the Character Generator, Character Translate, and Keyboard Language features.

2. The 3255 and 3251 must be specified with the same Power feature and must be connected to the same supply phase.

3. For U.S. customers, the Machine Nomenclature feature and the character sets are English (U.S.).

4. A maximum of four 3255s may be attached on each serial link.

Figure C-1. Configurator for IBM 3250 Graphics Display System

Appendix D. Features List

Feature Name	See Notes	IBM 3258 Control Unit	IBM 3255 Display Control	IBM 3251 Display Station
Power (Canada and United States)				
Power, 115 V± 10% 60 Hz Locking Plug	1	S	S	S
Power, 115 V± 10% 60 Hz Non-Lock Plug	1	S	S	S
Power, 208 V± 10% 60 Hz Locking Plug	1	S	S	S
Power, 208 V± 10% 60 Hz Non-Lock Plug	1	S	S	S
Power, 230 V± 10% 60 Hz Locking Plug	1	S	S	S
Power, 230 ± 10% 60 Hz Non-Lock Plug	1	S	S	S
Power Cable Length, 1.8 meters (6 feet)	2	S	S	S
Power (Countries except Canada, served by IBM World Trade Corporation)				
Power, 100 V +8% -12.5% 50 Hz	1	S	S	S
Power, 100 V +8% -12.5% 60 Hz	1	S	S	S
Power, 110 V +8% -12.5% 50 Hz	1	S	S	S
Power, 115 V +8% -12.5% 60 Hz	1	S	S	S
Power, 123.5 V +8% -12.5% 50 Hz	1	S	S	S
Power, 200 V +8% -12.5% 50 Hz	1	S	S	S
Power, 200 V +8% -12.5% 60 Hz	1	S	S	S
Power, 208 V +8% -12.5% 60 Hz	1	S	S	S
Power, 220 V +8% -12.5% 50 Hz	1	S	S	S
Power, 230 V +8% -12.5% 50 Hz	1	S	S	S
Power, 230 V +8% -12.5% 60 Hz	1	S	S	S
Power, 240 V +8% -12.5% 50 Hz	1	S	S	S
Signal Cable Length (3255/3251)				
Cable Length 4.6 meters (15 feet)	3			S
Cable Length 9.1 meters (30 feet)	3			S
Cable Length 15.2 meters (50 feet)	3			S
(Continued on next page)				

Legend: S = Specify feature. O = Special (optional) feature

Notes:

1. The Power feature of a 3251 must be the same as that specified for the 3255 to which the 3251 attaches.

2. If the Power Cable Length feature is not specified, a cable of 4.3 meters (14 feet) length is supplied.

3. At least one 3251 on each 3255 must have a cable length of 4.6 meters (15 feet).

Feature Name	See Notes	IBM 3258 Control Unit	IBM 3255 Display Control	IBM 3251 Display Station
Machine Nomenclature	4 & 5			
English (U.K.)		S	S	S
English (U.S.)		S	S	S
French		S	S	S
German		S	S	S
Italian		S	S	S
Japanese		S	S	S
Swedish	9	S	S	S
Character Generator character set	4,5, and 6			
English (U.K.)			S	
English (U.S.)			S	
French			S	
German			S	
Italian			S	
Katakana			S	
Swedish	9		S	
Character Translate character set	4,5, and 6			
English (U.K.)				S
English (U.S.)				S
French				S
German				S
Italian				S
Katakana				S
Swedish	9			S
Keyboard Language character set	4,5, and 6			
English (U.K.)				S
English (U.S.)				S
French				S
German				S
Italian				S
Katakana				S
Swedish	9			S
Extended Keyboard Support				S
Alphanumeric Keyboard	5 & 7			O
Numeric Keypad Alphanumeric Keyboard	8, 9, & 10			O
Program Function Keyboard				O
Light Pen				A

Legend: S = Specify feature. O = Special (optional) feature. A = Accessory feature.

Notes:

4. The features are available to customers only in countries served by IBM World Trade Corporation.

5. For U.S. customers, the Machine Nomenclature feature and the character sets are English (U.S.).

6. The character set of a 3251 must be the same as that specified for the 3255 to which the 3251 attaches.

7. As a prerequisite for the Alphanumeric Keyboard feature, one of the following character sets must be specified for the Character Generator, Character Translate, and Keyboard Language: English (U.K.), English (U.S.), French, German, Italian, or Katakana.

8. The Numeric Keypad Alphanumeric Keyboard is supported only when attached to a 3251 Model 1 with the Extended Keyboard Support specify feature, that is, attached to a 3255 Display Control Unit Model 2.

9. The Swedish language keyboard is available only as a Numeric Keypad Alphanumeric Keyboard, and can only be specified for use with a 3255 Display Control Unit Model 2.

10. The Numeric Keypad Alphanumeric Keyboard is not available for the Italian language.

Glossary

This glossary defines terms and abbreviations, as applicable to the 3250 system, that are used in the publication. If you do not find the term you are looking for, refer to the index or to *IBM Data Processing Glossary,* GC20-1699.

IBM is grateful to the American National Standards Institute (ANSI) for permission to reprint its definitions from the *American National Standard Vocabulary for Information Processing* (Copyright c 1970 by American National Standards Institute, Incorporated), which was prepared by Subcommittee X3K5 on Terminology and Glossary of the American National Standards Committee X3. American National Standard definitions are preceded by an asterisk.

absolute coordinate. (1) A grid location having reference to the origin of the grid. (2) Contrast with *incremental coordinate.*

absolute point. An addressing method whereby a display point is defined by the coordinates of its reference grid location.

absolute vector. (1) An addressing method whereby a vector is defined by the coordinates of the absolute point at each end of the vector. (2) Contrast with *incremental vector.*

alphanumeric data. (1) Information presented in the form of letters, digits, and punctuation marks. (2) Contrast with *graphic data.*

alphanumeric keyboard. A typewriter-like keyboard with a character set that contains letters, digits, and usually other characters such as punctuation marks, special characters, and the space character. It may also have keys that perform special functions.

application. The way a customer chooses to use the 3250 Graphics Display System.

application program. A program written for or by a user that applies to a particular application.

audible alarm. An alarm that is activated when predetermined events occur that require operator attention or intervention for system operation.

Blink attribute. An attribute that may be assigned to a field to alternately suppress and enable the display of the field.

block multiplexer channel. (1) A multiplexer channel that interleaves blocks of data. (2) See also *byte-multiplexer channel.* (3) Contrast with *selector channel.*

block multiplexing. A method of interleaving blocks of data. In a block multiplexer channel, this method permits concurrent processing of multiple channel programs, thereby improving the efficiency of the channel during periods of device activity that do not need use of the channel.

buffer program. A set of orders in sequence that, when executed, produces a display on the cathode-ray tube, permits entry of keyboard data, and/or enables the light pen.

buffer refreshed. Pertaining to a displayed image that is maintained by repeated executions of a buffer program.

byte-multiplexer channel. (1) A multiplexer channel that interleaves bytes of data (2) See also *block-multiplexer channel.* (3) Contrast with *selector channel.*

cathode-ray tube (CRT). An electronic vacuum tube, such as a television picture tube, that can be used to display graphic images.

channel. (1) * A path along which signals can be sent, for example, data channel, output channel. (2) In System/370, a hardware device that connects the processing unit and main storage with the I/O control units.

character mode. (1) A mode of display operation whereby characters are displayed on the screen of a 3251 Display Station by way of a character generator in the 3255 Display Control. (2) Contrast with *graphic mode.*

character-mode order. An order that sets the 3255 Display Control Unit to character mode, and allows buffer program data to be displayed as alphanumeric characters.

command. A coded byte from main storage of the host system that specifies, to the channel and the 3258 Channel Control Unit, the operation to be performed.

computer graphics. (1) The technique whereby information may be converted to or from graphic display by use of a computer. (2) See *interactive computer graphics.*

control-mode order. An order that is executed by the 3255 Display Control Unit to control operations within the 3255.

cps. Regeneration cycles per second of a displayed image.

CRT. Cathode-ray tube.

cursor. An underscore character, displayed on the screen, that shows where the next entered character will be displayed.

diagnostic. * Pertaining to the detection and isolation of a malfunction or mistake.

directed beam. A technique whereby the constituents of a display image are generated or recorded by programming the deflection of the electron beam in the cathode-ray tube.

display. (1) * A visual presentation of data (2) To present a display image on a display surface.

display buffer. Buffer storage in the 3255 Display Control that contains the buffer program.

display image. Those elements, such as graphic or alphanumeric data, that are presented at any one time on the screen of a display device.

GAM. Graphics Access Method.

GAM/SP. Graphics Access Method/System Product.

GPS. Graphic Programming Services.

graphic data. (1) Information presented as electronically drawn symbols or lines. (2) Contrast with *alphanumeric data.*

graphic mode. (1) A mode of display operation whereby points, vectors, and shapes can be presented on the screen of the 3251 Display Station. (2) Contrast with *character mode.*

graphic-mode order. An order that sets the 3255 Display Control Unit to graphic mode, and allows buffer program data to generate lines (vectors) on the screen.

Graphic Programming Services (GPS). A component of OS/VS that provides an assembler language interface for programming for the 2250 and 3250. GPS includes graphics access method.

Graphic Subroutine Package (GSP). A component of OS/VS that provides a high-level language interface for programming for the 2250 and 3250.

Graphics Access Method (GAM). The component of GPS that provides the I/O programming interface, within OS/VS, for the 2250 and 3250.

Graphics Access Method/System Product (GAM/SP). An IBM program product that provides support for the 3250 Graphics Display System, and the 2250 Display Unit Model 3.

graphics display. The presentation of information in graphic or alphanumeric form on the face of a TV-like display tube.

GSP. Graphic subroutine package

hertz (Hz). A unit of frequency equal to one cycle per second.

host system. A data processing system to which a 3250 Graphics Display System is connected. The host system which comprises a computer, its programs, and its peripheral equipment, provides overall control of the 3250 system.

Hz. Hertz.

IBM Virtual Machine Facility (VM/370). A time sharing system control program that consists of (1) a control program (CP) that manages the resouces of an IBM System/370 computing system in such a way that multiple remote terminal users have a functional simulation of a computing system (a virtual machine) at their disposal; and (2) the conversational monitor system (CMS), which provides general time sharing, program development, and problem solving facilities.

IBM Virtual Machine/System Product (VM/SP). An IBM program product for time-sharing system control. See *IBM virtual machine facility*

image. See *display image.*

in.. Inch.

incremental coordinate. (1) An addressing method whereby the coordinates of a point are defined as a displacement from another point that is not the origin. (2) Contrast with *absolute coordinate.*

incremental vector. (1) An addressing method whereby the end points of a vector are defined as a displacement from the current beam position. (2) Contrast with *absolute vector.*

instruction. (1) * In a programming language, a meaningful expression that specifies one operation and identifies its operands, if any. (2) A program step that is executed by the processing unit of the host system.

Intensity attribute. An attribute that may be assigned to a field to govern the amount of light emitted by the electron beam in that field.

interaction. An operator action (for example, a light-pen action) that invokes a response from the host system.

interactive computer graphics. In the 3250 Graphics Display System, the technique of using a keyboard or the light pen of the 3251 Display Station to work with information displayed.

I/O. Input/output.

K. 1K = 1024 (that is 2^{10}); used in referring to storage capacity

light pen. A hand-held pointer that allows the operator to select a point or a field on the display surface of a cathode-ray tube.

light-pen-mode order. An order that sets the 3255 Display Control Unit to accept, defer, or reject interruptions raised by the operator using the light pen.

Line Type attribute. An attribute that governs the form (solid, dashed, dotted, or dot-dashed) of a displayed vector.

mm. Millimeter.

MVS. Multiple Virtual Storage. See *OS/VS2.*

order. (1) A number of coded bytes, contained in the buffer program, that specify an operation or mode of operation to the 3255 Display Control Unit. Orders are set up, by the programmer, in main storage of the processing unit and are treated as data by both the channel and the 3258 Control Unit. (2) See *character-mode order, control-mode order, graphic-mode order,* and *light-pen-mode order.*

OS/VS1. IBM Operating System/Virtual Storage 1.

PFK. program function keyboard.

OS/VS2. IBM Operating System/Virtual Storage 2.

PCU. Physical control unit.

physical control unit (PCU). A parameter of the IODEVICE macro instruction that identifies, to the system, which 3251 Display Stations share a common 3255 Display Control Unit.

Problem-oriented routine. A routine within a program that does not contain privileged instructions. For example, language translators and service programs, as well as programs written by a user.

program function keyboard. A keyboard whose keys are used only to pass signals to a program to call for a particular program operation. Contrast with *alphanumeric keyboard*

regeneration. The continual refreshing of the display on a cathode-ray tube to provide a visible image.

selector channel. (1) An I/O channel designed to operate with only one I/O device at a time. Once the I/O device is selected, a complete record is transferred one byte at a time. (2) Contrast with *block-multiplexer channel* and *byte- multiplexer channel.*

sense. Device-dependent coded data that defines the internal state of the device, normally during unusual conditions.

Single-element intensification (SEI). Single-element intensification is the brightening of a vector, character, or point at which a light pen is pointed without intervention from the host system.

V. Volt.

vector. A displayed line connecting any two addressable points.

VM/370. IBM Virtual Machine Facility/370.

Bibliography

The IBM publications described here give information of interest to readers. The IBM 3250 Graphics Display System is compatible with the IBM 2250 Display Unit Model 3, apart from the differences defined in Chapter 7; therefore any reference in these publications to the 2250 Model 3 is pertinent also to the 3250 system.

For information on I/O channels and on IBM System/370, refer to:

IBM System/360 and System/370 I/O Interface Channel to Control Unit: Original Equipment Manufacturers' Information, GA22-6974.

This publication provides the definitions and function descriptions of the interface lines for the I/O interface - channel to control unit. The publication also contains the electrical, mechanical, and cabling considerations and specifications of this interface.

IBM System/370 System Summary, GA22-7001.

This publication provides basic information about System/370 to enable readers to gain a general understanding of this data processing system, and the interrelationships of its components. More detailed information is given in *IBM System/370 Principles of Operation.*

IBM System/370 Principles of Opertion, GA22-7000.

This publication provides, for reference purposes, a detailed definition of the machine functions performed by System/370. Its contents are principally addressed to assembler language programmers, although it is of interest to anyone concerned with the functional details of System/370. It is not, however, an Introduction or a textbook for System/370.

For information on programming for the 3250 system with IBM operating systems and the IBM Virtual Machine Facility/370, refer to *OS/VS Graphic Programming Services (GPS) for IBM 2250 Display Unit and IBM 3250 Graphics Display System,* GC27-6971.

This publication describes macro instructions and routines provided for use with OS/VS to aid in writing assembler language programs that use the 2250 Model 1 or 3 or 3251. It also provides general programming information for the 2250 or 3250.

OS/VS Graphics Subroutine Package (GSP) for FORTRAN IV, COBOL, and PL/I, GC27-6973.

This publication describes how a FORTRAN, COBOL, or PL/I programmer can write graphic programs for use with the 2250 or 3250 under control of OS/VS. It also describes how the graphic subroutine package may be used in a program written in assembler language.

OS/VS1 System Generation Reference, GC26-3791.

This publication supplies the information for generating an OS/VS1 System Control Program adapted both to the machine configuration and data processing requirements of an installation.

OS/VS1 Storage Estimates, GC24-5094.

Two types of reader are envisaged for this publication: system programmers and problem programmers. It contains instructions, formulas, and charts that can be used to estimate the real, virtual, and auxiliary storage requirements for VS1.

OS/VS1 Planning and Use Guide, GC24-5090.

This publication describes the facilities, features supported, and principles of operation of VS1, and suggestions on how to make the most effective use of the system. Information is provided on how to implement, modify, or extend the capabilities of the VS1 Control Program.

OS/VS2 System Programming Library: System Generation Reference, GC26-3792.

Primarily intended for system programmers, this reference publication provides information needed to plan and install an OS/VS2 system control program and a JES2 job entry subsystem.

OS/VS2 System Programming Library: Storage Estimates. GC28-0604.

This publication describes the real, virtual, and auxiliary storage areas of VS2 Release 2, and provides formulas for estimating the storage requirements for the system.

OS/VS2 System Programming Library: Initialization and Timing Guide, GC28-0681.

This publication contains information on the following general topics: system parameters in SYS1. PARMLIB;JES2 initialization parameters; how to use the System Resource Manager (SRM); how to use the System Activity Measurement Facility (MF/1); and system performance factors.

IBM Virtual Machine Facility/370: Introduction, GC20-1800.

This manual introduces VM/370, and defines the minimum equipment configuration necessary to execute it. The manual is prerequisite reading for a proper understanding of *IBM Virtual Machine Facility/370: Planning and System Generation Guide.*

IBM Virtual Machine Facility/370: Planning and System Generation Guide, GC20-1801.

This publication is intended for those persons responsible for the planning and installation of a VM/370 system. It is of special interest to graphics-display subsystem users because it contains planning and system generation information.

IBM Graphics Access Method/System Product: General Information, GC33-0125.

This publication is an introduction to the Graphics Access Method/System Product (GAM/SP). It describes the functions of GAM/SP, and explains how the product can be used with the IBM 3250 Graphics Display System, and the IBM 2250 Display Unit Model 3.

IBM 3250 Graphics Display System: Installation Manual - Physical Planning, GA33-3036.

This publication details the information required by a customer to prepare for the installation of an IBM 3250 Graphics Display System. It specifies permissible environmental conditions, power supply requirements, cable types and maximum lengths of cable runs, physical dimensions and weights of the units of the system. In addition, it includes both Metric and Imperial scale templates to assist in planning the spatial aspects of an installation.

IBM 3250 Graphics Display System: Component Description, GA33-3037.

This publication provides an in-depth explanation of the principles of operation of a 3250 system. It includes the software aspects of buffer programming, buffer orders, channel commands and I/O instructions. It includes examples of buffer routines, discusses programming techniques, and details system generation. It also contains an explanation of the operator controls. Appendixes give summaries of both absolute and incremental coordinates, character codes, buffer orders, channel commands, and status-sense combinations.

IBM 3250 Graphics Display System: Custom Features Summary, GA33-3086.

This publication provides an overview of the custom features available for the IBM 3250 Graphics Display System. It states the prerequisites needed for the installation of the various custom features, details their implementation, describes possible system configurations, and reviews any possible impact on the software.

Requests for the above publications should be made to your IBM representative or to the IBM branch office serving your locality.

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IBM® Technical Newsletter

OCT 17 1984

This Newsletter No. GN33-3229
Date August 1984

Base Publication No. GA33-3035-3
File No. S370-06

Prerequisite Newsletters None

An Introduction to the
IBM 3250 Graphics
Display System

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This Technical Newsletter provides replacement pages for the subject publication. Pages to be inserted and/or removed are:

v - viii	
ix, x	(text rearrangement only)
1-5, 1-6	
1-7, 1-8	(text rearrangement only)
X-7 - X-10	
X-11, Blank	(text rearrangement only)

Technical changes are indicated by a vertical line to the left of the change.

Summary of Amendments
Information has been added to address compatibility between the IBM 5080 Graphics System and the 3250 Graphics Display System.

Note: *Please file this cover letter at the back of the manual to provide a record of changes.*

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