Systems

IBM 3270
Information Display System:
Color and Programmed Symbols

IBM 3278 Display Station Models 2, 3, and 4
IBM 3279 Color Display Station Models 2A, 2B, 3A, and 3B
IBM 3287 Printer Models 1, 2, 1C, and 2C

IBM

Systems

IBM 3270
Information Display System:
Color and Programmed Symbols

IBM 3278 Display Station Models 2, 3, and 4
IBM 3279 Color Display Station Models 2A, 2B, 3A, and 3B
IBM 3287 Printer Models 1, 2, 1C, and 2C

IBM

Preface

This publication provides introductory information on color in the IBM 3270 Information Display System. It describes the IBM 3279 Color Display Station and the IBM 3287 Printer Models 1C and 2C. The publication also provides introductory information on the Programmed Symbols features that are available on these and some other 3270 system devices.

The publication is intended primarily for customers' DP managers and system analysts, and IBM marketing representatives and system engineers. The publication is also intended for customers' operations personnel and IBM education personnel.

After the *Introduction,* the publication is divided into three parts: *Part 1* deals with color and the color devices; *Part 2* deals with the Programmed Symbols features; and *Part 3* provides configuration and setup information.

The reader is assumed to have a general knowledge of the IBM 3270 Information Display System. Some IBM publications that the reader may find useful, or which are referred to in the text of this publication, are listed below.
* *An Introduction to the IBM 3270 Information Display System,* GA27-2739.
* *IBM 3270 Information Display System: Component Description,* GA27-2749.
* *Introduction to Programming the IBM 3270,* GC27-6999.
* *Graphical Data Display Manager (GDDM) and Presentation Graphics Feature (PGF): General Information,* GC33-0100.

Examples appear in this manual that include the names and addresses of individuals. All of these names and addresses are fictitious and any similarity to the names and addresses used by actual individuals is entirely coincidental.

The colors that appear in the illustrations in this manual are not necessarily precise representations of the colors that will be produced by the IBM 3279 Color Display Station and the IBM 3287 color printers.

Contents

Figures

THIS PAGE INTENTIONALLY LEFT BLANK

Frontispiece. IBM 3279 Color Display Station

Chapter 1. Introduction

The IBM 3279 Color Display Station (see Frontispiece) and the IBM 3287 Printer Models 1C and 2C provide color capability for the IBM 3270 Information Display System.

In addition, features known as Programmed Symbols are available on some models of the color devices and on some other 3270 devices.

This publication describes 3270 color and the Programmed Symbols features.

Color

The color capability is available at two different levels: Extended Color and Base Color.

On the 3279 Color Display Stations, Extended Color offers seven colors: red, blue, green, white, yellow, pink, and turquoise. Base Color offers four colors: red, blue, green, and white.

On the 3287 Printer Models 1C and 2C, Extended Color and Base Color both offer four colors: red, blue, green, and black. However, Extended Color gives full data stream compatibility for programs using Extended Color on 3279 Color Display Stations.

Extended Color allows color to be applied both to whole fields and to individual characters within fields, independently of any other attributes of the data. It also allows the terminal operator to enter the color of data at the terminal keyboard.

On both the 3279 Color Display Station and the 3287 color printers, Base Color can produce color from existing programs with little or no reprogramming. This is achieved by determining color from the existing field protection and intensity attributes. Base Color thus offers the user ease of entry into color display and color printing of data.

Color is Normal

Color is normal, not only in nature but in most modern methods of communication. It is nowadays taken for granted at the movies, on television, in photography, and in publishing. Our eyes and brains are accustomed to it. So if we use color in computer devices, we are making the man-machine interface more natural. The more natural this interface is, the more happily and confidently we may expect to work. We should make fewer errors and be more productive.

Inevitably, as the technology has become available to produce efficient color devices, color will begin to replace monochrome in computer applications. The introduction of color into the IBM 3270 system may thus be seen as a natural step.

The Advantages of Color

The first advantage of using color has already been stated: it is more normal and natural to work with a variety of colors than to work in monochrome. But color is more than simply pleasing; it has practical advantages in computer applications. These advantages derive mainly from the fact that the use of color is a very efficient way of coding, or categorizing, information for human users. By presenting data in computer displays or printouts in appropriate colors, we can draw attention more easily to selected items. We already use several different techniques - underscoring, highlighting, capital letters, and the layout of data - to differentiate between separate categories of data. The additional use of color as a distinguishing agent greatly increases the number of different categories that people can cope with simultaneously.

Just as color can be used to distinguish different items, so it can be used to link related items in the display or printout. For example, if a terminal operator enters or changes a data item that will affect other data items in the display, the affected data items can be programmed to change color in a way that at once relates cause and effect.

Programmed Symbols

The IBM 3279 Color Display Station, IBM 3278 Display Station, and the IBM 3287 Printer can be equipped, as optional features, with one or more sets of Programmed Symbols.

The Programmed Symbols features enable users to define their own special characters, symbols, or shapes. Examples of special characters and symbols include foreign language letters, mathematical and scientific symbols, and special type fonts such as bold and italic. These are all essentially alphameric applications of Programmed Symbols. The user can also define shapes or patterns that, when combined with other such shapes in adjoining character positions on the screen or printed page, will create a graphic representation.

The Advantages of Graphics

When numerical or statistical data is presented in a purely numerical form, many people find it difficult to understand. For this reason, charts and graphs are commonly used in business meetings and technical reports. The Programmed Symbols features enable the user to include graphic representations in computer displays and printouts.

Using Programmed Symbols features, application programs will be able to display and print data in a variety of graphic forms such as graphs, bar charts, pie charts, and histograms. Utilities that will convert numeric data into various chart forms are provided by an IBM program product known as Graphical Data Display Manager (GDDM), which is described in Chapter 9.

Extended Highlighting

Extended Highlighting is the term used for the facilities for presenting fields or characters underscored, blinking, or in reverse video on display devices (underscored only on printers). Like color, extended highlighting helps to draw attention to selected items in a display. Blinking, particularly, is useful for attracting the terminal operator's attention to exception conditions or error messages.

Extended highlighting is referred to in this manual in the context of the color devices that are the principal subject. However, extended highlighting is also available on the 3278 Display Station Models 2, 3, and 4 and on the 3287 Printer Models 1 and 2.

Other Functions

In addition to color, extended highlighting, and optional graphic capability, the 3279 Color Display Stations offer generally equivalent and compatible function to the 3278 Display Stations.

The 3287 Printer Models 1C and 2C provide, in addition to color, extended highlighting, and optional graphic capability, generally equivalent and compatible function to the 3287 Models 1 and 2, respectively.

Part 1. The 3279 Color Display Station and the 3287 Color Printer

Chapter 2. Product Descriptions

This chapter describes first the IBM 3279 Color Display Station and then the IBM 3287 Printer Models 1C and 2C.

The 3279 Color Display Station

The 3279 Color Display Station is a tabletop display device using a high-resolution color cathode ray tube (CRT) display.

Two levels of color are available:

● Extended Color Mode - provides seven different colors, using the extensions to the 3270 Data Stream (described in Chapter 3).
● Base Color Mode - provides four different colors, which can be produced by existing 3270 application programs with little or no reprogramming.

Extended Color

Using Extended Color, the 3279 Color Display Station allows fields or individual characters to be displayed in any of seven different colors: red, blue, green, white, yellow, turquoise, and pink. It also offers a choice of underscore, blink, or reverse video for highlighting. Special symbols and graphic representations of data can be displayed in color using the Programmed Symbols features, which are described in Part 2.

Base Color

To facilitate entry into the use of color, Base Color produces color displays from existing 3270 application programs with little or no reprogramming. Fields can be displayed in red, blue, green, or white. Field color is determined by the four combinations of the field protection and intensity attributes (as described in more detail in Chapter 3).

Models

The 3279 Color Display Station is offered in four models:

● Models 2A and 3A offer Base Color only. Extended Color, Extended Highlighting, and APL/Text are not available on these models.
Model 2A - 1920 characters in 24 rows of 80 characters.
Model 3A - 2560 characters in 32 rows of 80 characters.
● Models 2B and 3B offer both Base Color and Extended Color. These models also offer Extended Highlighting and APL/Text capability.
Model 2B - 1920 characters in 24 rows of 80 characters.
Model 3B - 2560 characters in 32 rows of 80 characters.

When operating in 3277-compatible format, the 3279 Models 3A and 3B will display 1920 characters in 24 rows of 80 characters.

Attachment

The 3279 is a member of the 3270 Information Display System. It can be used in clusters with the IBM 3274 Control Unit or the IBM 3276 Control Unit Display Station, in combination with 3278 Display Stations and 3287 and 3289 Printers. On the 3274 Control Unit, the 3279 can also be used in combination with IBM 3277 Display Stations and IBM 3284, 3286, and 3288 Printers.

For Base Color only: All models of the 3279 can be attached to any model of the 3274 Control Unit; 3279 Models 2A and 2B can be attached to all models of the 3276 Control Unit Display Station except Model 1; and 3279 Models 3A and 3B can be attached to all models of the 3276 except Models 1 and 2. On the 3274, the Color Display Control customization option must be selected. The 3276 must have the Color Display Attachment feature, which in turn requires the 3276 Extended Function Base feature.

For Extended Color: 3279 Models 2B and 3B can be attached only to the 3274 Control Unit (excluding 3274 Model 1B). In addition to Color Display Control, the 3274 must have the Structured Field and Attribute Processing customization option for Extended Color or Extended Highlighting.

To use the APL/Text capability of the 3279 Models 2B and 3B, the 3279 must be attached to either (1) a 3274 Control Unit with the APL/Text Control customization option, or (2) a 3276 Control Unit Display Station with the APL/Text Control feature. (APL/Text is not supported by 3274 Model 1B.)

Attachment to the 3274 Control Unit is with a Type A Terminal Adapter only. The maximum cable length from the terminal to the control unit is 1500 meters (4920 feet).

For further configuration details, refer to Chapter 10.

Product Description

The 3279 Color Display Station uses a three-gun, high-resolution, shadow-mask cathode ray tube of 356-millimeter (14 inch) diagonal.

On all models, characters are displayed within a 9 X 12 point matrix, and the basic 26 uppercase letters are within a 7 X 9 point matrix. The character set consists of 94 characters: 26 uppercase alphabetic, 26 lowercase alphabetic, 10 numeric, and 32 special characters. A monocase switch provides the capability of switching to uppercase alphameric mode for 3277 compatibility. All models of the 3279 use the 3270 field formatting capability, which permits individual data fields on the screen to be defined with various attributes, such as protected or unprotected, alphameric, displayable or nondisplayable, and selector light pen detection allowed or disallowed.

The 3279 Models 2B and 3B in conjunction with the extensions to the 3270 Data Stream and the appropriate 3274 customization options provide the following additional field and character attributes:

- Extended Color: red, blue, green, white, yellow, turquoise, and pink.
- Extended Highlighting: underscore, blink, and reverse video.

Each attribute can be specified independently of any other. The attributes can be set by the application program or selected by an operator from an appropriate keyboard (when permitted by the application program).

An important factor in picture quality on color displays is the precision with which primary colors can be overlaid to produce secondary colors. This is termed color convergence. The 3279, in conjunction with the control unit to which it is attached, provides a simple procedure for setting up and maintaining color convergence. The procedure can be carried out by an operator using only the keyboard and referring to a special pattern that is displayed on the screen. This procedure is usually necessary only at intervals of several months or after the display station has been relocated.

Apart from its color capability and other enhanced function, described above, the 3279 Color Display Station offers generally equivalent and compatible function to that provided on an appropriately configured 3278 Display Station, in the following areas:

- Keyboard functions such as cursor movement, tabbing, insertion, deletion, and erasing.
- Program function keys.
- Input flexibility, provided by a choice of keyboards and the selector light pen.
- Optional Magnetic Slot Reader.
- Optional Magnetic Hand Scanner (3274 attachment only).
- Local display-to-printer copying capability.
- Security functions, such as suppressed display and security keylock.
- Extended Highlighting.
- Programmed Symbols.
- APL/Text.
- Problem Determination procedures.

On the 3279, an audible alarm is provided as standard. The alarm sounds whenever a character is entered into the next-to-last position on the display screen. The alarm can also be activated under program control to alert the operator to a special condition. The volume of the alarm can be controlled by the operator.

Customer Setup (CSU)

The 3279 Color Display Station is designated as a customer-setup device, thereby offering the customer early availability, and flexibility in relocating the device.

The customer is responsible for providing an adequate and prepared site, and for setting up the 3279 by following the CSU instructions.

CSU procedures provide step-by-step instructions for positioning, setting up, and checking out each machine.

3279 Color Display Station - Specify Features

The following listing describes the Specify features for the 3279 Color Display Station.

Power: Display stations in the United States operate with 120 V, 60-Hz power. Units available through IBM World Trade Corporation can operate from one of several different power sources. See Chapter 11 for additional information.

Machine Nomenclature: Nine selections are available for IBM World Trade countries: Brazilian, Canadian French, English (U.K.), English (U.S.), French, German, Italian, Japanese, and Spanish-speaking.

Keyboard Language: Many keyboard languages are available for IBM World Trade countries. The keyboard language selected must be the same as the character set language on the 3276.

3279 Color Display Station - Special Features

The following listing describes the Special features for the 3279 Color Display Station.

Security Keylock: This feature provides keylock control over the display station and all attached devices such as the selector light pen, keyboard, and magnetic slot reader. With the lock closed, the terminal will not be available to the host system program, the data on the display screen is blanked out (except for the Operator Information Area), and attached devices are inoperative.

Switch Control Unit: This feature permits switching control of the display station between two different control units.

Selector Light Pen: The hand-held, light-sensitive pen enables the operator to interact directly with the display by selecting appropriately designated character fields. Selections may be either immediate or deferred, with deferred selections causing a visual indication that the field was selected. Versions are available for both 3279 screen sizes.

Keyboard Numeric Lock: This feature is used in conjunction with a keyboard to provide a means of alerting the operator to a keying error. During a numeric operation, this feature inhibits keyboard input operations whenever the operator attempts to enter alphabetic data without purposely overriding the feature. With this feature installed, if any key other than numerals 0 through 9, minus (-), decimal sign, or duplicate (DUP) is pressed, the keyboard is electrically locked. Once inhibited, keyboard input operations can be resumed only after the operator presses the RESET key at the keyboard. The feature is available as a customization option for the Attribute Selection and Overlay keyboards described below and in Chapter 6.

Note: *On Austrian/German, Belgian, Danish, French, Italian, Norwegian, Portuguese, and Spanish keyboards with the Numeric Lock feature installed, the comma (,) is the decimal sign.*

Magnetic Reader Control: This feature provides the capability of attaching a Magnetic Slot Reader or a Magnetic Hand Scanner.

Programmed Symbols: Two features provide storage and accessing for up to six 190-symbol sets whose characters, symbols, or shapes can be defined by the customer. Symbol sets are loaded under program control and accessed for display through programming or by an operator from the display keyboard. The Programmed Symbols features are described in detail in Part 2 of this manual.

Keyboards

The following keyboards are offered:

75-Key EBCDIC Typewriter Keyboard: This keyboard has 49 data keys and 26 control keys. Twelve program function (PF) keys are included in the keyboard.

75-Key EBCDIC Data Entry Keyboard: This keyboard has 35 data keys, 10 PF keys, and 30 control keys.

75-Key EBCDIC Data Entry Keyboard, Keypunch Layout: This keyboard has 35 data keys, 10 PF keys, and 30 control keys.

75-Key ASCII Typewriter Keyboard: This keyboard has 49 data keys and 26 control keys. Twelve PF keys are included in this keyboard.

87-Key EBCDIC Typewriter Keyboard: This keyboard has 49 data keys, 26 control keys, and 12 PF keys (on the right-hand side of the keyboard). The 12 PF keys included in the keyboard plus the additional 12 PF keys allow program support of 24 PF keys.

87-Key ASCII Typewriter Keyboard: This keyboard has 49 data keys, 26 control keys, and 12 PF keys (on the right-hand side of the keyboard). The 12 PF keys included in the keyboard plus the additional 12 PF keys allow program support of 24 PF keys.

76-Key Japanese English Typewriter Keyboard: (IBM World Trade Americas/Far East Corporation[1]). The 76-key Japanese English keyboard has 49 data keys and 27 control keys, in addition to the 12 PF keys included in the top row of data keys.

76-Key Japanese Katakana Typewriter Keyboard: (IBM World Trade A/FE). The 76-key Japanese keyboard, which provides 4-level shift capability, has 49 data keys and 27 control keys. Twelve PF keys are included in the top row of data keys.

76-Key Japanese Katakana Data Entry Keyboard: (IBM World Trade A/FE). This keyboard, which provides 4-level shift capability, has 49 data keys and 27 control keys, in addition to 10 PF keys.

88-Key Japanese English Typewriter Keyboard: (IBM World Trade A/FE). The 88-key Japanese English keyboard has 49 data keys, 27 control keys, 12 PF keys

---

[1] Henceforth termed 'IBM World Trade A/FE' in this chapter.

included in the top row of data keys, and an additional 12 PF keys which allow program support of 24 PF keys.

88-Key Japanese Katakana Typewriter Keyboard: (IBM World Trade A/FE). The 88-key Japanese Katakana keyboard, which provides 4-level shift capability, has 49 data keys, 27 control keys, 12 PF keys integrated into the top row of data keys, and an additional 12 PF keys which allow program support of 24 PF keys.

88-Key Japanese English/Japanese Katakana Typewriter/APL Keyboard: (IBM World Trade A/FE). The 88-key Japanese English/Japanese Katakana keyboard has modified keytops to allow entry of 81 APL-specific characters in addition to the basic character set (Japanese English or Japanese Katakana). An APL On/Off key controls whether the keyboard is in APL or basic character set mode. In contrast to the 88-key Japanese English/Japanese Katakana Typewriter keyboard without APL, this keyboard has only 12 program function keys (PF1 through PF12), which are the group of 12 keys to the right of the main keyboard area.

87-Key EBCDIC Typewriter/APL Keyboard: This is an 87-key EBCDIC Typewriter keyboard with modified keytops to allow entry of 81 APL-specific characters in addition to the 94-character EBCDIC set. An APL On/Off key controls whether the keyboard is in basic EBCDIC typewriter or APL mode. In contrast to the 87-key EBCDIC Typewriter keyboard without APL, this keyboard has only 12 program function keys (PF1 through PF12), which are the group of 12 keys to the right of the main keyboard area.

87-Key EBCDIC Typewriter/Text Keyboard: This is an 87-key EBCDIC Typewriter Keyboard with modified keytops to allow entry of 65 Text-specific characters in addition to the 94-character EBCDIC set. A Text On/Off key controls whether the keyboard is in EBCDIC typewriter or Text mode. In contrast to an 87-key EBCDIC Typewriter keyboard without Text, this keyboard has only 12 program function keys (PF1 through PF12), which are the group of 12 keys to the right of the main keyboard area.

Attribute Select Keyboards (3279 Model 2B or 3B to 3274 Attachment Only)

In some applications, the terminal operator may be required to enter the color and highlighting attributes of data. Selection of these attributes is provided on the following 87-key and 88-key keyboards using shift and alternate modes on the group of 12 PF keys at the right-hand side of the keyboard.
- 87-Key EBCDIC Attribute Select Typewriter Keyboard.
- 87-Key EBCDIC Attribute Select Typewriter/APL Keyboard.
- 88-Key Attribute Select Japanese English/Japanese Katakana Typewriter Keyboard.
- 88-Key Attribute Select Japanese English/Japanese Katakana Typewriter/APL Keyboard.

Except for the color marking and annotation on the right-hand group of PF keys, the Attribute Select keyboards are identical to the equivalent non-Attribute Select keyboards.

Overlay keyboards that are designed for use with programmed symbols and which also provide attribute selection keys are described in Chapter 6.

3279 Color Display Station - Accessories (Purchase Only)

The following accessories are available for the 3279 Color Display Station.

Magnetic slot reader: The magnetic slot reader accommodates a wide range, both in height and length, of magnetic striped card stock and plastic badges, including: job tickets, magnetic striped 80-column cards, operator identification badges, large and small credit cards, and so on.

Magnetic hand scanner: The magnetic hand scanner allows the user to read magnetic stripe labels that are attached to shelves, cartons, machines, and so on. It can also be used to read magnetic stripe tags which are hand-held or placed on a flat surface.

The 3287 Printer Models 1C and 2C

The 3287 Printer Models 1C and 2C provide the capability of printing in four colors - red, blue, green, and black. They also provide function equivalent to and compatible with the 3287 Models 1 and 2 (except that the Models 1C and 2C cannot be attached to a 3271 or 3272 Control Unit). The remainder of this chapter describes only those features of the 3287 Models 1C and 2C that are additional to the function provided by the Models 1 and 2.

The printer is offered in two models:

- Model 1C – 80-characters per second (cps) maximum print rate for each color on a line.
- Model 2C – 120-cps maximum print rate for each color on a line.

Product Description

The 3287 Printer Models 1C and 2C use a replaceable, multicolor ribbon cartridge. Print positions 1-120 can be printed in any of the four colors red, blue, green, and black. Print positions 121-132 can be printed only in black. A replaceable, all-black ribbon cartridge is also available.

The basic printer (without special features) prints fields in one of four colors, determined by the existing field protection and intensity attributes. Specify features allow the user to choose whether to mirror the colors used by the 3279 (with black on the printer equivalent to white on the 3279), or to reverse the roles of green and black. The features are described below; the way that colors are determined is described in detail in Chapter 3.

When the printer is equipped with the Extended Character Set Adapter, and the extensions to the 3270 data stream (described in Chapter 3) are used, color attributes can be applied to individual characters or whole fields. The Extended Color attributes are interpreted by the printers as follows:

Color attribute in data stream	Color printed on 3287 Models 1C and 2C
Neutral	Black
Red	Red
Blue	Blue
Green	Green
Pink	Black
Yellow	Black
Turquoise	Black

Attachment

The 3287 Models 1C and 2C can be attached to the 3274 Control Units and 3276 Control Unit Display Stations.

Enhanced function features (Extended Color and Programmed Symbols) are available only when attached to the 3274 Control Unit (excluding 3274 Model 1B).

Attachment to the 3274 Control Unit is to a Type A Terminal Adapter only. The maximum cable length from the terminal to the control unit is 1500 meters (4920 feet).

3287 Printer Models 1C and 2C - Specify Features

The following listing describes the Specify features for the 3287 Printer Models 1C and 2C.

Base Color - Black: This feature specifies that when in Base Color mode the printer

will print in black where the 3279 displays in green (or when the equivalent 3270 attribute byte code is received by the printer). The printer will then print in green where the 3279 displays in white (or when the equivalent 3270 attribute byte code is received).

Base Color - Green: This feature specifies that when in Base Color mode the printer will print in green where the 3279 displays in green (or when the equivalent 3270 attribute byte code is received by the printer). The printer will then print in black where the 3279 displays in white (or when the equivalent 3270 attribute byte code is received).

Heavy-Duty Blower: This feature is a cooling blower that must be specified when a 3287 Model 1C or 2C is being operated in an environment whose temperature ranges between 32.2°C (90°F) and 40.5°C (105°F).

Character Set - EBCDIC or ASCII: An EBCDIC or ASCII character set must be specified. The character set specified must be the same as the character set used on the control unit to which it is attached. ASCII is mutually exclusive with SNA Character String (SCS) and APL/Text.

Variable-Width Forms Tractor - Paper Handling: This feature needs to be specified when the Variable-Width Forms Tractor has been selected and there is a need to handle forms from 76.2 mm (3 in.) to 203.2 mm (8 in.) wide.

SCS (SNA Character String) Support: This feature provides the capability of receiving an SCS data stream from the host system. Full buffer usage in SCS support varies according to the 3274 or 3276 to which the printer is attached, and programming considerations. Color printing is not supported for SCS data streams.

X Print Error Indication: This feature prints an error graphic X on the line immediately below the last print line of a data buffer when the printer is operating in 3270 data stream mode and detects a parity error.

Character Print Operation: 960-, 1920-, 2560-, 3440-, or 3564- character print must be specified.

Power: Printers in the United States operate with 120 V, 60-Hz power. Units available through IBM World Trade Corporation can operate from one of several different power sources. See Chapter 11 for additional information.

Machine Nomenclature: Eight selections are available for IBM World Trade countries: Brazilian, Canadian French, English, French, German, Italian, Japanese, and Spanish-speaking.

Character Set Language: Many character set languages are available for IBM World Trade countries; however, character set languages on attached display stations and printers should be the same as the character set languages on the 3276.

3287 Printer Models 1C and 2C - Special Features

The following listing describes the Special features for the 3287 Printer Models 1C and 2C.

Variable-Width Forms Tractor: This is a forms-feeding device for continuous margin

punched forms from 7.6 cm (3 in.) to 38 cm (15 in.) wide. Up to six-part forms with a total thickness of 0.457 mm (0.018 in.) may be used. Five- and six-part continuous forms should be tried on an individual basis for acceptable feeding, registration, and print quality.

Friction Feed Paper Handling: This feature must be specifed on all 3287s without the Variable-Width Forms Tractor. A customer using the Variable-Width Forms Tractor has the option of ordering friction-feed paper handling once per machine. This feature friction-feeds single-part non-preprinted continuous-roll or fanfold paper [minimum width is 20.3 cm (8 in.); maximum width is 37.5 cm (14.78 in.)]. Included in this feature is a paper tear bar for tearing continuous forms, approximately 6.4 cm (2.5 in.) from the last line printed. An operator can interchange this feature with the Variable-Width Forms Tractor if Variable-Width Forms Tractor Covers were ordered.

Extended Print Buffer: This feature provides an additional 2K buffer storage (4046 bytes total), which allows 2560-, 3440-, or 3564-character print operations. This feature is a prerequisite for using the Programmed Symbols features.

Extended Character Set Adapter (ECSA): Provides the additional control and buffering necessary both for the extended character set in the APL/Text feature and for the field and character attributes for Extended Color, Extended Highlighting, and Programmed Symbols.

APL/Text: This feature, with its prerequisite Extended Character Set Adapter feature, enables the 3287 to print (with modified user application programs) the 222 APL/Text character set, including the 94-character EBCDIC set.

Programmed Symbols: Three features provide storage and accessing for up to six 190-symbol sets whose characters, symbols, or shapes can be defined by the customer. Symbol sets are loaded under program control and accessed for printing through programming. The Programmed Symbols features are described in detail in Part 2 of this manual.

3287 Printer Models 1C and 2C - Accessory (Purchase Only)

The following accessory is available for the 3287 Printer.

Forms Stand: This accessory permits continuous forms to be placed on a stand above floor level and provides for forms-stacking after printing.

Chapter 3. Color Capability

Introduction

Two levels of color are available:

- *Extended Color Mode* provides seven colors on displays and four on printers. In extended color mode, color is a new attribute to be associated with data fields or characters. Programs must be written (or modified) to include the new color attribute. The color attribute is not confined to output data: the display terminal operator can select the colors to be associated with the characters that are entered, provided that the application designer so permits and the appropriate keyboard has been installed.
  Extended color is available on the 3279 Models 2B and 3B and on the 3287 Printer Models 1C and 2C when equipped with the Extended Character Set Adapter.

- *Base Color Mode* provides four colors on both displays and printers. In base color mode, the colors are controlled through the existing field attributes of protection and intensity. All existing programs that use these attributes will thus produce color.
  A base color control (described later) determines whether the machines produce base colors or run in monochrome mode. Display stations and printers that are featured for use with extended color will produce base color or work as monochrome machines if extended color has not been used in a particular picture.

Extended Color

New Attribute Types

The IBM 3270 Information Display System currently provides format control by data field. A data field is established when a field attribute control code is written in the first position of a field. The field attribute, which is written by the program, uses a single character position that is displayed or printed as a blank and serves as a separation between successive fields. The characteristics controlled by these field attribute codes include:

- Protected (fixed format).
- Unprotected (variable input data).
- Intensity (not displayed or printed/normal/intensified).
- Alphameric input.
- Numeric input (auto shift).
- Auto lock.
- Auto skip.
- Selector pen detectable.
- Tab stop.

When screens and printers are programmed using these codes, they are described as being *formatted*. If no field attribute codes are used, the layout is said to be *unformatted*.

Enhancements to the 3270 system increase the number of attribute characteristics that can be associated with a field by adding two new attribute types: extended color and extended highlighting. In addition, these two new attributes can be associated either with whole fields or with individual characters. (A third new attribute - the symbol set attribute - is described in Chapter 7.) None of these additional attributes occupy positions in the display or printout.

The extended color attributes that are available are:

On 3279 2B and 3B   *On 3287 1C and 2C*

Neutral (White)   Neutral (Black)
Red   Red
Blue   Blue
Green   Green
Pink
Yellow
Turquoise

When none of these color attributes is in use, the default color on the screen is green, unless a field has the intensified attribute, in which case it is white. The default color on the printer is black. Alternatively, base color mode can be used, as described later in this chapter.

The extended highlighting attributes that are available are:

On 3279   *On 3287 1C and 2C*

Underscore   Underscore
Blinking
Reverse Video

When none of these attributes is in use, the default is no extended highlighting.

These new attributes, when specified for a field, apply to all the characters in the field except those characters that have been given attributes of their own explicitly.

Controlling the New Attributes

For managing these new attributes three new orders and one new command have been added to the 3270 control functions:

- The *Start Field Extended* order, like the existing Start Field, defines a new field; it allows the color and highlighting characteristics of a field to be set.
- The *Modify Field* order allows the programmer to change selected attributes of a field without the need to respecify those that are to remain unchanged.
- The *Set Attribute* order allows the programmer to specify the new attributes of color and highlighting for individual characters. This order works in a modal manner: in other words, all characters that are sent to a device following a Set Attribute of, say, 'Color = Red' will have the red character attribute until the end of the write or the next Set Attribute for color.
- The *Write Structured Field* command provides a general mechanism for conveying command-like functions called structured fields in the data stream to a terminal. These structured fields can be used by a program either to interrogate a device to establish its characteristics, such as whether it supports color, or to instruct the device on whether the new attributes of color and highlighting should be included in data sent from the terminal to the host computer and whether the operator can select these attributes when entering data.

These extensions to the 3270 control functions will be available only on 3274 Control Units (except Model 1B), and will be fully documented in a revision of the *IBM 3270 Information Display System: Component Description*, GA27-2749. The extended functions can be sent only to terminals properly configured to handle them. However, such terminals will accept and correctly execute programs that do not use the new function.

Remote applications with these extended functions using BSC line discipline require the BSC transparent mode of transmission, so that any combination of bits can be handled.

Operator Control and the New Attribute Types

Several of the keys used by the operator have additional function on displays equipped for the new attributes because of the need to manage any color or highlight attribute associated with a particular character:

- The CLEAR, ERASE EOF, and ERASE INPUT keys currently provide erasing functions by setting to null any character position on the display image affected by the key. These keys will also clear any of the new attributes associated with the characters.

- The DELETE key currently allows characters to be deleted from a field, and all characters in the same field and on the same line following the point of deletion are shifted left. Any character color or highlighting attributes present are deleted or shifted in the same way as the characters with which they are associated.

- The INSERT key currently allows characters to be inserted into a field, and all characters in the same field following the point of insertion are shifted right. The INSERT key will move any color or highlighting attributes associated with the shifted characters and will create new attributes for the inserted character. Except when the operator is allowed to specify color or highlighting and does so, these attributes will have default values, and any attribute specified for the field as a whole will control the inserted characters.

- All data keys will set the color and highlighting attributes of characters entered from the keyboard as follows. If the application designer has enabled color and highlighting selection by the operator, and the operator actually selects these attributes, the attributes entered will apply. Otherwise, the default values will apply to individual characters, and the attributes specified for the whole field will control the characters.

In certain special applications including, for example, the design of colored output, a terminal operator may need to enter the color and highlighting attributes of data from the keyboard. The Attribute Select and Overlay keyboards described in Chapters 2 and 6 are available for such applications. Figure 3-1 illustrates the attribute selection keys on the 87-key EBCDIC Attribute Select Typewriter Keyboard.
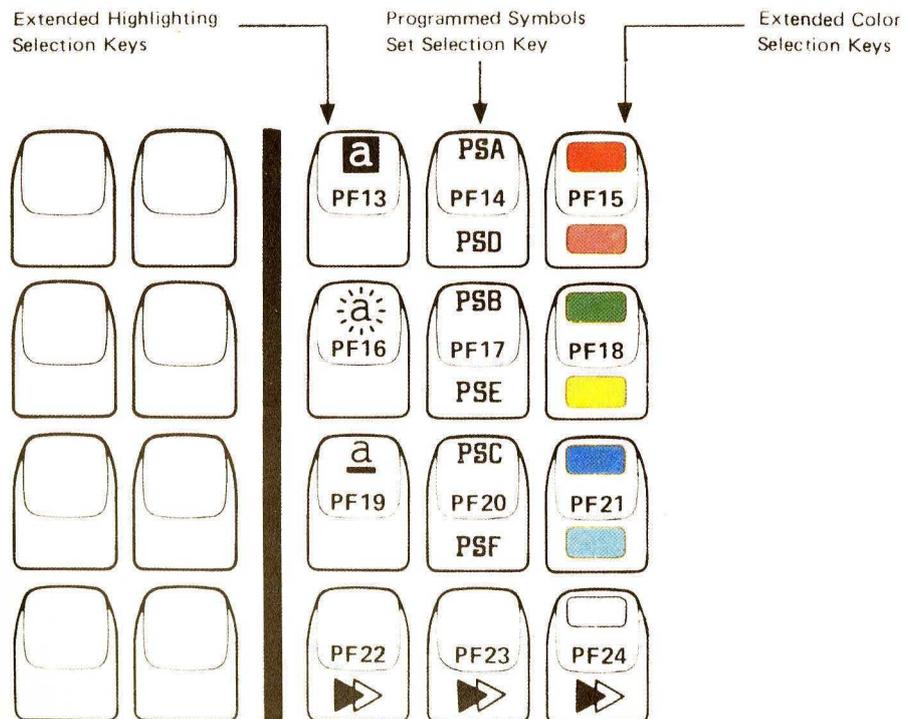

Figure 3-1. Attribute Selection Keys of the 87-Key EBCDIC Attribute Select Typewriter Keyboard

The operator chooses the color and highlighting required for the data that is being entered by using the upper and alternate shifts of these keys (provided always that the programmer has allowed use of this facility). Attributes selected with these keys apply to all characters subsequently entered until the operator makes another selection or the program inhibits use of the facility.

Printing the New Attributes

The new attributes that are available on the 3287 Models 1C and 2C are described in the section above headed 'New Attribute Types.' In designing applications to use these printers, the system designer should consider the following functional characteristics of these machines:

- Although only four colors (black, red, blue, and green) are available on the printer, data streams specifying all the extended colors are accepted by the printer: yellow, turquoise, and pink are printed in black.
- Although there are 132 usable character positions in the print line (as in the equivalent monochrome models), only the first 120 positions can be printed in red, blue, or green. The remaining 12 character positions will always print in black, though the color attributes will, of course, remain associated with fields or characters in these positions.
- The new attributes of color and highlighting can be copied from a display station to a printer using the BSC copy command, the copy function of the 3274, and operator-initiated print. A match of function between the display station and the printer is not essential: the best copy possible will be produced, given the facilities available on the printer. When extended functions are being used, the BSC copy command can be used only to copy from a display station to a printer.
  The 3274 Printer Authorization Matrix can be used to associate display stations and printers for the 3274 copy function and operator-initiated print.
- The highlighting techniques of blinking and reverse video are unavailable on a printer. A program can send these attribute values to a printer, but they will have no effect. The highlighting attribute of underscore can be used on a printer. On the 3287 Models 1C and 2C it is restricted, like color, to the first 120 print positions.
- The operator can install on the 3287 Models 1C and 2C an all-black cartridge in place of the color cartridge. Making this change will not prevent the printer from accepting color attributes sent to it by a program, but all printing will be in black only, and the multiple passes of the print head required for color printing will be suppressed. It is recommended that the all-black cartridge is used whenever color printing is not needed.
- The new attributes of color and highlighting cannot be used in SCS data streams from the host.

Using the New Attributes with the 3278 Display Station

When the 3278 is equipped with the Extended Character Set Adapter Feature, it can receive the new attribute types. The highlighting attribute values of underscore, reverse video, and blinking will display as on the 3279. The color attribute values can be stored in the device and read from it but they will not affect the displayed picture.

In addition to offering the designer the highlighting facility in monochrome programs, this compatibility between the 3278 Display Station and the 3279 Color Display Station means that programs can be written that will run on either type of device, provided that they have equivalent screen sizes and features.

System Performance using the New Attributes

The system designer must take many factors into account when considering a transaction design and the effect of it upon system performance. The following extra considerations apply when color and highlighting are used:

- Programs that read and write the new attributes will send more data over the telecommunication network than a similar program that does not use them. Also, the amount of processing done by these programs will tend to be greater. On the

other hand, it may be possible to use the new attributes in such a way as to reduce the number of pictures and fields that are needed in an application, and hence reduce the amount of data that is transmitted.

• The 3287 Printers Models 1C and 2C, when using the color cartridge, require separate passes of the print head for each color used on a line. In comparison with black or monochrome printing, throughput will be reduced when printing in more than one color as a function of the number of color changes on the page. Refer to the section 'System Performance with Programmed Symbols,' in Chapter 7, for details of potential extra print-head passes that can result from printing programmed symbols.

Base Color

Associating Color with the Protection and Intensity Attributes

Using extended color involves altering existing programs or writing new ones to include the new attributes, as well as installing the necessary models and features of the terminals and the appropriate releases of IBM software, as described in Chapter 5.

For some applications, a system of color that is less comprehensive but easier to introduce will be suitable.

Base color mode allows all programs that have been written for 3278 Display Stations and 3287 Printers Models 1 and 2 to execute in color on the equivalent 3279 or 3287 1C or 2C, provided these programs use the field attribute control codes of protection and intensity. Color will be produced as follows:

Protection	Intensity	Resulting Color	
		3279	3287 1C and 2C
Protected	Intensified	White	Black or green*
Unprotected	Intensified	Red	Red
Protected	Normal	Blue	Blue
Unprotected	Normal	Green	Green or black*

* Depending on the Base Color Specify feature ordered with the printer - see Chapter 2.

When field attribute control codes are not used (*unformatted* layouts), the 3279 will display all characters in green; the 3287 Models 1C and 2C will print in black.

In base color mode, the protected and unprotected field attribute control codes still determine whether the input data format is fixed or variable; color is only a secondary effect of the codes. Consequently, programming in these colors may be restricted by the way in which the logic of an application program needs to use protection codes.

Because the field attribute control codes govern base color, the colors apply only to whole fields. It is not possible with this system to give different colors to separate characters within a field or to use color in unformatted layouts.

Printing using base color mode is limited by the following:

• As with extended color, only the first 120 character positions of the 132 character print line of the 3287 Models 1C and 2C can be used to print in color.

• Color printing is not available in SCS data streams from the host.

• The 3287 Printers Models 1C and 2C, when using the color cartridge, require separate passes of the print head for each color used on a line. In comparison with black or monochrome printing, throughput will be reduced when printing in more than one color as a function of the number of color changes on the page.

**Operator Control
Capabilities with Base Color**

The following operator control capabilities are available on the 3279 and the 3287 Models 1C and 2C in addition to those that are provided on the 3278 and 3287 Models 1 and 2:

- *Base Color Control.* On the 3279, a base color switch selects either base color or monochrome mode. On the 3287 Models 1C and 2C, the same effect is achieved through the 'Set Alternate'/'Set Function' procedure, in a similar way to setting the maximum print positions. In base color mode, the 3279 and the 3287 Models 1C and 2C will produce color from the protection and intensity field attribute control codes, as described in the preceding paragraphs. In monochrome mode, the 3279 displays all data on the screen in green except for intensified fields, which show in white; the 3287 Models 1C and 2C print in black.
  The operator may use the base color control to select monochrome mode:

  —If color machines are being used for work normally done on monochrome machines.
  —If the base colors produced by an existing monochrome program do not suit the user's requirements.
  —If the installation has adopted extended color as its standard system, and base color is not in use.

  Base color and extended color can never be used in the same image. For any particular image, the use of extended color suppresses base color, regardless of the position of the base color control. As a result, the use of any extended color attribute within an image means that any character or field for which no color is specified will adopt the monochrome default of the display device or printer.
- *Copying.* Images that are copied using the BSC copy command, the copy function of the 3274, or operator-initiated print will be displayed or printed in base color or monochrome mode according to the setting of the base color control on the device that produces the copy.
- *All Black Cartridge.* On the 3287 Models 1C and 2C, the operator can install an all-black cartridge in place of the color cartridge. The all-black cartridge should be used whenever color printing is not needed.

Chapter 4. Color Applications

Color, both in nature and in modern methods of communication (television, movies, printing), is the normal way in which we see the world. Our senses and perceptual mechanisms are accustomed to it.

If we can involve more of our normal perceptual mechanisms in communicating with computers, we are likely to work more comfortably, quickly, and confidently. We should make fewer errors and be more productive.

The Advantages of Color in Computer Applications

The prime advantage of using color has already been stated: it is more normal and natural to work with a variety of colors than to work in monochrome. The two main practical applications of color are complementary to one another: to distinguish and to relate.

Color to Distinguish

The use of color is a major addition to the existing mechanisms for distinguishing one piece of information from another. We already use different fonts, sizes, and positions to distinguish different categories of information. We further distinguish by the use of underscoring, high intensity, and by the new extended highlighting techniques of blinking and reverse video, all of which are helpful for emphasizing or drawing attention to selected information. With the 3279 Color Display Station, we can use all these techniques plus color. Color is probably a more powerful distinguishing device than any of those previously mentioned; when used in conjunction with them, it greatly increases the range of distinctions that can be made.

Color to Relate

Just as color can be used to distinguish different items or categories of information, it can be used to relate similar ones. By using the same color, we can demonstrate a logical relationship between separate items of information on a display.

To take a simple example from an insurance application, suppose that a customer wishes to change one of the terms of his automobile insurance policy, the number of drivers insured. Both that item and the resultant change in premium could be displayed in the same new color. The two related pieces of information would then stand out clearly from all the other, unchanged, data. Color would thus have been used to relate cause and effect.

Apart from operator satisfaction, almost every advantage and application of color can be categorized as either distinguishing or relating items of information. However, the potential advantages within these major categories are not always obvious, so some aspects are expanded below.

Data Distinction and Comprehension

Because data presented in color is easier to separate, it is easier to comprehend. An operator rarely needs to read all the data on a display, usually only sections of it. The distinctions that color allows makes recognition of particular fields easier and quicker.

Differentiation is typically necessary between:
- Headings and data.
- Individual figures and totals.
- Historical data and forecasts.
- Budget (or plan) figures and actual performance figures.

Color extends the user's ability to differentiate at a number of different levels simultaneously. Some other applications for this facility are:
- Data sources: The terminal operator may need to be able to distinguish clearly between data that has been entered, program-generated data, data held on file, messages from the system, and so on.
- Data types: The terminal operator may need to be able to distinguish clearly between headings, field names, data as originally entered, data entered and since changed, instructions from the program, and so on.

- Data codes: In applications where the information being displayed is categorized using a numeric code, about seven coded categories are the most that can be readily handled by a human operator. If an additional categorization coded in color is introduced, the user can handle about six categories in each dimension and thus about thirty-six altogether.

Exception and Error Conditions

Color can often be more effective than other methods, such as underscoring or high intensity, for drawing the operator's attention to exception conditions. Further, the choice of color available offers a range of coding levels, which can be matched to the severity or importance of the exception condition.

Similarly, a color change indicating an error condition is likely to be more effective than a conventional error message in gaining the operator's attention. Different colors can be used to indicate the severity of particular error conditions.

Error avoidance is, of course, preferable to error correction. The use of well designed color screen formats can lead to a reduction in operator errors in comparision with the same application performed on a monochrome screen.

In some applications, error messages can be eliminated or greatly reduced, because a color change alone is enough to identify the type and position of an error. The operator does not need to read a message and then search the screen for the error before correcting it. Productivity could thus be improved.

Fewer errors could result in fewer error messages. Host transactions could be reduced, and operator productivity increased.

If an error is more easily identified, the time taken to correct the error will be reduced.

Terminal Monitoring Applications

The use of color displays for monitoring critical processes, and in military operations, is well established. However, there are many less critical monitoring applications where color can be used with advantage. For example, terminals are used in control consoles, in reservation systems, and in other environments where the operator spends some of the time keeping an eye on the display but at the same time carrying out other tasks. In these situations, the use of color to draw attention to a change in status can be very effective. Color can, of course, be used to augment traditional techniques such as blinking messages; but a colored change of status is probably easier to read than a blinking message.

Operator Guidance

Terminal operators can benefit from a guidance system that uses color. Such a system can be especially useful in guiding casual users, non-DP professional staff, and members of the general public who may have to use a terminal. Apart from the direct benefit in ease of operation, there may be a further gain through reduced training time. Some ways in which color might be used to guide operators are:
- To indicate where to enter the next data item by displaying the appropriate field name in a different color from the others. Once the data has been correctly entered, the field name can revert to the normal color, and a new field name can be shown in the different color; the operator is thus led through the data entry sequence.
- To distinguish optional fields from mandatory fields.
- To identify the area on the screen that tells the operator what must be done next. A color could be assigned for this purpose, and the operator might as a result be able to move much more rapidly through a particular transaction or inquiry sequence.

Operator Satisfaction

The potential productivity gains outlined in the foregoing sections may be further enhanced by the improved operator satisfaction that can result from well designed color screen formats. This operator satisfaction arises in various ways. For example:

- Color used properly is more pleasing to the eye than monochrome data, and generally makes the display more interesting.
- An operator making fewer mistakes is likely to be happier and more productive.
- The use of color is likely to increase the acceptance of display terminals by end users.

New Applications

Some potential computer applications may be regarded as impractical using monochrome terminals. This is especially likely to have been the case where color is an essential aspect of the existing (manual) method of doing the job.

Examples include applications involving colored scheduling charts or utility diagrams. In everyday commercial applications, color may sometimes be essential to render complex tabular data intelligible. Color brings the opportunity of integrating these low-productivity chart-drawing tasks into the rest of the application. The advantages of consistent and well presented data, as well as the improved productivity resulting from the use of computer devices to generate the charts, can now be realized.

Examples of Color Applications

Many early users of 3279 color displays will be using base color with existing application programs, which may not have been modified in any way. The first of the examples that follow illustrates the way that such a color display might appear, and goes on to show how some small changes in the use of the protection and intensity attributes can enhance the color display.

Auto Policy Inquiry

Figure 4-1 shows a data display produced by an auto insurance inquiry and update application. The policyholder's details appear at the top, and details of the cars insured and their insurance ratings appear below. The figure shows the display as it would appear on a 3279 with the base color switch in the monochrome position. All fields are in green with the exception of a warning message that is intensified and thus appears in white.

Figure 4-1. Auto Policy Display in Monochrome

Figure 4-2 shows the display that would result from switching the 3279 base color switch to the base color position. In order to demonstrate, in subsequent illustrations, the possibilities of tuning base color displays, it has been assumed that all fields in this display were given the protected attribute, in addition to which, as already mentioned, the warning message field has the intensified attribute. As a result of these attributes, most of the display appears in blue, with the warning message highlighted in white.
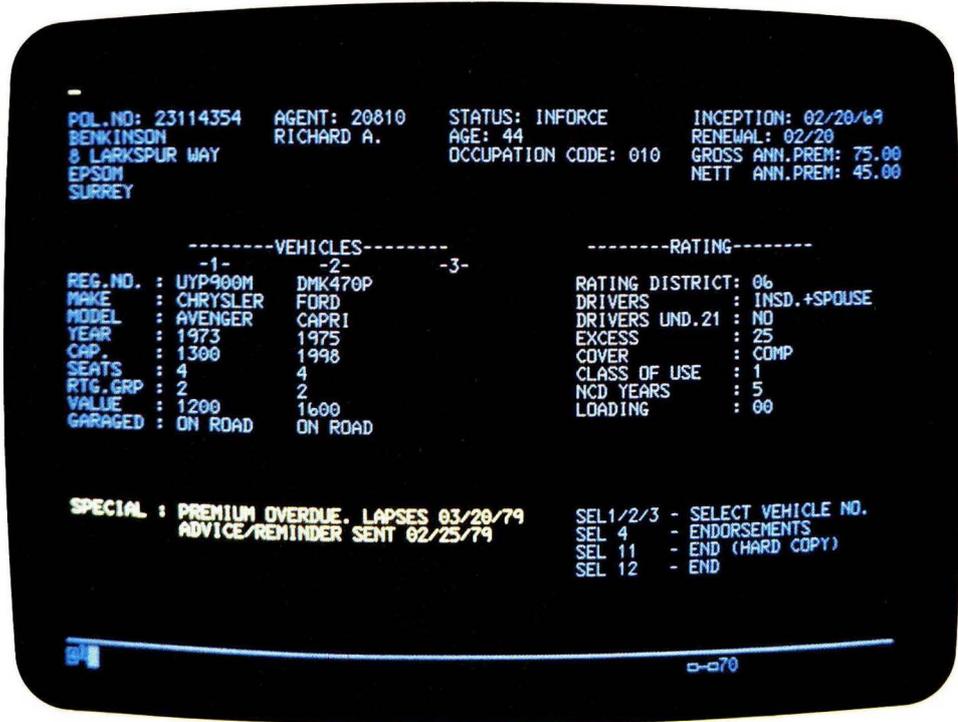
Figure 4-2. Auto Policy Display in Base Color without Tuning

The display contains headings, inquiry data, control information, and a warning message. The first level of improvement that can be made is to distinguish variable data from headings. This can be done without altering the protected status of the variable fields, simply by adding the intensified attribute to those fields. As a result, the variable data fields now become white, while the headings remain blue. This is shown in Figure 4-3.
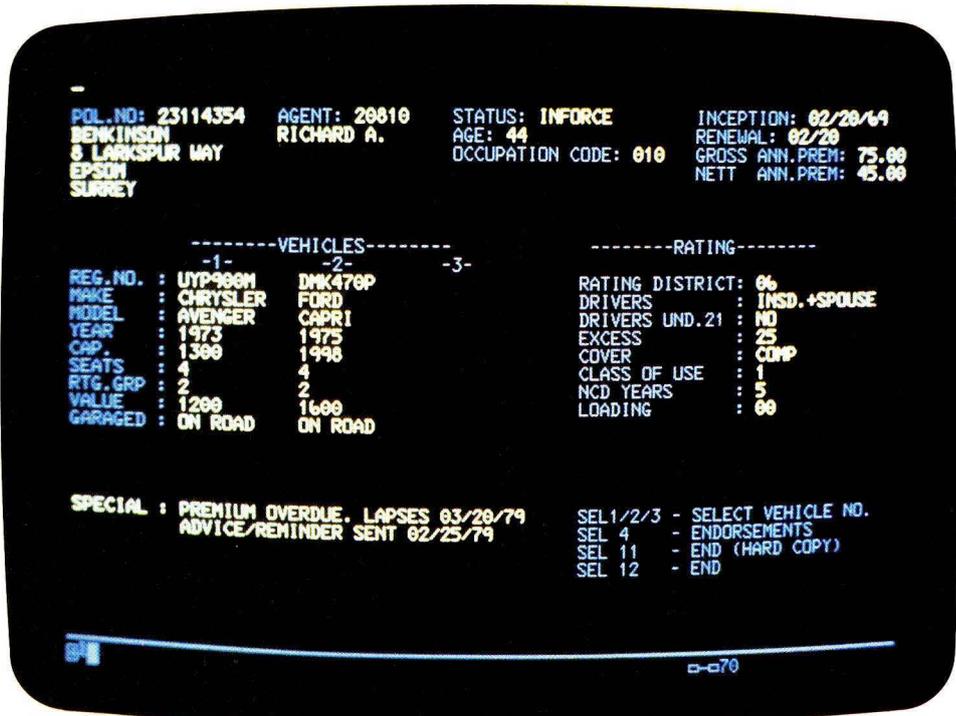
Figure 4-3. Auto Policy Display with Some Color Tuning

A second level of color tuning has been applied to the display illustrated in Figure 4-4. The protected attribute has been removed from headings, from the word 'SPECIAL' in the warning message, and from some of the control data. As a result, the headings and the control data are in green, the word 'SPECIAL' has become red, but the warning message has remained protected but not intensified and thus appears in blue.

Figure 4-4. Auto Policy Display with Further Color Tuning

In the preceding examples, it was assumed initially that all fields had the protected attribute. This assumption was made in order to illustrate progressively the various degrees of tuning that can be carried out. In practice, a greater degree of variation in the use of the protection and intensity attributes is likely to be encountered, and so some of the tuning described above may not be necessary.

The use of color for formatting and highlighting has improved the appearance and legibility of the display in the foregoing examples. Nevertheless, in practice compromises may have to be made between required colors and field protection when using base color mode. For example, if it were necessary to protect every field in a display, the colors red and green could not be used. Furthermore, with a limit of four colors, conflict can occur between the use of particular colors for formatting and highlighting.

Extended color mode provides additional colors and gives control of color that is independent of other field attributes. Figure 4-5, the final example in the auto policy series, assumes a migration to extended color.

Three colors - green, white, and blue - are used to separate different types of field. Because of its significance as a warning color, red has been used for the warning message.

A further use of color - its abilty to indicate relationships - is shown in Figure 4-5. It is assumed that the insured has telephoned to request that his cover is extended from the 'Insured and Spouse' driver category to 'Any' driver (including drivers under 21). The operator has entered the requested change (through another display frame, not illustrated), and is now redisplaying the policy details frame.

A fifth color, yellow, is being used to highlight all details that have been affected by the change in cover: the driver categories, the excess payment, and the revised annual premium details.

Figure 4-5. Auto Policy Display in Extended Color

The illustrations above have shown the use of base color, the effect of the base color switch, and the use of additional color from the extended color mode. Within these illustrations, the following applications of color have been used:

- *Distinguishing:* The use of different colors for heading fields and data fields made it easy to separate them, thereby improving the legibility of the display.
- *Highlighting:* The use of red and yellow to highlight messages and changes.
- *Relating:* The use of yellow in Figure 4-5 demonstrates the way that a single color can be used to relate fields, in this case all the policy details that are affected by a change in one of those details.

Telephone Equipment Application

Figures 4-6 through 4-9 illustrate the use of extended color in a telephone equipment ordering application.

The customer requires an additional telephone to be installed in his apartment. The operator will be prompted in color for the customer's name and address. Mandatory fields will be shown in red, optional fields in yellow. Initially, only the first field is color highlighted: Figure 4-6 shows the mandatory 'CUST NAME' field in red.

Figure 4-6. Telephone Equipment Application - Initial Prompt

The next display is shown in Figure 4-7. The headings 'STREET NUMBER' and 'TYPE' appear in yellow because these fields are optional. The first mandatory field is no longer highlighted by being in red; instead, red is used for the next mandatory field that must be completed, the street 'NAME' field.

Figure 4-7. Telephone Equipment Application - Optional and Mandatory Fields

Figure 4-8. Telephone Equipment Application - Color to Indicate the Data Source

In Figure 4-8, in response to the 'NAME' prompt, the operator has entered an abbreviated street name, 'SEM'. Figure 4-8 shows the application program's response to this abbreviated entry. A selection of possible addresses from a data base is displayed in turquoise, which has been chosen to represent data supplied by the program rather than the operator. The red prompt at the foot of the display tells the operator to choose the correct address.

The final display in this sequence, Figure 4-9, shows the result of the operator's selecting an address. Not only is the selected address highlighted, by being shown pink, but also the apartment 'TYPE' field is in pink. This is to indicate to the operator that the application program has made an assumption about the apartment type.

Figure 4-9. Telephone Equipment Application - Color to Relate Data

The foregoing four illustrations have shown further ways in which the use of color can save time and reduce errors. The use of color to lead the operator through a data entry sequence is important. Temporary color changes were used to show mandatory and optional data entry steps. Color was also used to identify the source of information that originated from the program, and to relate an assumption made by the program to a selection made by the operator.

Work Scheduling Application

Figure 4-10 shows a more complex display resulting from a work-scheduling application.

The display shows jobs that are awaiting processing in a machine shop. Jobs are listed in Order Number sequence, with various other items of information such as quantity, set up and run times, and status. The data current on day 134 has been compared with the required completion date, by the application program. Jobs that are pending are highlighted by being displayed in yellow, while those that are late are in red.

Figure 4-10. Color to Clarify a Complex Display

This example has shown how color can help the operator when a data display contains a high density of information. Color makes it possible to highlight different degrees of exceptional status thereby improving the efficiency of the operator, who must single out key pieces of information.

Design Considerations for Color

When starting to use color in computer display devices or printers, the user might well begin by considering how color is used in non-computerized areas of the enterprise. The use of colored pens or markers may be consistent and well established, especially in technical areas. Such well established usage should, if at all possible, be continued and extended in the use of color displays. In financial applications, the use of red is well established and would almost certainly require continuity in computerized applications. Typewriters may use multicolor ribbons whose colors have well established meanings. Color coding may already exist in hardcopy input documents.

Establishing Color Standards

The design of individual data layouts within an application needs to be carried out according to the standards that the customer's analysts and programmers establish for the use of color. In establishing these standards, designers should consider not only the existing uses of color, but also potential future uses. They should also bear in

mind such factors as the need to highlight, distinguish, or relate, and the likely or known preference of the operators who must use the devices.

In base color mode, freedom in establishing color standards is limited by the way that color is linked to the protection and intensity attributes. In particular, the need to protect data is likely to be the overriding consideration.

Guidelines on the Use of Color

The following paragraphs contain some guidelines on the use of color on the 3279 and the 3287 color printers. These guidelines should be considered in conjunction with any other appropriate sources of guidance, for example, the results of the user's own pilot studies, before the conversion or creation of application programs begins. The guidelines are divided into three main areas of color usage: formatting, highlighting, and warnings.

Formatting

Green is probably the most generally suitable color for large areas of data because of its monochrome compatibility and wide general acceptance. In addition, it may be specified efficiently using the monochrome default.

Blue is a suitable low contrast color to use with green to separate headings and data fields. White and other brighter colors may be used when higher contrasts are needed, but will be most effective if used sparingly. White should not be used if it is likely to be confused with high intensity characters or fields, which will also appear in white on the 3279, if not explicitly given another color. In general, the brighter colors will be more suitable for highlighting and warnings.

Highlighting

Color adds to the capability provided by extended highlighting (blinking, reverse video, and underscore). Color can be used in conjunction with or as an alternative to extended highlighting. Care should be taken not to confuse or irritate operators by, for example, unnecessarily blinking a colored field. In many applications, a color change will alone be sufficient to attract the operator's attention.

White, yellow, and pink are good highlighting colors. They will be most effective when used to highlight small parts of much larger fields of contrasting color, for example, green or blue.

Warnings

There are typically two rather different situations in which the application program issues warnings to the terminal operator.

Most systems and applications issue occasional warning messages to the user to indicate such conditions as lack of further storage, or end of file. The user will typically be involved in a procedural session at the terminal, so a warning message in red or yellow, for example, is likely to be seen immediately.

The second case is the monitoring type of application mentioned earlier, where the operator's attention is shared between the terminal and other tasks. In such cases it may be important to catch the operator's attention as quickly as possible. Again, such colors as red and yellow are particularly suitable, possibly reinforced by one of the extended highlighting techniques.

Red and yellow tend to be associated with warnings because these colors are used in automobile traffic control lights, instrument warning lights, and so on.

The recommended colors for warnings are therefore red, yellow, and possibly pink. It may be useful to grade the severity of warnings by color allocation, for example:

Severe warnings   — Red
General warnings   — Yellow
Noncritical warnings   — Pink

The order shown here is to some extent arbitrary. An application designer should make the final judgment.

Printed Output for Color Applications

IBM printers, whether high-speed line printers in data-processing centers or slower line printers or terminal printers at remote locations, provide mainly monochrome hard copy. However, the use of color display devices affects printing requirements; many of the advantages that have been described for color displays are applicable to hard copy. Decisions must therefore be made on how to print data from color display applications, such as whether to:

● Print in monochrome, perhaps using such techniques as underscoring and overprinting to compensate for the lack of color.

● Use the 3287 color printers.

The 3287 Models 1C and 2C offer four colors, which equate to the colors available on the 3279 Color Display Station as shown in Figure 4-11.

Extended Color Mode	
3279 Color Display Station	*3287 Printer Models 1C and 2C*
Red	Red
Green	Green
Blue	Blue
Neutral (White)	Neutral (Black)
Turquoise	Black
Pink	Black
Yellow	Black
Default: Green with White for Intensified	*Default:* Black

Base Color Mode			
Field Attributes	*3279 Color Display Station*	*3287 Printer Models 1C and 2C*	
		Specify Feature: Base Color—Black	*Specify Feature: Base Color—Green*
Protected and Intensified	White	Green	Black
Unprotected and Intensified	Red	Red	Red
Protected and Normal	Blue	Blue	Blue
Unprotected and Normal	Green	Black	Green

Figure 4-11. Relationship between Displayed and Printed Colors

As Figure 4-11 shows, red, green, and blue are common to display devices and printers. It is desirable that the colors used for highlighting data in hard copy should match those used in displays. The uses of red, green, and blue on displays should therefore be chosen with their potential compatible usage on printers in mind.

If hard copy is of prime importance, the use of colors on the printer should receive first consideration, and the use of colors on the display should be made compatible with the hard copy.

If base color mode is to be used, the question of which base color option is to be specified for the 3287 is likely to depend on whether the user's requirements for printed output are for the closest possible match with the display colors (perhaps using the Copy function), or for predominantly host-directed printing with black as the norm. (Note that whichever base color option is specified, unformatted buffers print in black.)

The Human Aspect

In considering the use of color in an application, designers should not ignore the nature of the relationship between the operator and the display device. Factors such as whether an operator uses the display continuously or infrequently, whether the type of use is mainly inquiry, data entry, or monitoring, all potentially influence the color design. Regular or continuous users are likely to prefer a subtle use of color. Intermittent users, on the other hand, may well prefer a stronger use of color; they require more prompting and clearer guidance.

However, color should not be used simply to make displays pretty. Overuse of color leads to confusion.

Considering the Future Use of Color

The 3279 Color Display Station provides base color to facilitate the use of color with existing application programs, with little or no reprogramming. In many cases, base color will be adequate for immediate purposes. Nevertheless, the time may come when the user wishes to extend his applications and when extended color becomes desirable. It is thus worthwhile considering at the outset the way that extended color would be used, even if only base color will be used initially.

Chapter 5. Programming Support For Color

This chapter provides information about programming support for incorporating 3279 Color Display Stations and the color models of the 3287 Printer into 3270 system configurations. The chapter is arranged in three parts:
1. Compatibility considerations for the 3279 and the 3287 Models 1C and 2C.
2. The support that will be provided by IBM host programming.
3. Considerations for customer written programs.

Compatibility Considerations

The 3279 Color Display Station and the 3287 Printer Models 1C and 2C when attached to a 3274 or a 3276 control unit provide the same appearance to programs as do the 3278 and the 3287 Models 1 and 2 for all functions and features that do not depend for their operation upon the extensions to the 3270 Data Stream.

Thus host programming subsystems that previously supported the 3278 and 3287 attached to a 3274 or 3276 will support the 3279 and the 3287 Models 1C and 2C as follows:
- When the 3279 or the 3287 Model 1C or 2C is running with the base color control set for monochrome, or when the 3287 Model 1C or 2C is loaded with an all-black ribbon, the device will operate as if it were the equivalent monochrome device.
- When the 3279 is running with the base color switch set for color, or the 3287 Model 1C or 2C is running with base color enabled and is loaded with a four-color ribbon, base color will be produced according to the field protection and intensity attributes in the data stream (as described in earlier chapters).

The display and printing of images in base color mode may call for changes to customer written programs for optimum use of color; these considerations are discussed in the third part of this chapter and in Chapter 4 above. In addition, the following significant exception should be noted:
- On the 3279 in monochrome mode, fields with the high intensity attribute are displayed in white. Whereas on the 3278 the operator can control the contrast between intensified fields and fields of normal intensity, the operator has no such control over white on the 3279.

Functions and features such as extended highlighting and extended color that depend for their operation upon the extensions to the 3270 Data Stream are only available on the 3279 Models 2B and 3B and on printers equipped with the appropriate features. The devices must also be attached to an appropriately featured 3274 Control Unit. Existing programs will run on machines that are configured in this manner in monochrome or base color mode as described above with the following significant compatibility exceptions:
- BSC Copy - Where 3274 Control Units using the BSC line protocol are featured for the extensions to the 3270 Data Stream, and a device is using characters from the APL/Text character set, the BSC Copy command is restricted to copying from display stations to printers. If the APL/Text character set is not available on the printer, print will not be inhibited: instead, characters with the corresponding code point in the printer's base character set will be produced.
- Unsupported Code Points - Instead of being replaced with hyphens, invalid control codes will be rejected and all graphics code points will be retained in the device buffers. The characters displayed or printed as a result are not defined.

Revised editions of the publications *IBM 3270 Information Display System: Component Description, GA27-2749,* and *Introduction to Programming the IBM 3270,* GC27-6999, will provide detailed information relating to the use of color and extended highlighting, together with full details of these compatibility exceptions.

Support for Extensions to the 3270 Data Stream

As described in Chapter 3, extensions to the 3270 data stream are provided to manage the new extended attributes for color and highlighting. The extensions are also required for the programmed symbols features and the symbol set attributes described in Part 2 of this manual. These extensions comprise the new Write Structured Field command, which provides a new general mechanism for device control, and the three new orders: Start Field Extended, Modify Field, and Set Attribute. The first two of these orders are used to define and alter both the old and the new attribute types when they apply to whole fields; Set Attribute sets the new attributes when they are applied to individual characters. These extensions to the 3270 data stream will be supported by IBM System/370, including the IBM 4300 Processors, and IBM 8100 Information System host programming as described in the following paragraphs.

IBM System/370 Host Programming

Telecommunication Access Methods

Telecommunication access methods provide the support required by application programs to use the capabilities of devices, protocols, and networks. The following paragraphs briefly summarize the support that these access methods will provide for the extensions to the 3270 Data Stream.

For machines equipped only for base color mode, the support presently available for the equivalent monochrome models applies.

Basic Telecommunications Access Method (BTAM)

BTAM (OS/VS1 and OS/VS2-MVS) and BTAM-ES (DOS/VSE) are being extended for the 3274 Model 1D local channel operation so that users can transmit, by a new WRITE macro, the extensions to the 3270 Data Stream, which in turn allow the specification of extended color, extended highlighting, and programmed symbols. Neither BTAM (OS/VS1, OS/VS2-MVS) nor BTAM-ES (DOS/VSE) requires modification to transmit the extensions to the 3270 Data Stream for remote 3270 operation. However, for remote operation, applications must employ BTAM BSC transparency macros.

Advanced Communications Function/Virtual Telecommunications Access Method (ACF/VTAM)

ACF/VTAM Release 1 supports the extensions to the 3270 Data Stream in OS/VS2-MVS, OS/VS1, and DOS/VS for SNA attachment only.

ACF/VTAM Release 2 and Release 3 provide both SNA and non-SNA support under OS/VS2-MVS, OS/VS1, and DOS/VSE systems. They support the extensions to the 3270 Data Stream, including BSC transparency mode and local/remote transparency, and provide for identification of extended devices.

Advanced Communications Function/Virtual Telecommunications Access Method Extended Entry (ACF/VTAME)

ACF/VTAME supports the extensions to the 3270 Data Stream in DOS/VSE systems for SNA attachment.

Advanced Communications Function/Telecommunications Access Method (ACF/TCAM)

ACF/TCAM (OS/VS1 and OS/VS2-MVS) is extended to support the extensions to the 3270 Data Stream including screen macro support for local non-SNA attachment and support for BSC transparency mode.

Data Base/Data Communication (DB/DC) Subsystems

In order to use extended color and highlighting in a wide variety of data entry, update, and inquiry applications, support from IBM DB/DC subsystems will be provided as described below.

Note that no special support is provided for base color mode. Devices that use this mode are treated as if they were the equivalent monochrome models: the color is controlled by means of the support at present available for the protection and intensity field attributes.

Customer Information Control System/Virtual Storage (CICS/VS)

The following highlights the scope of CICS/VS support under DOS/VSE, OS/VS1, and OS/VS2:

- The Basic Mapping Support (BMS) component will provide support for the specification of extended color and highlighting at the field level. Users will have new keywords by which they can specify the required attribute values together with default options. Facilities will be available for the user to change these values within the application program.
- Character attributes can be used in BMS TEXTBLD output.
- Existing maps will be compatible with those supporting the new function. The conversion of applications to extended color can thus be undertaken gradually, without the need for widespread alterations all at one time.
- BMS support for the 3287 Printer uses formatted print buffers. The extended color and highlighting attributes can be used to describe fields when formatting printer buffers.
- Programs that use the CICS/VS Terminal Control (TC) interface, which allows users to create their own data streams, will be able to specify the new 3270E commands and orders within their data streams. Programs using this interface will therefore be able to specify extended color and highlighting at both the field and the character level. If an application requires operator selection of extended attributes, the Write Structured Field command, which is required to set the inbound reply mode to include such attributes, must be sent using this interface.
- Users installing CICS support for extended functions will need at the same time to install equivalent releases of the following access methods as appropriate for their system:

> ACF/VTAM
> ACF/TCAM
> BTAM
> BTAM-ES
> ACF/VTAME

- CICS/VS will support all methods of attachment that are supported by the access method. Support for BSC attachment includes support for BSC transparency.

Information Management System/Virtual Storage (IMS/VS)

The following is the scope of IMS/VS support under OS/VS1 and OS/VS2 for the 3279 Color Display Station:

- The Message Format Services (MFS) facility will provide support for the user to specify extended color and highlighting as field attributes, and will allow these attributes to be changed under program control. Default values will be available for these attributes.
- Existing display formats used by MFS will be compatible with those supporting the new function so that conversion of applications to extended color can be a phased process.
- Users installing IMS/VS support for extended functions will need at the same time to install equivalent releases of the following access methods as appropriate for their system:

ACF/VTAM
                              ACF/TCAM
                              BTAM
     ● IMS/VS will support all methods of attachment (BSC, SNA, and local non-
        SNA).
     IMS/VS users can employ either host-initiated or operator-initiated copy functions
     to print the contents of the display screen, including color.

**Interactive
Subsystems**

Support from interactive subsystems will be provided so that extended color together
with highlighting can be used in applications such as interactive computing, program
writing and testing, and statistical and numerical analysis.

No special support is provided for base color. Devices that use base color are
treated as if they were the equivalent monochrome models.

**Virtual Machine
Facility/370 (VM/370)**

VM/370 is a system control program that manages a single System/370 computing
system so that it appears to be a multiple computing system whose resources are
available to many users at the same time. The Conversational Monitor System (CMS),
a component of VM/370, is a time-sharing system that provides a general-purpose
conversational facility that is suitable for program development and problem solving.

The 3279 Color Display Station will be supported as a VM/370 operator console in
the same way as a 3278.

     ● VM/370 will support within the control program (CP) the setting of extended
        color and extended highlighting for six different areas of the color display. These
        six areas are: input, status, CP messages, virtual machine messages, error
        messages, and input redisplay lines.
     ● VM/370 will support within CMS the development and execution of application
        programs that specify extended color and highlighting attributes on a field and
        character basis; it will also support attribute selection from the keyboard. The
        attributes can be sent to 3287 printers that are 'attached' to CMS applications.
     ● VM/370 will allow all subsystems and environments that can operate as a virtual
        machine and that in their own right support extended functions to direct
        extended data stream output to displays attached to those systems.
     ● VM/370 will provide BSC transparency support for the transmission of any bit
        combination over BSC lines. Local non-SNA attachment will be supported.
     A Set Intensify facility is currently available under VM/370. This facility can be
     used to help determine color in the 3279 base color mode.

**Time Sharing Option
(TSO)**

The support for the extensions to the 3270 Data Stream in the Time Sharing Option of
OS/VS2-MVS with either ACF/TCAM or ACF/VTAM includes:
     ● A No Edit operand on the TPUT macro to allow outbound transmission of
        extended data streams.
     ● For inbound data, No Edit operands are provided in the STFSMODE macro in
        TSO with ACF/VTAM and in the FULLSCR macro in TSO with ACF/TCAM.
     ● The GTTERM macro, which provides the capability of determining whether the
        device supports the extensions to the 3270 Data Stream.

Note: *Support for the extensions to the 3270 Data Stream does not function with
TSO-ACF/TCAM using 3704/5 EP mode. Application programs using ACF/TCAM can
use 3704/5 EP mode.*

Virtual Storage APL (VSAPL)

VS APL will support extended color and extended highlighting in the VM/CMS and TSO environments. This support will be provided by an APL auxiliary processor that will use the facilities of the Graphical Data Display Manager (GDDM) program product described in Chapter 9.

To aid application development and the end-user, a VSAPL workspace will be provided which uses this auxiliary processor. The workspace will be based on the IBM 3277 APL Graphics Attachment Support PRPQ P09014 (Program Number 5799-AXW) and will contain function similar to the PGF functions described in Chapter 9.

IBM 8100
Information System
Host Programming

Distributed Processing Control Executive (DPCX)

DPCX offers users of the IBM 8100 Information System a programmable multi-application display-oriented system.

With DPCX, the user can start utilizing the system in 3270 Data Stream Compatibility (DSC) mode for 3270/SNA applications, and subsequently progress to distributed processing.

DPCX will support the extended color and highlighting attributes in DSC mode, and facilities for programming them will be available in the Full Screen Processing (FSP) application programming capability for both displays and printers attached to the 3274 Control Unit Model 51C:

- A programmer will be able to specify the attributes in panel definition only for whole fields.
- The attributes can be written and changed dynamically during program execution.

Devices using base color will be supported as if they were the equivalent monochrome models; no special programming support will be provided.

Distributed Processing Programming Executive Base (DPPX/BASE)

The DPPX/BASE program product is a multipurpose operating system designed for distributed processing. This operating system will support 3279 Color Display Stations when connected to a 3274 Control Unit Model 51C and when equipped for the extensions to the 3270 Data Stream. By means of the Data Stream Interface (DSI), user-written programs can use the extended functions of color and highlighting, including the use of these attributes at both field and character level.

Devices using only base color and attached to a 3274 or 3276 Control Unit will be supported as if they were the equivalent monochrome model.

Distributed Processing Programming Executive/Distributed Presentation Services (DPPX/DPS)

This program product provides mapping services that render user-written programs largely independent of the terminal devices with which they will interact.

DPS supports the extensions to the 3270 Data Stream, including the highlighting attribute, as part of its support for the IBM 8775 Display Terminal.

This support for the highlighting attribute, together with similar support for the extended color attribute, will be available for 3279 Color Display Stations connected to 3274 Model 51C Control Units attached to 8100 systems.

DPPX/DPS consists of two components:

- Interactive Map Definition (IMD) feature

  —IMD enables the application programmer to create and update screen panel layouts interactively at program development time. During the definition process, the programmer can see the run time format being created at the display.
  —The programmer will be able to specify extended color attributes at the field level; the programmer will also be able to specify whether or not these attributes can be changed dynamically during program execution.

—Appropriate keywords and default values for the color attributes will be provided.

● Format Management (FM)

—FM provides the run time support for the interaction between the application program and the terminal.

—If the application programmer has so specified, the program can change during its execution the field color attributes established in the IMD-generated map. Character color can be specified dynamically as part of the data for a field.

The DPPX/DPS facilities for programming the protection and intensity field attributes can be used for the secondary purpose of programming for base color on 3279 Color Display Stations attached to a 3274 Control Unit Model 51C or a 3276 Control Unit Display Station.

DPPX/DPS does not support the use of extended highlighting, extended color, or base color on 3287 printers.

Distributed Processing Programming Executive/3270 Data Stream Compatibility (DPPX/DSC)

This licensed program allows keyboard display devices and printers attached to the 8100 Information System processors to communicate with System/370 host application programs as though the control units were directly attached by data link to the host processor.

This function will be extended:

● To support System/370 host programs that use the functions of the extensions to the 3270 Data Stream, including extended color and highlighting, in configurations where the SDLC line discipline is in use between the 8100 Information System processor and the host system.

● To support 3279 Color Display Stations and 3287 Printers Model 1C and 2C when connected to a 3274 Control Unit Model 51C attached to an 8100 Information System processor.

Devices using base color are supported as if they were the equivalent monochrome model.

Considerations for Customer Written Programs

The 3279 Color Display Station and the 3287 Printer Models 1C and 2C have been designed so that color can be introduced into programs as easily as possible:

● Base color mode can often be used without changing any programming systems and without user code changes, although some tuning may be useful.

● Extended color mode can be used by installing programming support for the extensions to the 3270 Data Stream (as described above) and then programming for extended color in a similar manner to that used for manipulating the present 3270 field attributes.

● Migration from base color to extended color can be achieved by installing programming support for the extensions to the 3270 Data Stream: thereafter, extended color can be introduced as fast or as slowly as the customer finds convenient.

The remainder of this section contains general advice about programming for color. General information on programming for the 3270 can be found in the publication *Introduction to Programming the IBM 3270*, GC27-6999.

Base Color Mode

Because base colors are generated from the existing 3270 field protection and intensity attributes, for which programming facilities already exist, no special support from programming components will be provided. All programs that operate with formatted buffers on existing 3278 Display Stations Model 2 or 3 or on 3287 Printers Model 1 or 2 will operate with a 3279 or 3287 Model 1C or 2C of the equivalent model and feature configuration. Provided that the base color control is set for color, and that the printer is fitted with a four-color ribbon, the programs will produce base color without programming changes.

Some programs will give satisfactory color results without further attention. This is because the algorithm used to determine base color has been chosen so that the use of color reflects the use of the existing field attributes. Nevertheless, the use of these field attributes, particularly intensity, is more critical than with monochrome, and in some programs added care will be required to obtain the best color results. This type of critical examination can be regarded as a first level of tuning for color.

A second level of tuning, which may be needed to achieve the greatest potential from an application, is to revise completely the way in which intensity is used within certain pictures. It is also possible, though less likely, that a programmer will be able to alter the protected attributes of fields. With careful design, the effectiveness of the monochrome version of the program, if that remains a consideration, need not be affected by such changes.

It is important to note that this type of tuning can be carried out for individual pictures; an entire application does not have to be changed all at once. Indeed it may only be necessary or worthwhile to make such changes to the nucleus of highly critical and frequently used displays.

Color printing requires the buffer of the 3287 Model 1C or 2C to be formatted, and the protection and intensity attributes to be used. Because these attributes have no significance for a monochrome printer, some programs may not transmit them and will thus need to be altered if they are to produce color printouts. In programming for printed output, these attributes, especially field protection, can be used with a freedom not possible when they are used to format a display.

Programs that print using unformatted buffers or the SNA Character String (SCS) data stream print in black because in these cases the protection and intensity field attributes are not present.

Installation standards need to be established to ensure that monochrome or base color mode is correctly selected by the operator, using the base color control. A programming convention to indicate to the operator which mode is applicable to each application should be considered.

Extended Color Mode

The following general points apply to the use of extended color for new applications or for applications that are being upgraded from monochrome or from base color:

- The system requires support of the extensions to the 3270 Data Stream and the use of the new color attributes within the new orders provided by that data stream. As a consequence, the new versions of access methods and subsystems will be needed as discussed above.
- New subsystem releases will not impact existing application programs, and no extensive conversion of maps will be required.
- Extended attributes written by programs to control units that are not properly configured to handle them will be rejected. Devices equipped for extended function will accept the present 3270 data streams.
- The 3279 Color Display Station and the 3287 Printer Models 1C and 2C always generate an extended color image if any extended color attribute is used to create the image. In the absence of any extended color attribute, monochrome or base color mode will apply, according to the position of the device's base color control. Programmers who wish to ensure that base colors are not used can do so by sending an extended color attribute, which could be 'Color = Default', as part of each image. To avoid the possibility of an operator noticing the picture change from base color to extended color, an extended color attribute should be applied to one of the first fields created in any picture.
- If a 3279 Color Display Station has its base color control in the monochrome position, white will be the color displayed for fields with the extended color attribute 'Color = Neutral'; however, white will also be the color displayed for fields that have no extended color attribute but which are intensified. It may therefore be deemed wise not to use high intensity in new programs written for extended color.

Specifying color or extended highlighting at the character level introduces some new considerations:

- If both field and character attributes apply to a particular character, the character attribute will always take precedence.
- In formatted images, whenever a character attribute is not specified, the field attribute is applied by default.
- Character attributes can be used in unformatted images. Extended color can therefore be used in applications that use unformatted displays.
- Character attributes are not positional; the character position to which they refer is not fixed on the screen, as is the case with a field. They are tied to their characters and are deleted and inserted with them. For example, if a blue 'G' is deleted from in front of a yellow 'Y', the 'Y' and all characters to its right in the line or field will move one place to the left *taking their attributes with them.* While this is clearly helpful in applications such as text entry, it means that it is not possible to pre-format a screen with color character attributes in fixed positions, except within protected output fields.
- Operators can be provided with keyboards that enable them to select character attributes. If this facility is to be useful, the inbound data stream format that is used must include character attributes, and the application program must analyze and handle the incoming attributes.

Part 2. The Programmed Symbols Features

Chapter 6. Programmed Symbols Feature Descriptions

This chapter describes the Programmed Symbols (PS) features, first on the 3279 and 3278 Display Stations, and then on the 3287 Printers.

The 3279 Color Display Station and The 3278 Display Station

On the 3279 and 3278 Display Stations, each character is represented by a pattern of dots selected from a matrix. Each dot within the matrix is known as a point. Characters are normally represented by predefined patterns accessed by character codes in the data stream that is sent to the display device.

Programmed Symbols features are available on the 3279 Models 2B and 3B and on the 3278 Models 2, 3, and 4. These features allow users to define their own dot patterns within the character matrices. The features provide storage and accessing for either two or six sets, each set containing 190 user-definable characters or symbols.

3278 Models 2 and 3 have matrices of 9 points horizontally by 16 points vertically; 3278 Model 4 and all 3279 models have matrices of 9 points horizontally by 12 points vertically.

Symbols are loaded and accessed under program control. A symbol may be a special character in an alphameric application, or it may be a shape that forms part of a graph or other graphic representation of data.

Feature Description

The user-defined symbols in Programmed Symbols sets are held in special storage planes. A storage plane may be a single plane or it may be a triple plane. Triple-plane storage is used with color devices so that more than one color can appear within a single character position. This capability is valuable in graphic applications (as described in Chapter 7).

Two Programmed Symbols features are available on the 3279 and 3278 Display Stations:

- Programmed Symbols 2 (PS-2) provides storage and accessing for 380 special symbols in two single-plane sets each with a capacity for 190 symbols.
- Programmed Symbols 4 (PS-4), which is available only as an addition to PS-2, provides storage and accessing for a further 760 special symbols in four sets each with a capacity for 190 symbols. On the 3279, one of these four sets is a single-plane set, and the other three are triple-plane sets. On the 3278, all four are single-plane sets.

In general, the PS-2 feature is likely to be adequate for alphameric applications, while PS-4 will generally be necessary for graphic applications.

Configurations

A 3279 Color Display Station Model 2B or 3B or a 3278 Display Station Model 2, 3, or 4 can be equipped with the PS-2 feature alone or with PS-2 and PS-4. (PS-4 is not available without PS-2.)

On the 3278, the Extended Character Set Adapter is a prerequisite for the PS features.

Attachment

A 3279 or 3278 equipped with PS feature(s) can be attached to 3274 Control Units Models 1A, 1C, 1D, and 51C.

The 3274 must have the Structured Field and Attribute Processing option and the Programmed Symbols option, and, in the case of the 3279, the Color Display Control option.

Use of the 3270 Extended Data Stream is a prerequisite for specifying programmed symbols attributes for fields and characters.

Keyboards

The following keyboards can be used with 3278 Display Stations and 3279 Color Display Stations that are equipped with Programmed Symbols features for those applications in which the terminal operator enters characters from the symbol sets.

88-Key Japanese English/Japanese Katakana Typewriter Overlay Keyboard: (IBM World Trade Americas/Far East Corporation). This keyboard, without overlay, has the same layout and can be used in the same way as the 88-key Japanese English and Japanese Katakana Typewriter keyboards (see Chapter 2). This keyboard has, however, special narrow keytops that permit the use of customer annotated overlays. These overlays are used to show the special font symbols associated with the keys when one of the Programmed Symbols sets is selected. The required symbol set, and any required extended color and highlighting attributes, can be selected by the operator through use of the appropriate PF keys (13-24) in uppercase and alternate shift on this keyboard.

87-Key EBCDIC Typewriter Overlay Keyboard: This keyboard, without overlay, has the same layout and can be used in the same way as the 87-key EBCDIC Typewriter keyboard (see Chapter 2), with the basic 94-character EBCDIC character set. This keyboard has, however, special narrow keytops that permit the use of customer annotated overlays. These overlays are used to show the special font symbols associated with the keys when one of the Programmed Symbols sets is selected. The required symbol set, and any required extended color and highlighting attributes, can be selected by the operator through use of the appropriate PF keys (13-24) in uppercase and alternate shift on this keyboard.

Operator selection of the symbol set attribute is also possible with the following Attribute Select keyboards, as described in Chapter 2.
- 87-Key EBCDIC Attribute Select Typewriter Keyboard.
- 87-Key EBCDIC Attribute Select Typewriter/APL Keyboard.
- 88-Key Attribute Select Japanese English/Japanese Katakana Typewriter Keyboard.
- 88-Key Attribute Select Japanese English/Japanese Katakana Typewriter/APL Keyboard.

The 3287 Printer

On the 3287 Printers, each character is represented by a pattern of dots selected from a matrix of 10 dots horizontally by 8 dots vertically. Characters are normally represented by predefined patterns accessed by character codes in the data stream that is sent to the printer.

Programmed Symbols features are available on the 3287 Models 1, 1C, 2, and 2C. These features allow users to define their own dot patterns within the character matrices. The features provide storage and accessing for up to six sets, each set containing 190 user-definable characters or symbols.

Symbols are loaded and accessed under program control. A symbol may be a special character in an alphameric application, or it may be a shape that forms part of a graph or other graphic representation of data.

Feature Description

The user-defined symbols in programmed symbols sets are held in special storage planes. A storage plane may be a single plane or it may be a triple plane. Triple-plane storage is used with color devices so that more than one color can appear within a single character position. This capability is valuable in graphic applications (as described in Chapter 7).

Three Programmed Symbols features are available on the 3287 printers:

On Models 1, 2, 1C, and 2C

- Programmed Symbols 2 (PS-2) provides storage and accessing for 380 special symbols in two single-plane sets each with a capacity for 190 symbols.
- Programmed Symbols 4 (PS-4), which is available only as an addition to PS-2, provides storage and accessing for a further 760 special symbols in four single-plane sets each with a capacity for 190 symbols.

On Models 1C and 2C Only

- Programmed Symbols 4A (PS-4A), which cannot be combined with either of the other PS features, provides storage and accessing for 760 special symbols in four sets each with a capacity for 190 symbols. Three of the sets are single-plane sets, and the fourth is a triple-plane set. PS-4A is available only on the 3287 Models 1C and 2C.

    In general, the PS-2 feature is likely to be adequate for alphameric applications. The PS-4 feature will generally be needed for monochrome graphic applications, while the PS-4A feature will be needed for color graphics.

Configurations

The 3287 Printer Models 1 and 2 can be equipped with the PS-2 feature alone or with PS-2 and PS-4.

The 3287 Printer Models 1C and 2C can be equipped with the PS-2 feature alone, with PS-2 and PS-4, or with PS-4A alone.

The Extended Character Set Adapter and the Extended Print Buffer are prerequisites for the Programmed Symbols features on the 3287.

Programmed Symbols features can coexist with the APL/Text character set.

Attachment

A 3287 equipped with Programmed Symbols feature(s) can be attached to 3274 Control Units Models 1A, 1C, 1D, and 51C.

The 3274 must have the Structured Field and Attribute Processing option and Programmed Symbols option.

Use of the extensions to the 3270 Data Stream is a prerequisite for specifying programmed symbols attributes for fields and characters.

Chapter 7. Programmed Symbols Capability

Introduction

All display stations and printers in the IBM 3270 Information Display System have a base character set. A second set is present if the machine has the APL/Text feature. Application programs use the characters or symbols in these sets as they are; they cannot alter or add to them.

The Programmed Symbols features allow users of the 3278 Display Station, the 3279 Color Display Station, and the 3287 Printers to define additional characters and symbols to meet the special needs of their own applications. Examples are technical symbols, foreign language letters, and sets of graphic elements which can be used to build graphs, bar charts, and other graphic representations of data.

- Programmed symbols are loaded under program control, and can be altered whenever required.
- Operators can enter either standard characters or programmed symbols, provided that the appropriate keyboard is installed and the application designer so permits. The operator can also use APL or Text characters on devices equipped with the appropriate features.
- On a 3279 Color Display Station Model 2B or 3B or a 3287 Printer Model 1C or 2C programmed symbols can be displayed or printed in extended or base color mode. Using extended color, it is possible for more than one color to be used within a single character position. This facility is valuable when using graphic elements to build a multicolored display image.
- Programmed symbols can be used in conjunction with the extended highlighting attributes.
- Programs must be written (or modified) to use the facilities for controlling and referring to programmed symbols.

User Defined Symbols and the Symbol Set Attribute

Data transmitted to and from the IBM 3270 Information Display System is held in encoded form. For example, the code for the lowercase letter 'a' is the hexadecimal number 81. In the 3278 Display Station, the 3279 Color Display Station, and the 3287 Printer, symbols displayed or printed are made up of a pattern of dots (or points). When it is required to display or print the letter 'a', the hexadecimal number 81 is used in the data stream to refer to the appropriate dot pattern in the character set of the device.

The Programmed Symbols features provide display stations and printers with additional storage that the user can load with the point patterns that form the special symbols needed for an application. Enough space is provided to hold the patterns for 190 symbols in each symbol set; devices can hold up to six programmed symbols sets.

Programs refer to these symbol sets through the symbol set attribute, which works in a similar way to the extended color and highlighting attributes described in Part 1 of this manual. For example, if a symbol set named 'X' contains the pattern of dots for the Greek character alpha at position 81, data with code 81 and the symbol set attribute 'X' will print or display as alpha.

Thus the symbol set from which each data character is to be taken is an attribute of the character itself (or of its field). The default, if no symbol set attribute is specified, is the base character set of the device.

The relationship between the code of the data, its attributes, and the symbol sets is shown in Figure 7-1.

Multicolored Characters

The user may need, in certain circumstances, to be able to display or print in more than one color *within a single character position.* For example, suppose that, using programmed symbols, a user has defined a number of graphic symbols that can be combined to form the lines in a graph. The graph is to show three separate lines: last
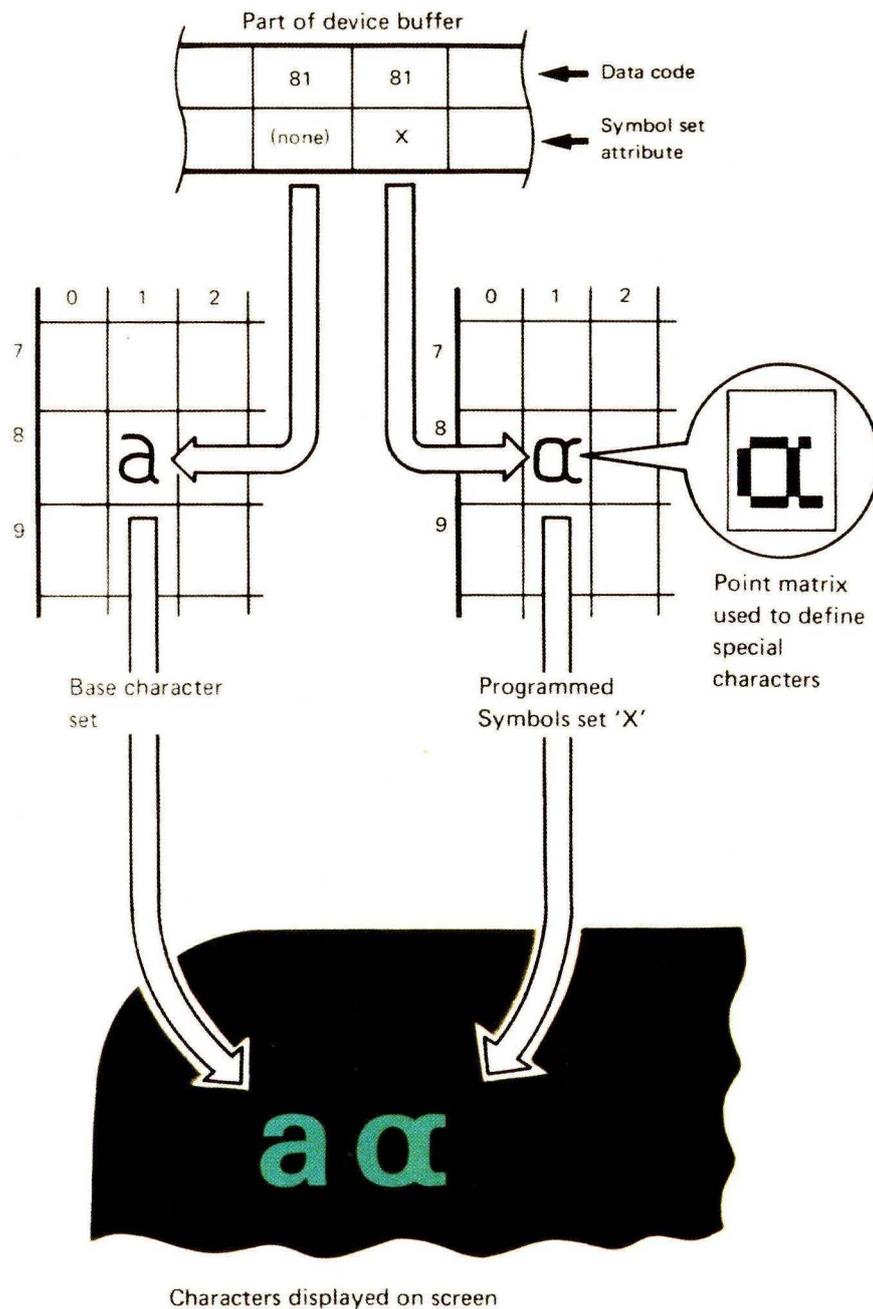
Figure 7-1. Data Codes, Attributes, and Symbol Sets

year's sales, this year's forecast sales, and this year's actual sales. Each line is to be displayed in a different color. The lines may well cross one another at certain points, and the area covered by the intersection of the lines will be significantly smaller than the area covered by a single character position. If more than one color could *not* be displayed within one character position, the points of intersection might appear as shown in Figure 7-2, which would be unacceptable.

The programmed symbols features overcome this difficulty by enabling the user to define symbols in more than one color. The system works as follows.

Some of the symbol sets available in the Programmed Symbols features are *triple-plane* symbol sets. Such sets contain three times the normal amount of storage for

Single character position
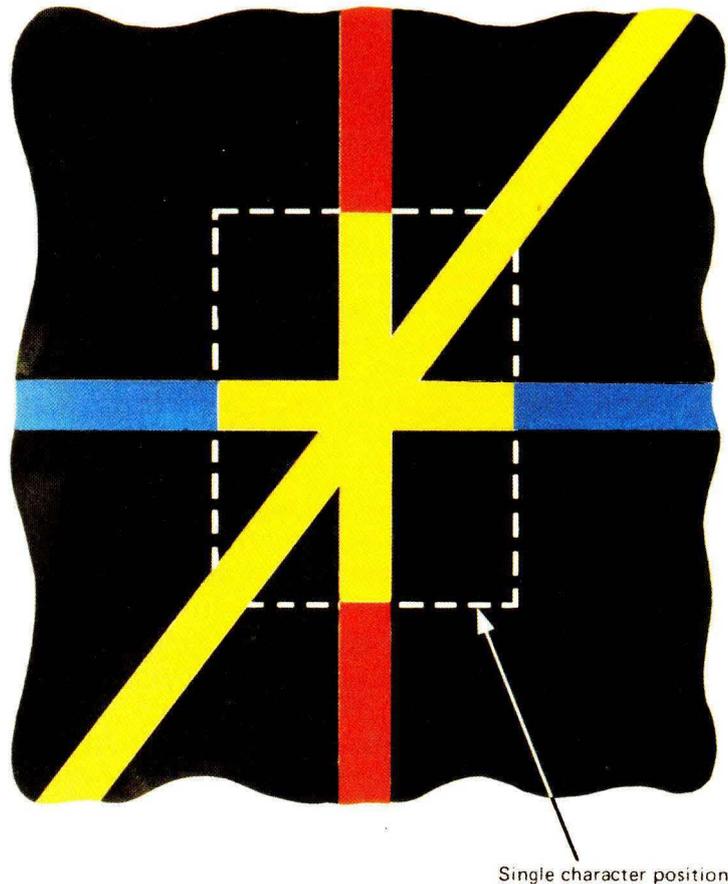
Figure 7-2. Line Intersection with No Multicolored Character Facility

each defined character, arranged in three planes each representing one of the three primary colors red, blue, and green. By defining only a portion of the total symbol in each color plane, the user can obtain a whole symbol in more than one color. For example, the three line intersection shown in Figure 7-2 could be defined as shown in the upper part of Figure 7-3. The lower part of Figure 7-3 shows the various ways that the character could appear when displayed or printed:

• If a symbol defined in a triple-plane set is displayed or printed with the color attribute 'neutral', the pattern defined in each color plane is presented in that color. When part of a whole symbol appears in more than one color plane, the colors will combine, as follows:

| | Color of Point | |
Plane in which point is defined	3279	Printer
Red	Red	Red
Blue	Blue	Blue
Green	Green	Green
Red and Blue	Pink	Neutral (Black)
Red and Green	Yellow	Neutral (Black)
Blue and Green	Turquoise	Neutral (Black)
All three	Neutral (White)	Neutral (Black)

In the example shown in Figure 7-3, the yellow line has been obtained by defining that part of the intersection symbol in both green and red.

- If a symbol defined in a triple-plane set is displayed or printed with an explicit color attribute other than neutral (for example, blue), the whole symbol, as defined by combining all three planes, is displayed or printed in the specified color.
- If a symbol defined in a triple-plane set is displayed or printed without any color attribute, the whole symbol will appear in monochrome or base color mode, in the same way as any standard character.

Unless the user deliberately loads the three planes in a triple-plane symbol set separately, the system will load the same pattern into all three planes; thereafter, the triple-plane set will behave (for any character that has the same pattern in all three planes) exactly as if it were a single-plane set. Consequently, a triple-plane set can always be used as if it were a single-plane set.

Controlling Programmed Symbols

To control Programmed Symbols features, the IBM 3270 Information Display System provides facilities for establishing the status of the features on a device, for loading the sets, and for using them to display data.

Establishing Status

The Write Structured Field command provides a general mechanism for device control in the extensions to the 3270 Data Stream. In particular, a programmer can use it to find out:

- The characteristics of the device, such as the size of the screen or the length of the print line, and whether it supports color.
- The size of the matrix used to define symbols for the device, in points vertically and horizontally, and the number of points per inch in each direction.
  These details can be used by programs to proportion correctly any graphical pictures constructed with the symbol sets.
- How many programmed symbols sets the device can hold, and whether each is a single-plane or triple-plane set.
- Whether a set is loaded, and, if it is, the one-character name by which it is known to the device and the program.

Loading the Sets

The storage in which programmed symbols are held must be loaded after the device is powered on. A programmer, having defined symbol sets, can load them into this storage at any time by means of the Write Structured Field command.

The data sent to a device to load a symbol set includes:

1. A header with control information for the device, such as the number of the set to be loaded and the one-character name by which it will be known; whether any previous symbols in the set being loaded should be cleared; and, if a color triple-plane set, whether the data is for all three of the primary color planes or for one specific plane only.
2. The EBCDIC code point in the symbol set of the first pattern defined in the load; the patterns for subsequent code points follow sequentially.
3. The point patterns that make up each character. Eighteen bytes are needed for each display character that uses a 9 X 12 or a 9 X 16 point matrix, and ten bytes for each printer character with a 10 X 8 point matrix. Because the proportion of points used to define a character within a matrix is often small, a special compression technique can optionally be used for transmitting this data.

Transient patterns appear on the display screen while data is being loaded into the programmed symbols buffers.

Programmed Symbol set 'y'
(a triple-plane set)
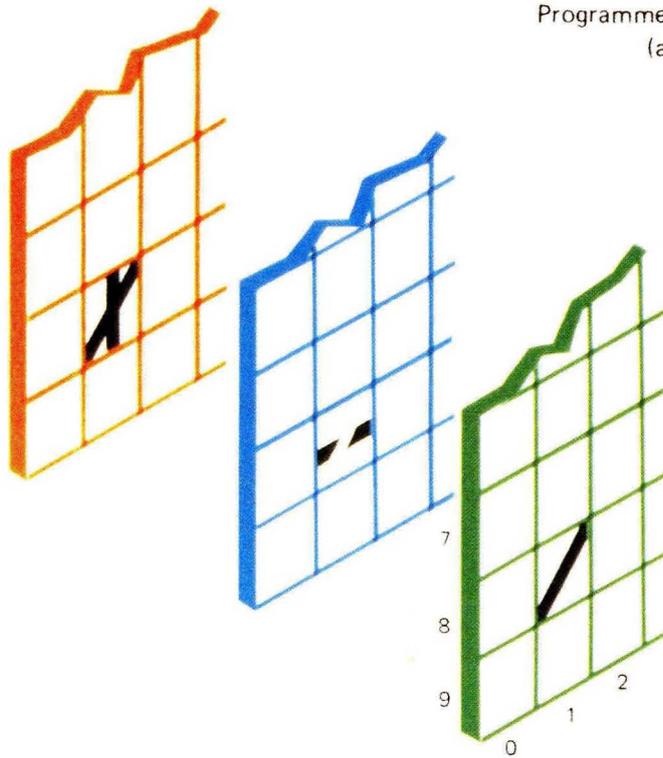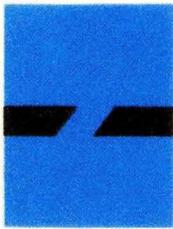
Red Plane   Blue Plane   Green Plane

Portions of symbol defined in different color planes

Part of device buffer

81	81	81	← Data code
Y	Y	Y	← Symbol set attribute
neutral	blue	(none)	← Color attribute

Symbol displayed
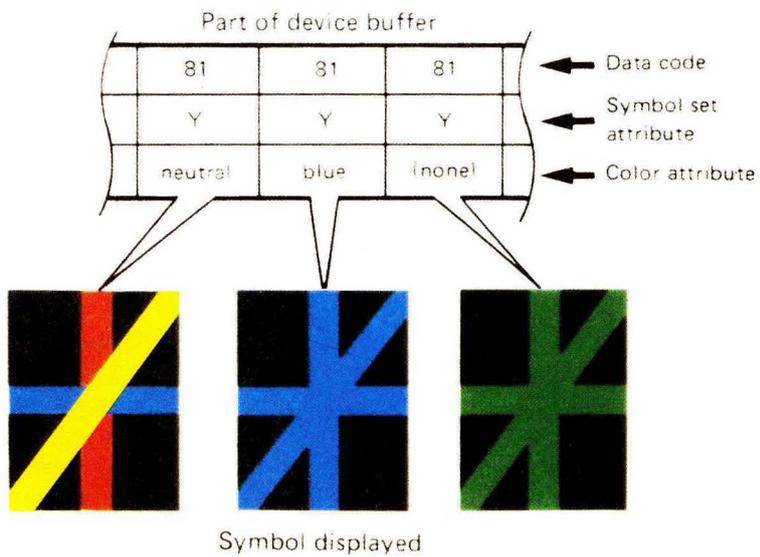
Figure 7-3. Triple-Plane Symbol Sets

Using the Sets

As described in Part 1 of this manual, three orders have been added to the 3270 control functions to manage the extended color and extended highlighting attributes: *Start Field Extended* and *Modify Field*, which allow the new attributes to be specified and altered for whole fields; and *Set Attribute*, which allows them to be specified for individual characters. Symbol set attributes will also be controlled by these three orders.

Together with the Write Structured Field command, these comprise the extensions to the 3270 Data Stream. The Structured Field and Attribute Processing option will be available only on 3274 (except Model 1B) Control Units, and will be fully documented in a revision of the *IBM 3270 Information Display System: Component Description,* GA27-2749. Symbol set attributes can only be sent to terminals properly configured to handle them.

Remote applications with these extended functions using BSC line discipline require the BSC transparent mode of transmission.

Operator Control of Programmed Symbols

Several of the keys used by the operator have additional function on displays equipped with programmed symbols features because of the need to manage the symbol set attribute of characters:

- The CLEAR, ERASE EOF, and ERASE INPUT keys currently provide erasing functions by setting to null any character position on the display image affected by the key. These keys will also clear any character symbol set attribute associated with those positions.

- The DELETE key currently allows characters to be deleted from a field, and all characters in the same field on the same line and following the point of deletion are shifted left. Any character symbol set attributes present are deleted or shifted in the same way as the characters with which they are associated.

- The INSERT key currently allows characters to be inserted into a field, and all characters in the same field following the point of insertion are shifted right. The INSERT key will move any symbol set attribute associated with the shifted characters, and will create an attribute for the inserted character. Except when the operator is allowed to select the symbol set to be used, and does so, this symbol set attribute will have the default value, and any attribute specified for the field as a whole will control the inserted characters.

- All data keys will set the symbol set attribute of characters entered from the keyboard as follows. If the operator is allowed to select the symbol set to be used and actually does so, the appropriate symbol set attribute will be applied. Otherwise, the default value will be applied to individual characters, and the attribute specified for the whole field will control the characters.

For applications in which the terminal operator is required to select characters from the programmed symbols sets when entering data, the Overlay and Attribute Select keyboards described in Chapter 6 are available. The operator can choose the symbol set as well as the color and highlighting for the data that is being entered by using the upper and alternate shifts of the right-hand twelve function keys (provided always that the programmer has allowed use of this facility). Attributes selected with these keys apply to all characters subsequently entered until the operator makes another selection or the programmer inhibits use of the facility.

When an operator has selected a symbol set for entering data, each data key accesses the character in the symbol set with the same EBCDIC code as its normal character. Depending upon the language of the keyboard, an operator can therefore use 94 symbols plus the space character from a set. The remainder of the 190 symbols in the set can be accessed only by program. The optional Overlay keyboard provides a means of indicating to the operator the programmed symbols associated with the keys.

Programmed symbols storage is volatile, and will therefore be cleared whenever an operator powers down the device.

Printing Programmed Symbols

The Programmed Symbols features can be used on the 3287 Models 1, 2, 1C, and 2C. In designing applications that use these features on the printers, the system designer should consider the following points:

- Programmed symbols cannot be used with SCS data streams.
- Symbol set attributes can be copied from a display station to a printer using the BSC copy command, the copy function of the 3274, and operator-initiated print. However, the symbol sets themselves are not copied, so the user must ensure that the necessary sets of symbol patterns (with the same names as are used on the display device) are loaded into the printer by the host computer before starting a copy operation. If the required symbol set has not been loaded into the printer, or the printer is not equipped with Programmed Symbols features, a copy will be made using the basic character set of the printer.
  When extended functions are being used, the BSC copy command can be used only to copy from a display station to a printer.

System Performance With Programmed Symbols

The system designer must take many factors into account when considering a transaction design and the effect of it upon system performance. The following extra considerations apply when programmed symbols are used:

- Programs that read and write symbol set attributes will send more data over the telecommunication network than a similar program that does not use them. Also, loading the patterns into the symbol sets, especially when an application program does this dynamically, will increase the amount of data transmitted.
- The processing done by programs that use the programmed symbols sets will tend to be greater than similar ones that do not use them. In particular, this applies to programs that manage the symbol sets dynamically, such as presentation graphics, compared to those that maintain fixed sets for the whole of an application or session.
- Symbols on the 3287 Printer are normally defined to use only a limited proportion of the points in the full symbol matrix, and not to use horizontally adjacent points. If, for graphics purposes, symbols are defined that do not conform to these restrictions, the 3287 Models 2 and 2C will print at the speeds of the Models 1 and 1C, and on all models two passes of the print head will be needed for a line containing such symbols. In the case of the Models 1C and 2C, when using the color cartridge, up to two separate passes of the print head will also be needed for each color used on a line.

Chapter 8. Programmed Symbols Applications

The applications for the Programmed Symbols features fall into two main categories: alphameric and graphic.

Alphameric Applications

Alphameric applications are those in which the capability provided by programmed symbols is used to extend the range of special characters, symbols, or signs that can be displayed or printed in text. Listed below are some examples of the special characters that a user might define and use:

- Characters from foreign alphabets.
- Mathematical signs and symbols.
- Scientific signs and symbols.
- Special type fonts, for example, italics.

Some of these special characters are shown in Figure 8-1.
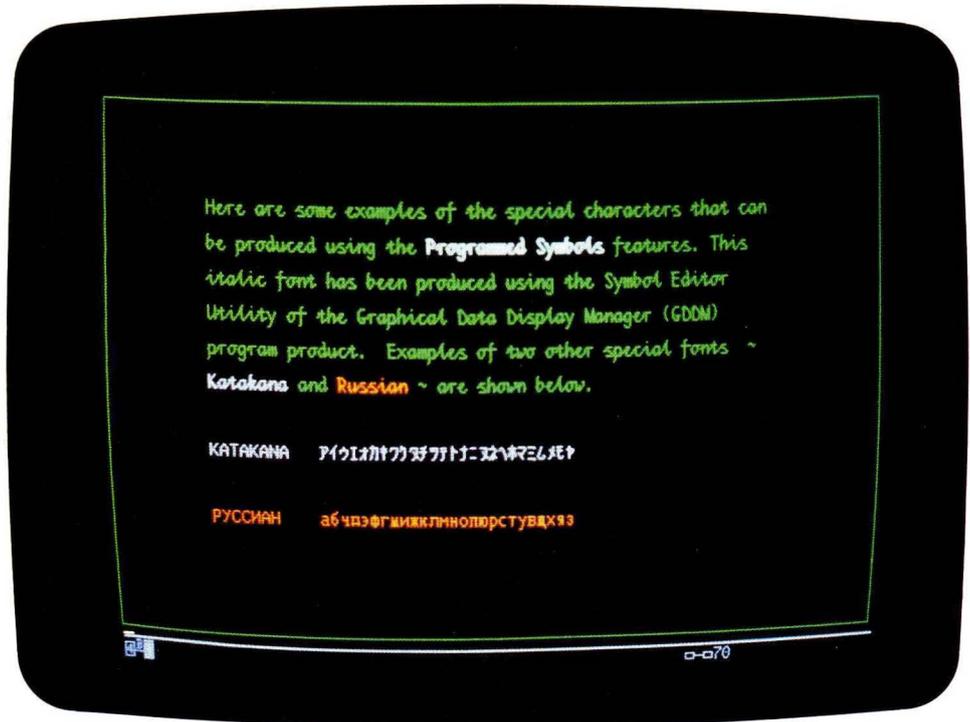
Figure 8-1. Special Characters Produced Using Programmed Symbols

In general, the PS-2 features (described in Chapter 6) are likely to be adequate for alphameric applications.

Graphic Applications

Graphic applications are those in which the programmed symbols capability is used to define shapes or picture components that, when combined with other such components in adjoining character positions on the screen or printed page, will create a pictorial, or graphic, representation.

In general, graphic applications on the 3278 and the 3279 are likely to require the PS-2 and PS-4 features. On the 3287 printers, monochrome graphics will generally require the PS-2 and PS-4 features, while color graphics will require the PS-4A feature.

The Advantages of Graphics

The use of numbers to convey information pervades modern life. This mode of communication is well suited to machines but is often found difficult by people. Many people find that they cannot readily extract and comprehend information from purely numerical data. When large masses of numbers are involved, or when a significant relationship must be extrapolated from several sets of numerical data, the task becomes even more difficult.

A graphic representation of data can be an effective alternative to a numeric representation. Unlike words or numbers, pictures are an almost universal language, one of the oldest and most natural ways in which people communicate. Pictures can convey information more directly, by using the brain's ability to distinguish shapes, patterns, colors, and shadings. Numerical data can thus be made more accessible to people by converting it into a graphic form.

Graphic applications can be divided into two types, graphic enhancement and graphics-essential:

1. *Graphic enhancement* applications are those in which the use of graphics enhances the presentation of numerical data that was nevertheless already available through computer devices.
2. *Graphics-essential* applications are those which depend on graphic presentations to the extent that while graphics were not available on computer devices, the application was not computerized.

   Some of these applications are described below.

Business Planning, Analysis, and Tracking

Business planning and analysis are typical applications in the graphic enhancement category. For example, numeric data for the expenditure by various departments of an organization over a period of time will typically have been available at a computer terminal previously, but can be so much more effectively presented with the aid of graphics. Figure 8-2 illustrates the use of programmed symbols on a monochrome device, the 3278 Display Station, to produce a typical business chart. The data in this example is presented as a surface chart, that is, each separate element of data is added to the surface of the previous element.
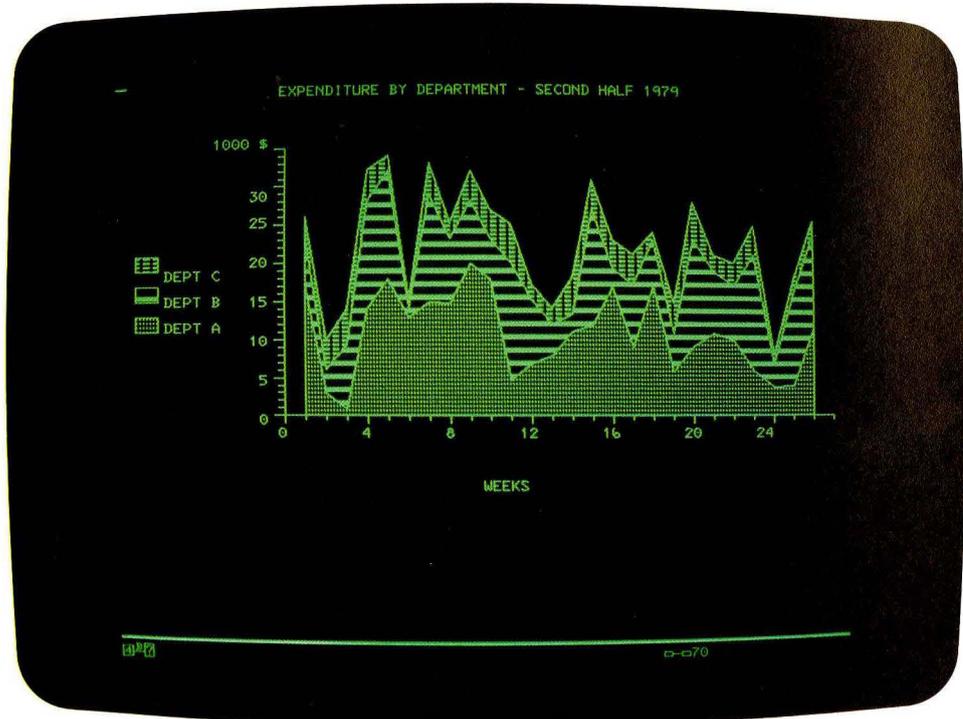
Figure 8-2. A Business Chart in Monochrome

Figure 8-3 shows a business chart in color. The data in this example is presented as a pie chart on a 3279 Color Display Station. The example shows how color helps to distinguish the separate elements of the chart.
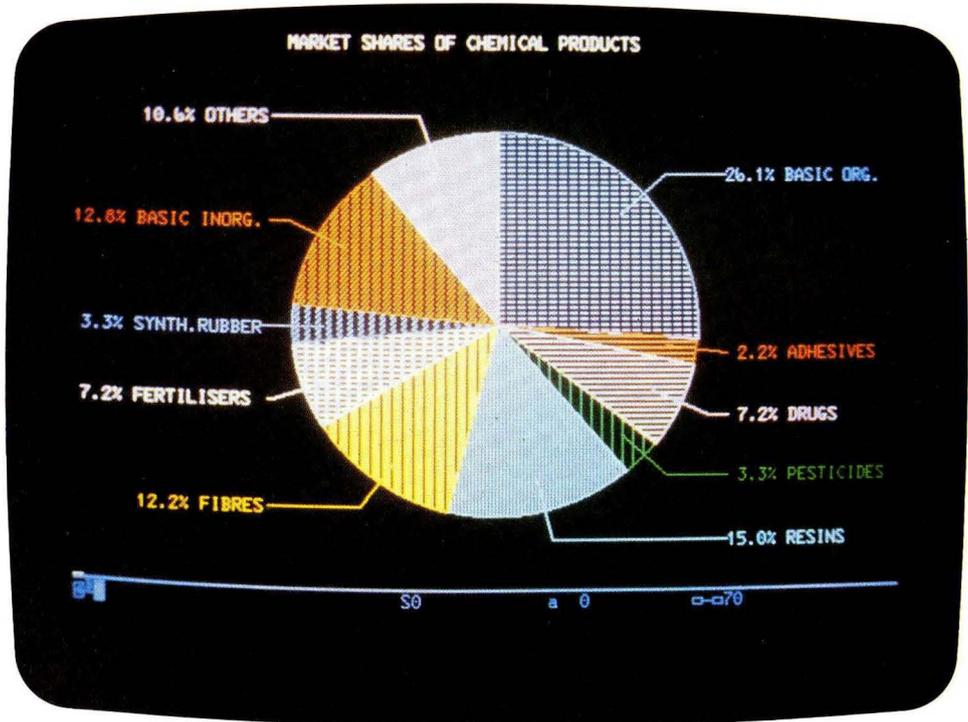

Figure 8-3. A Business Chart in Color

Scheduling

Scheduling is a typical application in the graphics-essential category. Noncomputerized scheduling typically involves large, manually-prepared wall charts. In addition to eliminating the cumbersome manual preparation work, the automation of scheduling makes it possible for complex scheduling data to be simultaneously presented in different offices and even different geographical locations. As in the nonautomated presentation of scheduling information, color is likely to be regarded as essential.

Project Management and Control

Project management and control is another graphics-essential application. Graphics will typically be used in this application to display critical paths and dependencies in the management of complex projects. Enterprises particularly likely to require this application of graphics include the construction industry, utilities and services such as railroads and electrical supply, and local and central government projects.

Process Monitoring and Control

Graphics can be used to show the status of a process or operation diagrammatically. Typical examples include flow diagrams in chemical processing plants and oil refineries. The interpretation of the data in such diagrams is often of critical importance, so the use of color will often be regarded as essential.
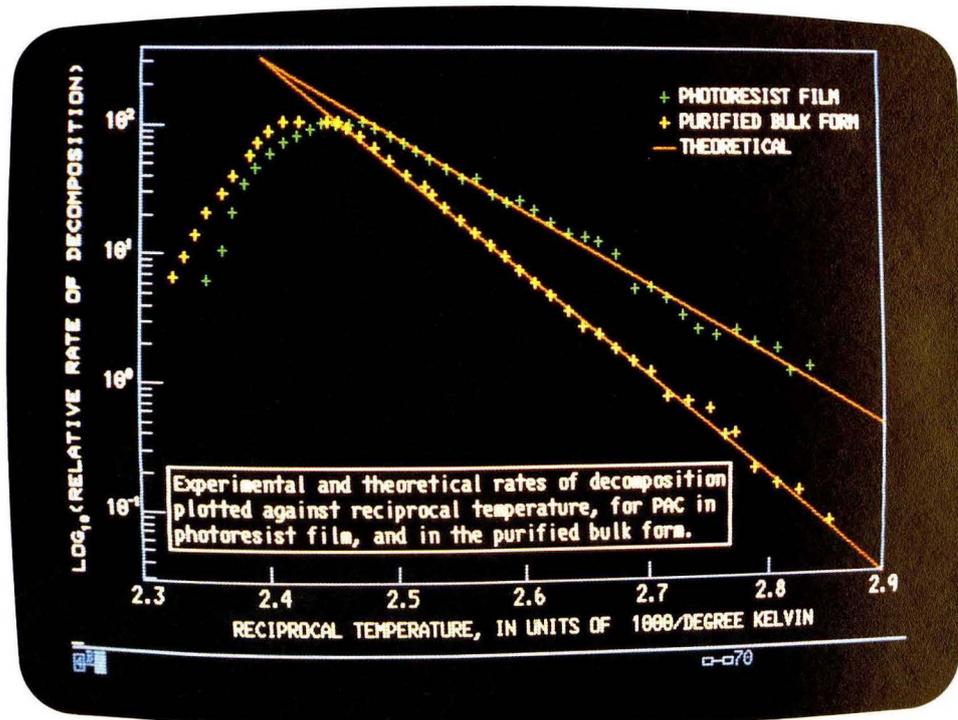
Figure 8-4. Technical Data Analysis

Technical Data Analysis

Technical data analysis applications are in the graphic enhancement category. Information that is available in numeric form may be presented graphically with improved comprehension and resultant improved productivity. Typical users will be research and development professionals. One typical display is shown in Figure 8-4.

Computer Assisted Instruction

There is probably no area in which the relative value of a graphic representation of information is higher than in education, and computer-assisted instruction is no exception. Graphics, especially when combined with color, have enormous potential in the enhancement of computer-assisted instruction and on-line tutorial material.

Graphic Arts and Publishing

In the graphics applications that have been considered above, graphics are only a means to an end: the enhanced accessibility of information. In the graphic arts and publishing, the creation of designs and illustrations is often an end in itself. The graphic capability provided by programmed symbols, especially when augmented by color, has considerable potential in the fields of graphic design, visualization, and the creation of illustrations as shown in Figure 8-5.

Summary

The brief descriptions above cover just a few of the potential applications for the computer graphic capability provided by the programmed symbols features. A list of possible applications follows.

Business Graphics

Planning, Analysis, and Tracking
 Time trend analysis
 Comparison of data sets
 Forecasting
 Sales analysis
 Presentations to groups
Scheduling
 Transportation and distribution logistics
 Personnel and equipment schedules

Figure 8-5. A Publishing Application

Project Management and Control
 Critical path charts
 Status charts
Forms Creation and Completion
 Orders
 Payrolls
 Billing
 Reports

Technical Graphics

Industrial Process Monitoring and Control
 Network and pipeline maps
 Online display of variables
Scientific Engineering
 Data reduction and analysis
 Modeling and simulation
Medical
 Electrocardiograms, scans, and pathological analysis
 Analysis of test and experimental data

Other Applications

ComputerAssisted Instruction
Graphic Arts and Publishing
 Illustrations and diagrams
 Page layout and composition
Data Processing Installations
 Flowcharts and diagrams
 Program documentation

Chapter 9. Programming Support for Programmed Symbols

IBM programming support for the Programmed Symbols features is provided at several levels:

- IBM system control programs, telecommunications access methods, data-base/data-communication subsystems, and interactive subsystems provide various levels of support for the use of programmed symbols features.
- A program product - Graphical Data Display Manager (GDDM), with an optional Presentation Graphics Feature (PGF) - provides an application programming interface for users of the Programmed Symbols features.

The support of the symbol set attribute from IBM host components is described immediately below, and is followed by a description of the program product GDDM and its optional Presentation Graphics Feature. Finally, some programming considerations are given for users of programmed symbols.

Support for the Symbol Set Attribute from IBM Host Components

Chapter 5 in Part 1 of this manual describes the support that will be provided by IBM System/370, including the IBM 4300 Processors, and IBM 8100 Information System host programming for the extensions to the 3270 Data Stream and in particular for the extended color and highlighting attributes. This support of the extensions to the 3270 Data Stream will also apply to the symbol set attribute, so the following paragraphs describe only considerations unique to this attribute. Unless otherwise stated, the support applies to:

- —3278 Display Station Models 2, 3, and 4.
- —3279 Color Display Station Models 2B and 3B.
- —3287 Printer Models 1 and 2.
- —3287 Printer Models 1C and 2C.

IBM System/370 Host Programming

Telecommunication Access Methods

Support is as for extended color and highlighting, described in Chapter 5.

Data Base/Data Communication (DB/DC) Subsystems

Customer Information Control System/Virtual Storage (CICS/VS)

Symbol set attributes can be specified for display devices and printers in BMS maps, BMS TEXTBLD requests, and CICS/VS Terminal Control (TC) requests in the same way as for color and highlighting. The user is responsible for establishing the status of the programmed symbols features and for loading the symbols by means of the CICS/VS terminal control interface and the Write Structured Field command.

For presentation graphics, the CICS/VS programmer will be able to access the facilities of the Graphical Data Display Manager (GDDM) program product described later in this chapter. The Interactive Symbol Editor Utility of GDDM can also be used to create symbol sets for use in alphameric applications.

Information Management System/Virtual Storage (IMS/VS)

IMS/VS will support the symbol set attribute on the 3278 Display Station and the 3279 Color Display Station in the same way as for extended color and highlighting. IMS/VS user application programs will be able to load the sets by inserting messages with programmed symbols image patterns in IMS/VS output queues.

IMS/VS users may employ either host-initiated or operator-initiated copy functions to print the display screen contents, including color and programmed symbols. In the case of programmed symbols, users should ensure that the proper Programmed Symbols buffers have been loaded prior to issuing the copy request. Note that for the SNA attachment of printers, programmed symbols are offered only in SLU Type 3; therefore, under SNA, users must load the printer's Programmed Symbols buffers by application programs that do not run under IMS/VS control.

Interactive Subsystems

Virtual Machine Facility/370 (VM/370)

VM/370 and the Conversational Monitor System (CMS) support for the symbol sets is an enhancement of the support that will be available under VM/370 for extended color and highlighting, described in Chapter 5.

- VM/370 will support within CMS the programming and execution of application programs that use the symbol set attributes on a field and character basis.
- VM/CMS programmers will be able to access the facilities of the Graphical Data Display Manager (GDDM) program product described later in this chapter.

Time Sharing Option (TSO)

The ACF/TCAM and ACF/VTAM environments of TSO will both support use of symbol sets on 3278 and 3279 display stations as part of their support for the extensions to the 3270 Data Stream described in Chapter 5.

TSO users will be able to access the facilities of the Graphical Data Display Manager (GDDM) program product described later in this chapter.

Virtual Storage APL (VSAPL)

VSAPL will support extended color, extended highlighting, and programmed symbols in the VM/CMS and TSO environments. This support will be provided by an APL auxiliary processor that will use the facilities of the Graphical Data Display Manager (GDDM) program product described in this chapter.

To facilitate application program development and the end-user, a VSAPL workspace will be provided that uses this auxiliary processor. The workspace will be based on the IBM 3277 APL Graphics Attachment Support PRPQ P09014 (Program Number 5799-AXW) and will contain functions similar to the PGF functions described in this chapter.

IBM 8100 Information System Host Programming

Distributed Processing Control Executive (DPCX)

The symbol set attribute will be supported in 3270 Data Stream Compatibility (DSC) mode and the Full Screen Processing (FSP) application programming capability in the same way as for extended color and highlighting.

The user is responsible for loading and managing the symbol set buffers in the devices.

Distributed Processing Programming Executive Base (DPPX/BASE)

Symbol set attributes and the loading and managing of symbol set buffers will be supported in DPPX/BASE through the Data Stream Interface (DSI).

Distributed Processing Programming Executive/Distributed Presentation Services (DPPX/DPS)

The Interactive Map Definition and Format Management components of DPPX/DPS will support the symbol set attribute in the same way as for extended color and highlighting.

It is the user's responsibility to define, load, and manage the symbol sets.

DPPX/DPS does not support the use of Programmed Symbols features on the 3287 printers.

Distributed Processing Programming Executive/3270 Data Stream Compatibility (DPPX/DSC)

This licensed program allows keyboard display devices and printers attached to the 8100 Information System processors to communicate with System/370 host application programs as though the control units were directly attached by data link to the host processor.

This function will be extended to support System/370 host programs that use the functions of the extensions to the 3270 Data Stream (including symbol set attributes) in configurations where the SDLC line discipline is in use between the 8100 Information System processor and the host system.

Using this facility, System/370 programs that use the facilities of the Graphical Data Display Manager (GDDM) program product support terminals attached to the 8100 Information System.

Graphical Data Display Manager (GDDM) and The Presentation Graphics Feature (PGF)

The program prcduct Graphical Data Display Manager (GDDM) and the optional Presentation Graphics Feature (PGF) are designed to offer a versatile, easily-used pictorial display capability to a wide range of users. By exploiting certain characteristics of display terminals and printers, the programs can present information on a display surface in alphameric or graphic form, or in both forms simultaneously.

GDDM forms the foundation for graphics, by providing the functions needed to create any display compatible with the equipment available to the user. These functions are implemented either by a user-supplied application program or by the Presentation Graphics Feature.

PGF is designed to enable the user to generate common business charts (via GDDM) in two ways:

- In conjunction with a user application program.
- *Interactively*, by the terminal user, with no need for an application program.

The latter method does not provide all the features and flexibility of GDDM and PGF, but it is nevertheless especially useful because it requires only simple keyboard entries and can be used by nontechnical personnel. This enables a customer to begin basic graphics operations immediately upon obtaining GDDM and PGF, without waiting for the development of application programs.

GDDM and PGF will operate in conjunction with a number of host operating systems and subsystems and several programming languages. Specific information on these is provided later in this chapter.

A more detailed description of GDDM and PGF is given in the publication *Graphical Data Display Manager (GDDM) and Presentation Graphics Feature (PGF): General Information*, GC33-0100.

Summary of Product Capabilities

GDDM and PGF contain many functions used for graphic displays. These functions, which are summarized below, can be grouped into two general classes:

- *Utilities*, which can be used *independently* of application programs.
- *Basic Functions*, which are used by an application program or a utility.

Utilities

An Interactive Symbol Editor Utility is supplied with GDDM. Two further utilities are provided with PGF: an Interactive Vector Symbol Utility and an Interactive Chart Utility.

Interactive Symbol Editor Utility (GDDM)

The Interactive Symbol Editor Utility enables the display user to create and edit sets of images or symbols. These sets of symbols can be maintained in libraries and used both by GDDM and by other programs that require them. Multicolored symbols can be defined for use on color devices.

| Interactive Vector Symbol Utility (PGF) | The Interactive Vector Symbol Utility provides the user with the ability to construct vector symbol sets for use by GDDM. Vector symbols differ from symbols produced by the Interactive Symbol Editor Utility in the following ways: |

- Vector symbols are defined by a series of straight lines drawn from point to point in a defined space.
- Vector symbols can be scaled at run time to any desired size or angle by calls to GDDM.

  Sets of vector symbols can be stored in symbol-set libraries.

Interactive Chart Utility (PGF)

The Interactive Chart Utility operates on the display terminal. It can be invoked independently, or by a call interface from an application program. In either case, it enables the terminal user to create line graphs, surface charts, bar charts, histograms, pie charts, and Venn diagrams.

Basic Functions

Both GDDM and PGF contain functions that are used to construct a picture. They can be invoked by calls from application programs or by the utilities.

GDDM

The basic functions of GDDM provide for:

- Screen format control.
- User-defined coordinates.
- Deletion or clipping of parts of a picture to fit within a specified boundary.
- Alphameric input and display.
- Graphics construction and display (for example, lines, arcs, text, shaded areas).
- Control of attributes (color, line type, line width, symbols, shading patterns).
- Display and printing control.

  By incorporating calls to these functions in an external program, the customer application programmer can create any chart or picture compatible with the equipment available. For example, this interface can be used to design special-purpose displays other than the types offered by PGF.

PGF

The basic functions of PGF constitute a high-level interface to GDDM for constructing certain types of charts. These functions are called *Business Graphics Routines*, and are accessible by calls from an application program, which can be simpler than one employing GDDM functions directly. The Chart Utility also uses some of these routines.

The following types of chart can be produced by the Business Graphics Routines:

- Line graph (with or without data point markers).
- 'Scatter' plot (data points only, no lines).
- Surface chart.
- Histogram.
- Bar chart (composite, multiple, or floating).
- Pie chart (percentage or absolute values).
- Venn diagram.

The Operating Environment for GDDM and PGF

Processing Units

GDDM and PGF will run on any IBM System/370 or IBM 4300 series processing unit with sufficient storage to meet the combined requirements of:

- The host operating system.
- Access method.
- DB/DC or interactive subsystem.
- GDDM and PGF.
- The user application program.

  Both GDDM and PGF require the floating-point feature.

Programming Languages

The functions provided in GDDM and PGF are accessible by the following programming languages:
- FORTRAN.
- PL/I (with Optimizing Compiler).
- COBOL.
- System/370 Assembler language.
    CICS/VS cannot accept application programs written in FORTRAN.

Subsystem Environments

GDDM and the PGF feature can be used in the following subsystem environments:
- CICS/VS (DOS/VSE, OS/VS1, OS/VS2-MVS).
- TSO with ACF/TCAM or ACF/VTAM.
- VM/370 (CMS).
    VSAPL in the VM/CMS and TSO environments permits application programs to communicate with GDDM. VSAPL users are provided with functions similar to the PGF functions through a distributed workspace based on the IBM 3277 APL Graphics Attachment Support PRPQ P09014 (Program Number 5799-AXW).

Considerations for Customer Written Programs

The following paragraphs contain general advice about programming for the Programmed Symbols features. General information on programming for the 3270 can be found in the publication *Introduction to Programming the IBM 3270*, GC27-6999.

All users of the symbol set attributes, including those who intend to use them only for presentation graphics, should be aware of the following:
- Programmed symbol sets require support of the extensions to the 3270 Data Stream, and the use of the Write Structured Field command and the new orders provided by the data stream.
- Versions of access methods and subsystems that support the extensions to the 3270 Data Stream will be needed. These access methods and subsystems have been defined in Chapter 5.
- New subsystem releases will not affect existing application programs, and no extensive conversion of maps will be required.
- Extended attributes written by programs to control units that are not properly configured to handle them will be rejected. Devices equipped for extended function will accept the present 3270 data streams.
- When defining symbols, especially any that are to be used as a general fill or background pattern, the designer should avoid patterns in which the points occur predominantly on alternate rows of the character matrix only. This is because the devices refresh the screen image in two groups of alternate rows. Appropriately designed fill patterns are provided by GDDM.

As described above, GDDM both generates and loads the symbol sets that are required by a presentation graphics application. However, the system designer who wishes to use the programmed symbol sets in alphameric applications will need to consider the following points:
- The programmer must design and create the symbol sets needed by the application. Because the size of the point pattern used to define a symbol differs between display devices and printers, and between one display device and another, more than one symbol set may be needed. Normally, it will prove sound practice to maintain an installation library of these symbol set definitions. The Interactive Symbol Editor Utility of GDDM can be used to create these sets.
- The programmer must arrange for the device symbol set buffers to be loaded, using the Write Structured Field command or any higher level facility provided by the subsystem environment in which the program is to run.

- Routines within a program that are concerned with resetting the terminal to a known state following any abnormal condition should be capable of restoring the volatile symbol set storage if necessary. In most environments, the extended data

stream facilities for enquiring into the status of the devices can be used to
monitor the need for reloading.

● When programming the symbol sets at the character level, the following points
should be considered:

—If both field and character attributes apply to a particular character, the
character attribute will always take precedence.

—In formatted displays, whenever a character attribute is not specified, the field
attribute is applied by default.

—Character attributes can be used in unformatted displays. Programmed
symbols can therefore be used in applications that use unformatted displays.

—Character attributes are not positional; the character position to which they
refer is not fixed on the screen, as is the case with a field. They are tied to
their characters and are deleted and inserted with them. This is appropriate
for applications such as text entry, but it means that it is not possible to pre-
format a screen with character attributes in fixed positions except within
protected fields.

—Devices can hold up to six symbol sets, and operators can be provided with
keyboards that enable them to choose which symbol set to use as they enter
data. If this facility is used:

• The symbol sets that the operator will use must be loaded before data entry
begins. Installation standards will be needed to ensure that the operator
knows which symbol set selection key on the keyboard accesses which
loaded set, and also which data key accessses which individual symbol
within a set. Overlay keyboards are available to assist the operator in this.

• The Write Structured Field command must be used to enable operator
selection of the symbol set attribute and to include the attribute in data sent
from the terminal to the host.

• The application program must analyze and handle the incoming attributes.

**Printing using the Symbol
Sets**

The symbol sets of a printer need to be managed and loaded in the same way as
those of a display device.

The symbol sets themselves are never physically copied from a display device to a
printer. The programmer must ensure that any symbol set which may be needed for a
copy function is loaded when the application begins.

The local copy function is not appropriate for applications, such as presentation
graphics, that create and use symbol sets dynamically. Such applications should
produce their printed output by means of direct printing from the host.

Characters copied to a printer with a symbol set attribute that refers to a set not loaded
in the printer will print from the base character set of the printer with undefined results
for code points that are not supported in the base set. It is the responsibility of the
application designer to ensure that this does not give rise to any integrity problem.

**Programming of Triple-
Plane Symbol Sets**

Buffers for triple-plane symbol sets are provided on the 3279 Color Display Station
and the 3287 Printer Models 1C and 2C so that symbols containing more than one
color can be used in graphic applications.

The great majority of alphameric applications will need to associate only a single
color with a character position. The triple-plane symbol set buffers can be used
interchangeably with the normal single-plane buffers for this purpose; no special
symbol definition or programming is required. A more detailed discussion is given in
Chapter 7, 'Programmed Symbols Capability.'

When multicolored symbols are required, the appropriate patterns must be defined
in the three primary colors, loaded using the appropriate control structures, and
referenced for use with a 'neutral' color attribute. The GDDM program product
attends to all these matters.

Part 3. Configuration and Setup Planning

Chapter 10. Configuration

This chapter provides simplified configuration information for the 3279 Color Display Station and 3287 color printers. It also provides configuration information for the use of Programmed Symbols and APL/Text, on both color and monochrome devices.

Figure 10-1 shows the possible configurations for producing base color only.
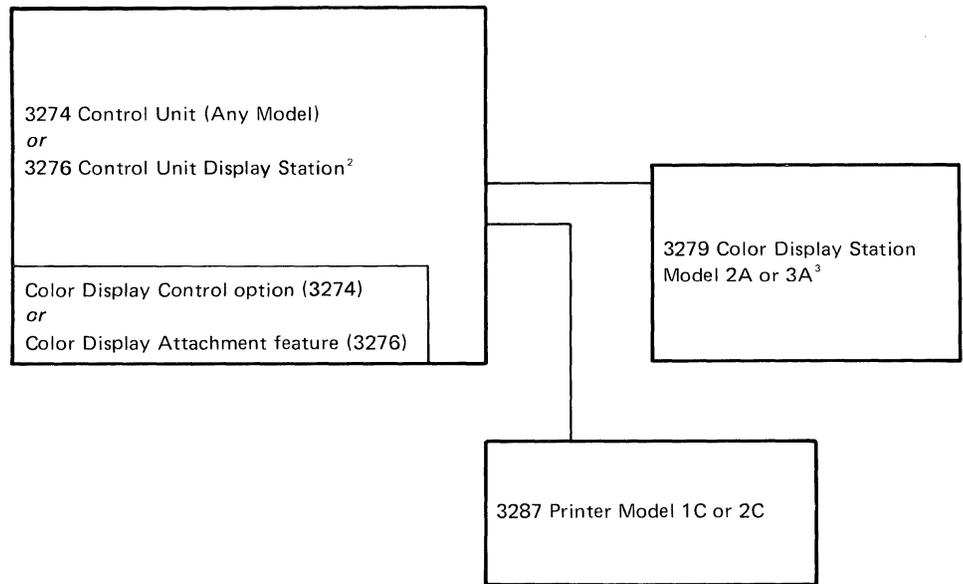
Notes:
1. *The Color Display Control option or Attachment feature is required only for the 3279, not for the printers.*
2. *3279 Model 2A cannot be attached to 3276 Model 1.*
   3279 Model 3A cannot be attached to 3276 Model 1 or 2.
3. *3279 Models 2B and 3B can be attached in the same way as Models 2A and 3A but only their base color capability can be used.*

Figure 10-1. Configurations Supporting Base Color Only

Figure 10-2 shows the possible configurations for producing extended color and for using Programmed Symbols and APL/Text features either in color or in monochrome.

The interdependencies of the various features and customization options are described below.

Control Unit Features and Options

Color Display Control or Color Display Attachment

This customization option (for 3274) or special feature (for 3276) is required if any 3279 Color Display Station is to be attached. The option or feature is not necessary for the 3287 color printers.

On the 3276 Control Unit Display Station, the Extended Function Base feature is a prerequisite for the Color Display Attachment feature.

3274 Control Unit
Model 1A, 1C, 1D, or 51C

Customization Options
- Color Display Control [1]
- Structured Field and [2,3] Attribute Processing
- Programmed Symbols [3]
- APL/Text Control [4]

3279 Color Display Station
Model 2B or 3B

PS–2 [3]	PS–4 [3A]
APL or Text Keyboards [4]	

3278 Display Station
Model 2, 3, or 4

Extended Character Set Adapter [2,3,4]

PS-2 [3]	PS-4 [3A]
APL/Text and APL or Text Keyboards	

3287 Printer Model 1C or 2C

Extended Character Set Adapter [2,3,4]

PS–2 [3] or PS-4A [3]	PS–4 [3A]
Extended Print Buffer [3]	
APL/Text [4]	

3287 Printer Model 1 or 2

Extended Character Set Adapter [2,3,4]

PS–2 [2,3]	PS–4 [3A]
Extended Print Buffer [3]	
APL/Text [4]	

Notes

1. The Color Display Control option is required only for the 3279, not for the color printers.
2. These features are required for Extended Color and Extended Highlighting.
3. These features are required for Programmed Symbols.
3A. These features are optional for Programmed Symbols.
4. These features are required for APL/Text. If only APL/Text is required, the terminal devices can also be attached to a 3276 Control Unit Display Station equipped with APL/Text Control. (When attached to a 3276, the screen capacity of the 3278 or 3279 must not be greater than that of the 3276.)

Figure 10-2. Configurations Supporting Extended Color, Programmed Symbols, and APL/Text

Structured Field and Attribute Processing

This customization option is required if the extensions to the 3270 Data Stream are to be used for extended color, extended highlighting, or Programmed Symbols.

Programmed Symbols

This customization option is required to use the Programmed Symbols feature(s) of any attached device.

APL/Text Control

This customization option (for 3274) or special feature (for 3276) is required to use the APL/Text capability of any attached device.

On the 3276 Control Unit Display Station, the Extended Function Base feature is a prerequisite for the APL/Text Control feature.

Configuration Support

On the 3274 Control Unit, the Color Display Control and APL/Text Control customization options are provided with all levels of Configuration Support. For the Structured Field and Attribute Processing and the Programmed Symbols customization options, Configuration Support 'C' must be specified. The necessary amount of control storage must also be provided on the 3274 to support the options that are required.

Terminal Device Features

Extended Character Set Adapter

This special feature is required if the extensions to the 3270 Data Stream or APL/Text are to be used. Extended color, extended highlighting, and Programmed Symbols all use the extensions to the 3270 Data Stream.

The Extended Character Set Adapter function is standard on the 3279 Models 2B and 3B.

To use the Extended Character Set Adapter, the Structured Field and Attribute Processing option and/or the APL/Text Control option is required on a 3274 Control Unit, and the APL/Text Control feature is required on a 3276 Control Unit Display Station.

PS-2 and PS-4 Features

These special features provide programmed symbols capability. PS-2 can be specified alone, but PS-4 is available only in addition to PS-2. These features require the Programmed Symbols option on the 3274 Control Unit.

PS-4A Feature

This special feature is available only on the 3287 Printer Models 1C and 2C. PS-4A can be specified only on its own, that is, without either PS-2 or PS-4. PS-4A requires the Programmed Symbols option on the 3274 Control Unit.

Extended Print Buffer

This special feature is required on any printer equipped with Programmed Symbols feature(s).

APL/Text

This special feature is available on the 3278 Display Station and 3287 Printers. The APL/Text capability is standard on the 3279 Color Display Station Models 2B and 3B. The APL/Text capability can only be used when APL/Text Control is present on the 3274 or 3276.

APL/Text Keyboards

Various APL and Text keyboards are available for display stations. Refer to Chapter 2 for details.

Chapter 11. Setup Planning

Introduction

The 3279 Color Display Station and the 3287 Printer Models 1C and 2C are, like their monochrome equivalents, designated as customer-setup machines. A planning and setup guide will be available in advance of the availability of the machines to enable the customer and the IBM Marketing Representative to develop a tailored plan for the setup of the machines.

The physical characteristics and requirements of the 3279 and the 3287 are given below.

The 3279 Color Display Station

	Display Unit	*Keyboard*
Height:	380 mm (15 in.)	90 mm (3.5 in.)
Width:	445 mm (17.5 in.)	See Note 3 below
Depth:	545 mm (21.5 in.)	255 mm (10 in.)
Weight:	~~21 kg (46 lb)~~ 27Kg (58 lb)	See Note 3 below

Notes:

1. *The 3279 is normally located on a customer-supplied desk or table. Recommended keyboard height (measured from the floor to the bottom of the keyboard) is 660 mm (26 in.).*
2. *The keyboard adds 254 mm (10 in.) to the depth of the display unit.*
3. *Depending on which keyboard is fitted, the keyboard width varies between 432 mm (17 in.) and 510 mm (20 in.); the keyboard weight varies between 4.5 kg (10 lb) and 6 kg (13 lb).*

Heat Output: 243 watts (207 kcal/hr 825 BTU/hr)

Airflow: Natural convection

Power Requirements: kVA 0.30
                        Phase 1
                        Ampacity 15

Power Cable: The power cable is 2.8 meters (9 feet) long if no alternative length is specified. Alternative lengths that can be specified are:

1.8 m (6 ft) in U.S. only
4.5 m (15 ft)

Voltages: The 3279 can be supplied to operate from various input voltages at 60 Hz or 50 Hz, as shown in Figure 11-1.

	100 – 127 Volts	200 – 240 Volts
IBM (United States/Canada)	X	
IBM World Trade Americas/Far East	X	X
IBM World Trade Europe/Middle East/Africa	X[1]	X

[1] Saudi Arabia only

Figure 11-1. Voltages that can be specified for 3279 Color Display Station

The 3287 Printer Models 1C and 2C

The physical characteristics and requirements of the 3287 Printer Models 1C and 2C are the same as for the Models 1 and 2. These details are summarized below.

Height: 254 mm (10 in.), or 349 mm (13.75 in.) with forms tractor
Width: 597 mm (23.5 in.)
Depth: 533 mm (21 in.)
Weight: 37.7 kg (83 lb), or 39.5 kg (87 lb) with forms tractor

There should be a minimum distance of 760 mm (30 in.) between the 3287 and any display terminal.

Heat Output: 215 kcal/hr (853 BTU/hr)

Airflow: 1.5 m³/min (55 CFM)
             3 m³/min (105 CFM) with Heavy-Duty Blower feature

Power Requirements: kVA 0.25
                      Phase 1
                      Ampacity 15

Power Cable: The power cable is 2.8 meters (9 feet) long if no alternative length is specified. Alternative lengths that can be specified are:

1.8 m (6 ft) — not available in E/ME/A
3.7 m (12 ft) — not available in E/ME/A
4.5 m (15 ft)

Voltages: The 3287 can be supplied to operate from various input voltages, as shown in the Figure 11-2.

	Volts at 60 Hz				Volts at 50 Hz					
	100	110	120	127	100	110	200	220	230	240
IBM United States/Canada			X							
IBM World Trade Americas/Far East	X	X	X	X	X	X	X	X	X	X
IBM World Trade Europe/Middle East/Africa			X¹					X		X

¹ Saudi Arabia only

Figure 11-2. Voltages that can be specified for 3287 Printer Models 1C and 2C

Environmental Requirements

The 3279 and the 3287 are designed to operate under heating and lighting conditions typical of commercial offices. Their environmental requirements are as follows:

Operating Temperature Range: 10°C to 40°C (50°F to 105°F)

Relative Humidity Range: 8% to 80%

Maximum Wet Bulb Temperature: 26.7°C (80°F)

Ambient Light: The 3279 has a built-in filter with an anti-reflective coating, and is designed to work under the normal range of office lighting. The terminal should be sited away from the glare of direct sunlight or other bright sources of light.

Index

IBM 3270 Information Display System:
Color and Programmed Symbols

**READER'S
COMMENT
FORM**

Order No. GA33-3056-0

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators
of IBM systems. This form may be used to communicate your views about this publication. They will be sent
to the author's department for whatever review and action, if any, is deemed appropriate. Comments may be
written in your own language; use of English is not required.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring
any obligation whatever. You may, of course, continue to use the information you supply.

Note: *Copies of IBM publications are not stocked at the location to which this form is addressed. Please direct
any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative
or to the IBM branch office serving your locality.*

Possible topics for comment are:

Clarity   Accuracy   Completeness   Organization   Index   Figures   Examples   Legibility

What is your occupation? _

Number of latest Technical Newsletter (if any) concerning this publication: _ _ _ _ _ _ _ _ _ _ _ _—

Please indicate in the space below if you wish a reply.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM
office or representative will be happy to forward your comments or you may mail directly to the address
in the Edition Notice on the back of the title page.)

GA33-3056-0

Reader's Comment Form

IBM®
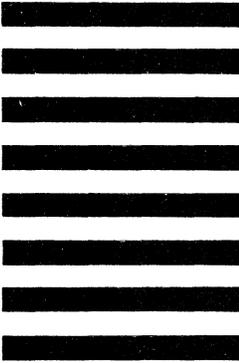
International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, N.Y. 10604

IBM World Trade Americas/Far East Corporation
Town of Mount Pleasant, Route 9, North Tarrytown, N.Y., U.S.A. 10591

IBM World Trade Europe/Middle East/Africa Corporation
360 Hamilton Avenue, White Plains, N.Y., U.S.A. 10601

IBM 3270 Information Display System: Color and Programmed Symbols   Printed in U.S.A.   GA33-3056-0

GA33-3056-0

IBM®