
PRELIMINARY
REFERENCE MANUAL

RETRO-GRAPHICS™

Terminal Enhancement, Models RG1000/TV60,61,62,63
For the TeleVideo® Model 910, 912, 920, 925, or 950 Video Terminal

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PREFACE

The Retro-Graphics™ Models RG1000/TV60,61,62,63 terminal enhancements are GEN.11™ graphics upgrade products from Digital Engineering, Inc. The RG1000/TV60,61,62,63 series is designed for use in the TeleVideo® Models 910, 912, 920, 925, and 950 video terminals. The TV60 enhancement is used in the Models 925 and 950, TV61 in the Model 910, TV62 in the Model 912, and TV63 in the Model 920. As there are no operational differences among these terminal enhancements, for ease of reference the phrase "RG1000" applies to the entire enhancement line.

This manual provides information and instructions for use of the Retro-Graphics enhanced TeleVideo terminal in graphics display applications.

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SECTION 1 - INTRODUCTION

The first part of this section introduces the reader to this manual and lists other publications applicable to the Retro-Graphics™ enhanced terminal. The second part introduces the reader to the Retro-Graphics concept, as implemented by the RG1000 enhancements.

1.1 USING THIS MANUAL

This Reference Manual was prepared for use as described in the following paragraphs.

1.1.1 Intended Audience

The information in the manual is intended for programmers, technicians, and experienced terminal operators (users who have at least some knowledge of computers in general and graphics applications in particular). The reader need not be familiar with Retro-Graphics terminal enhancements or the specific Tektronix® terminals they emulate.

1.1.2 Organization of Information

The manual is divided so that it may be easily used by readers of varying backgrounds. Section 1.2 provides an overview for readers unfamiliar with DE™ GEN.II™ terminal enhancements. Section 2 contains procedures to set up the enhanced terminal for operation with the host computer system. Section 3 gives information about how the RG1000 affects normal alphanumeric operation of the terminal. Section 4 describes use of the enhanced terminal as an emulator of the Tektronix 4027, with the assumption that the reader may have little or no knowledge of the 4027. Section 5 describes use of the enhanced terminal as an emulator of the Tektronix 4010, again assuming the reader may not have knowledge of the terminal. Appendix A contains detailed information about commands and control sequences accepted by the enhanced terminal.

1.1.3 Related Publications

Other manuals published by Digital Engineering to support the Retro-Graphics terminal enhancement are:

- RG1000/TV60 Installation Manual--provides information and procedures for retrofitting the TeleVideo® Model 925 or 950 terminal with the RG1000/TV60 kit.
- RG1000/TV61,62,63 Installation Manual--provides information and procedures for retrofitting the TeleVideo Model 910, 912, or 920 with the RG1000/TV61,62,63 kit.

These manuals should be used along with documentation for the standard video terminal and the graphics applications programs to be used with the enhanced terminal.

1.2 THE RETRO-GRAPHICS CONCEPT

Retro-Graphics terminal enhancements convert alphanumeric terminals into graphics terminals. Previous Retro-Graphics products, such as the VT640 for the DEC™ VT100™, emulate the Tektronix 4010 Computer Display Terminal. The RG1000 is a GEN.II Retro-Graphics product; it emulates most functions of the Tektronix 4027 Color Graphics Terminal and provides additional advanced graphics features. For compatibility with other Tektronix and DE products, the RG1000 also emulates the Tektronix 4010.

1.2.1 Bit-Map Graphics

The Retro-Graphics enhancement uses the bit-map method of creating a graphics display. The display area of the terminal screen is divided into a rectangular grid of dots called pixels (short for "picture elements"). Data bits stored in a video memory array define which pixels are "on" (light) and which are "off" (dark). Graphics elements are drawn by a microprocessor, which writes data into the video memory. This data is then "mapped" from the video memory to the screen by RG1000 and terminal display circuits.

The graphics display area is composed of 640 pixels in the horizontal direction and 240 in the vertical direction. Each location (pixel) in the display is identified by (X,Y) coordinates, starting with (0,0) in the lower left corner and ending with (639,239) in the upper right corner when the entire display area is used. Coordinates that refer directly to pixels in the display are called screen coordinates in this manual. Figure 1-1 illustrates RG1000 screen coordinates.

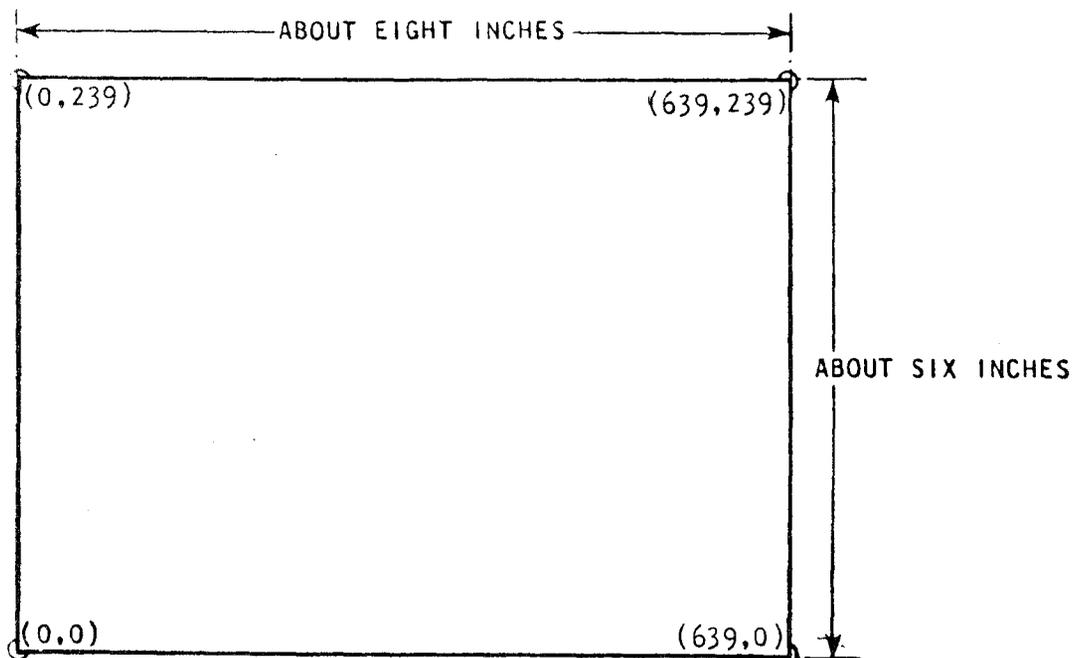


Figure 1-1. Screen Coordinates

The RG1000 can be set to accept input that refers to screen coordinates or to coordinates used by one of the Tektronix terminals it emulates. The RG1000 scales graphics based on the Tektronix 4010 or 4027 coordinate systems so they can be displayed on the terminal screen with the intended proportions. More information about scaling is contained in Appendix A under the SHRINK command.

1.2.2 Modes of Operation

The enhanced terminal can be operated in any of three modes: TRANSPARENT MODE, 4027 MODE, or 4010 MODE. These modes of operation are shown in upper-case text in this manual to distinguish them from other terminal and RG1000 modes. Transitions from one mode to another are made with F keys, menu selections, or escape sequences, as shown in Figure 1-2.

In TRANSPARENT MODE the enhanced terminal functions as though it were not equipped with the terminal enhancement. With a few exceptions, the RG1000 is "transparent" to both the terminal and the host computer. Section 3 contains information about these exceptions.

In 4027 MODE the terminal emulates a subset of the Tektronix 4027 commands and performs additional functions. In this mode internal firmware controls many functions, reducing the amount of host computer time required to create a graphics display. The terminal CRT is monochrome, but colors displayed by the 4027 are simulated with patterns of dots called shading patterns. Section 4 describes use of the enhanced terminal in 4027 MODE; Appendix A contains details about each 4027-MODE command.

In 4010 MODE the terminal emulates the Tektronix 4010. Section 5 describes use of the enhanced terminal in 4010 MODE; Appendix A contains details about each control sequence used in 4010 MODE.

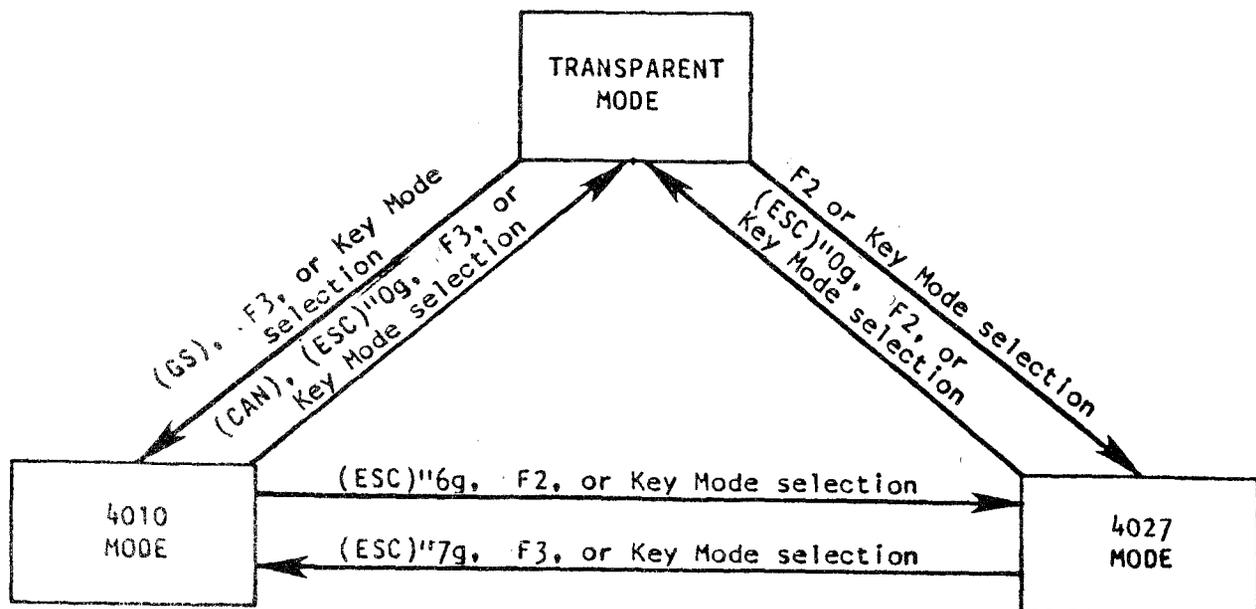


Figure 1-2. Mode Transition Diagram

1.2.3 Functional Block Diagram

The Retro-Graphics terminal enhancement is placed functionally between the video terminal and the host computer system (Figure 1-3). It handles communications between the terminal and the host, taking control when Retro-Graphics functions are to be performed. Video from the terminal is mixed with video from the RG1000, so the display can be partly or entirely created from either source.

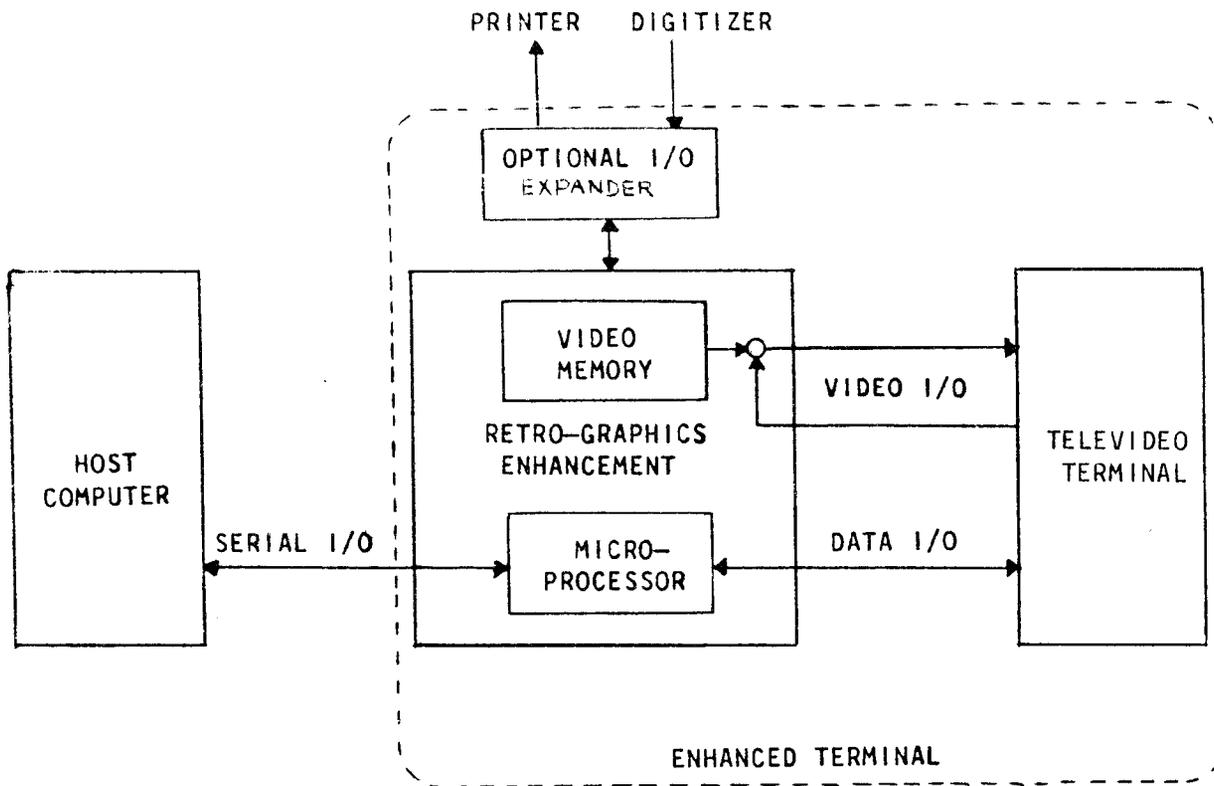


Figure 1-3. Retro-Graphics Functional Block Diagram

SECTION 2 - SETUP AND SELF-TEST

Because the Retro-Graphics enhancement is placed functionally between the terminal and the host computer, two communications interfaces must be set up: terminal-to-RG1000 and RG1000-to-host (Figure 2-1). The terminal-to-RG1000 interface, which is set with the terminal's switches, is always configured to standard Retro-Graphics parameters. The RG1000-to-host interface, defined using RG1000 commands, varies according to requirements of the host system. Sections 2.1 and 2.2, respectively, contain procedures for setting up these interfaces.

Terminal settings not mentioned in this manual are optional and can be set according to user preference or the requirements of a specific application, as described in the TeleVideo operator's manual.

Many of the RG1000 settings can be stored in nonvolatile memory; these settings are only recalled when the terminal is powered off and back on (resetting the terminal does not reset the RG1000).

When the terminal is properly set up, two self-test routines can be initiated from the keyboard, a memory test and a graphics display test. Section 2.3 describes these self-tests.

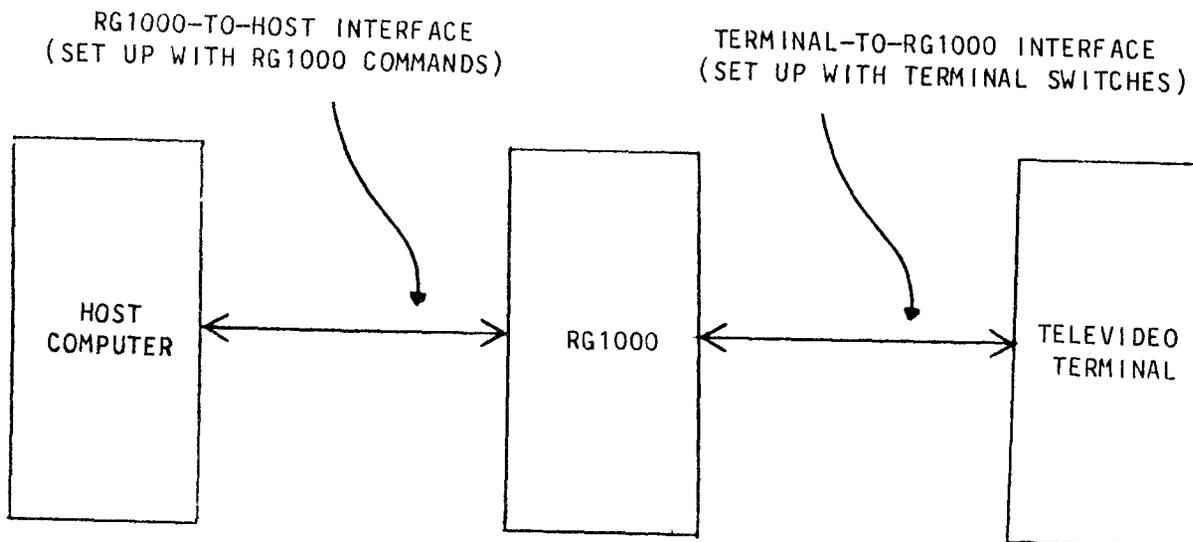


Figure 2-1. Terminal/RG1000 Interfaces

2.1 Setting Up Terminal-to-RG1000 Communications

The terminal cannot communicate with either the RG1000 or the host until the required communications settings have been made via the terminal's switches. Use the following procedure to make these settings. More information about terminal switches can be found in the appropriate TeleVideo operator's manual.

1. Make sure the terminal is properly connected to the host computer system and apply power. After a brief delay, the following message should appear on the screen*:

Vx.x (C) Copyright Digital Engineering, Inc. 1982

2. Make the following switch settings according to the model of terminal in use.

Model 950 Switch Settings

Switch S1-1	DOWN	(S1-1 through S1-4 set 9600 baud rate)
Switch S1-2	DOWN	
Switch S1-3	DOWN	
Switch S1-4	DOWN	
Switch S1-5	DOWN	(S1-5 sets 8 bits-per-character)
Switch S1-6	DOWN	(S1-6 sets 1 stop bit)
Switch S2-1	UP	(S2-1 sets duplex on)
Switch S2-3	DOWN	(S2-3 through S2-5 set no parity)
Switch S2-4	DOWN	
Switch S2-5	DOWN	
Switch S2-7	DOWN	(S2-7 and S2-8 set full duplex)
Switch S2-8	UP	
Switch S2-9	UP/ DOWN	(S2-9 up for 60 Hertz) (S2-9 down for 50 Hertz)

Model 925 Switch Settings

Switch S1		(all S1 switch settings same as Model 950)
Switch S2-1	DOWN	(S2-1 sets duplex on)
Switch S2-2	DOWN	(S2-2 sets Model 925 operation)
Switch S2-3	DOWN	(S2-3 through S2-5 set no parity)
Switch S2-4	DOWN	
Switch S2-5	DOWN	
Switch S2-7	UP	(S2-7 and S2-8 set full duplex)
Switch S2-8	DOWN	
Switch S2-9	UP/ DOWN	(S2-9 up for 60 Hertz) (S2-9 down for 50 Hertz)

* It is not abnormal for a Retro-Graphics enhanced terminal to initially power on with the message NOV RAM ERROR. This message appears if nothing has been previously saved in the RG1000 nonvolatile memory. If the message occurs after one or more values have been saved (Section 2.2), it indicates a failure of the nonvolatile RAM.

Models 912 and 920 Switch Settings

Switch S1-1	UP	(S1-1 through S1-10 set baud rate)
Switch S1-2	DOWN	(Sets 9600 baud)
Switch S1-3 through 10	UP	
Switch S2-1	UP	(S1-1 UP mandatory for 912/920)
Switch S2-2	DOWN	(Sets standard character set)
Switch S2-3	UP	(Sets full duplex)
Switch S2-4	UP/ DOWN	(Sets 60 Hertz) (Sets 50 Hertz)
Switch S2-5	UP	(Sets no parity)
Switch S2-6	DOWN	(Sets 1 stop bit)
Switch S2-7	UP	(Sets 8-bit word)
Switch S2-8	UP	(S2-8 UP mandatory for 912/920)
Switch S2-9	-	(Setting not used by RG1000)
Switch S2-10	-	(Cursor setting user-selectable)
Switch S3	-	(See 912/920 documentation to set Switch S3 for host compatibility)
Switch S5	-	(See 912/920 documentation to set Switch S5 for host compatibility)

Model 910 Switch Settings

Switch S1-1,2,3,4	DOWN	(Sets 9600 baud rate)
Switch S1-5	DOWN	(Sets 8-bit word)
Switch S1-6	DOWN	(Sets no parity)
Switch S1-7	-	(Setting not used by RG1000)
Switch S1-8	DOWN	(Sets 1 stop bit)
Switch S1-9,10	-	(Setting not used by RG1000)
Switch S2-1,2	DOWN	(Sets standard 910 operation)
Switch S2-3	UP/ DOWN	(Sets 60 Hertz) (Sets 50 Hertz)
Switch S2-4,5	-	(Cursor setting user-selectable)
Switch S2-6	UP	(Sets full duplex)
Switch S2-7	UP	(Sets screen dark)
Switch S2-8,9,10	-	(See Model 910 documentation to set S2-8,9,10 for host compatibility)

Make other settings as required by the user. Turn the terminal off and on again to make the new switch settings take effect.

NOTE

If an ANSWERBACK MESSAGE is defined (and is echoed by the host or local echo) it must not contain a control character acted on by the RG1000. For example, the enhanced terminal enters 4010 MODE and initiates vector drawing when it receives a (GS) character.

The terminal is set up for communications with the RG1000, but communications with the host must still be established as described in Section 2.2.

2.2 Setting Up RG1000-to-Host Communications

Use the following procedure to set up communications between the RG1000 and the host computer. More details about each command are given in Appendix A.

1. Simultaneously press the CTRL and B keys. The "Key Mode" menu shown below should be displayed across the bottom of the screen. If the (mode) indication to the right of the menu is not 4027, position the cursor at the 4027 selection with the right/left arrow keys and press RETURN.

```
CLR 4027 4010 TRAN PRT F1234567890123 SF1234567890123 PD0123456789.TESB (mode)
```

For Models 925 and 950: Enter the command !TERminal 1(CR)

For Models 910, 912, and 920: Enter the command !TERminal 2(CR)

This setting ensures that the terminal enhancement recognizes the model of TeleVideo terminal in which it is operating.

2. Determine the communications settings required by the host computer:

!BAUd (transmit),(receive)(CR)	Set transmit/receive rate
!DUPlEx (duplex)(CR)	Set duplex
!NBIts (bits)	Set number of bits per byte
!PARity (parity)(CR)	Set parity
!RSS (remote start/stop protocol)	Set communications protocol
!SBIIts (bits)	Set number of stop bits

3. If any of the following communications settings are required, enter them with the appropriate 4027-MODE commands (Table 2-1 lists permissible values):

!ECHO (echo)(CR)	Set echo
!PAUse (delay)(CR)	Set transmission delay *
!TRAIler (code),(code)(CR)	Define trailer codes **

* Transmission delay can be used if for any reason a delay must be introduced between characters transmitted to the host computer. The default setting of (0) is usually used.

** Trailer codes are appended to each string of graphics data transmitted by the RG1000 to the host computer. A single (CR) is commonly used.

4. If any initial operating-attribute settings are to be made, enter them with the appropriate 4027-MODE commands (Table 2-2 lists permissible values):

!ENTry (mode)(CR)	Set entry mode
!INPut (source)(CR)	Set graphics input source
!MARGins (margins)(CR)	Set margins
!PFKey (settings)(CR)	Enable/disable key mode
!STOps (tab stops)(CR)	Set tab stops
!TERminal (terminal type)(CR)	Set terminal type
!HERtz (frequency)(CR)	Set frequency

5. Type !SAVe (CR) to save these settings in nonvolatile memory.

Table 2-1. Terminal Enhancement-to-Host-Computer Communications Settings

<u>KEYWORD</u>	<u>PARAMETER</u>	<u>PERMISSIBLE VALUES</u>
BAUD	(transmit) (receive)	(50/75/110/134/150/300/600/1200/1800/ 2000/2400/3600/4800/7200/9600/19200) same as (transmit)
DUPlEx	(duplex)	(Full,Modem) (Full,Nomodem) (Half)
ECHo	(echo)	(Local/Remote)
NBIts	(bits)	7 or 8
PARity	(parity)	(Even/Odd/None/High/Low)
PAUse	(pause)	(positive integer)
RSS	(protocol)	(No/Host/Terminal/Both)
SBIts	(bits)	1, 2, or 4
TRAIler	(code),(code)	0-127 Any ASCII Decimal Equivalent (ADE)

Table 2-2. Enhanced Terminal Operating Attribute Settings

<u>KEYWORD</u>	<u>PARAMETER</u>	<u>PERMISSIBLE VALUES</u>
ENTry	(mode)	(1/2/3) 1 = TRANSPARENT; 2 = 4027; 3 = 4010
INPut	(source)	(1/2/3) 1 = crosshair cursor; 2 = light pen 3 = digitizing tablet
MARgins	(left) (right)	(1) - (79) inclusive (2) - (80) inclusive
PFKey	(setting)	(L/R) Local = enable (CTRL B) and function keys Remote = disable (CTRL B) and function keys
STOps	(tab stops)	(n,n,n . . .n) each n between 2 and 80 in ascending order, maximum 12 stops
TERminal	(1) (2)	(1) identifies terminal as a Model 925 or 950 (2) identifies terminal as a Model 910, 912, or 920
HERtz	(frequency)	(50/60) 50 = 50 Hertz; 60 = 60 Hertz

- Power the terminal off and back on. After a brief delay, the copyright message should appear. A NOVRAM ERROR message should not appear; if there is a NOVRAM ERROR, the RG1000 enhancement must be repaired. See Appendix A, Table A-4, for default communications settings that apply when a NOVRAM ERROR occurs.

The enhanced terminal should now communicate correctly with the host computer. Settings can be changed and saved at any time as requirements change. After the terminal is set up for operation, see Section 4 for information about operation as a 4027-type graphics terminal and Section 5 for information about operation as a 4010-type graphics terminal.

2.3 Initiating the Memory and Graphics Self-Tests

Built-in self-test routines check operation of the enhanced terminal. These tests are invoked with the following commands:

```
!GTest [RETURN]    graphics memory test
!TTest [RETURN]    graphics display test
```

The !GTest command initiates a test of the enhanced terminal's memory. On successful completion of the test, the messages "RAM OK" and "ROM OK" are displayed. If the test fails, the message STATIC RAM ERROR, GRAPHICS RAM ERROR, or ROM #___ ERROR is displayed.

The !TTest command initiates a sample graphics display to demonstrate overall operation of the enhanced terminal. The test display shows the characters in each standard font and displays sample graphics (see Figure 2-2).

SECTION 3 - TRANSPARENT MODE

When operated in TRANSPARENT MODE, the Retro-Graphics enhanced terminal functions as a standard TeleVideo terminal; see the appropriate TeleVideo operator's manual for information. The few differences between a standard TeleVideo terminal and TRANSPARENT-MODE operation of an enhanced terminal are detailed in the following paragraphs.

3.1 FUNCTIONS

The RG1000 imposes very few functional limitations on operation of the terminal as an alphanumeric terminal:

- The ASCII (GS) control character is used to access 4010 MODE. Unintentional transitions into 4010 MODE occur if the (GS) is sent or echoed to the RG1000 for any other reason.
- The control sequences sent by the F1-F4 keys are normally used by the RG1000 for local Retro-Graphics functions such as mode transitions. The RG1000 can, however, be set up to send them to the host instead.

SECTION 4 - 4027 MODE

In 4027 MODE the enhanced terminal emulates most of the functions of a Tektronix 4027 Color Graphics Terminal. Programs written according to 4027 protocol should run correctly with the Retro-Graphics enhancement. The following functions are performed in 4027 MODE:

- Setting up the terminal for display of graphics
- Plotting (drawing) points, lines, arcs, filled polygons, and filled arcs
- Entering dot matrix or vector character text into the graphics display
- Transmitting selected points for interactive applications
- Displaying and reporting status
- Copying, storing, and retrieving blocks of graphics data
- Programming and executing function keys and macros
- Printing the graphics display (an optional printer interface is required)

The following topics are covered in this section:

- 4.1 Using 4027-MODE Commands and Coordinates
- 4.2 Entering and Leaving 4027 MODE
- 4.3 Preparing for Graphics and Text
- 4.4 Drawing Graphics
- 4.5 Adding Text to the Display
- 4.6 Erasing Graphics and Text
- 4.7 Using Graphics Input Mode (Crosshair Cursor)
- 4.8 Displaying and Reporting Status
- 4.9 Transferring Blocks of Graphics Data
- 4.10 Programming Keys and Macros
- 4.11 Producing Hardcopy Output
- 4.12 Programming the Host

The first topic is an overview of the command structure and coordinate systems used in 4027 MODE. It is not intended that the user perform any 4027-MODE functions while reading Section 4.1. Subsequent topics are written so the user may try each function from the keyboard as it is presented. Each 4027-MODE command is briefly explained and, in most cases, illustrated with an example. Appendix A lists 4027-MODE commands alphabetically and provides detailed command and parameter information (defaults, acceptable value ranges, optional parameters, etc.).

4.1 4027-MODE COMMANDS AND COORDINATES

In 4027 MODE the enhanced terminal expects inputs from the keyboard or host to follow Tektronix 4027 protocol. The next few paragraphs summarize the 4027 command structure and coordinate system for readers who have not previously used them.

4.1.1 4027 Command Structure

4027-MODE commands are based on easily remembered "keywords" that serve as mnemonics for the function performed by the command; for example, the VECTOR command draws a vector or line in the display. The entire keyword can be used, but only the first three letters are necessary. To distinguish it from ordinary text, the command must be preceded by a command character, usually the exclamation point (!). Most commands are followed by parameters to further define the function being performed (such as coordinates for drawing). The command must be terminated so the RG1000 can tell when it has received the complete command; the carriage return (CR) control code terminates a single command. For example, a command to set workspace margins at column 10 and 70 would look this way:

```
!MAR 10,70(CR)
```

All 4027 commands follow the basic format described above. Additional details about 4027 command structure follow:

- The default command character is the (!); the user may select a different character (see the !COMmand command in Appendix A). The command character cannot be used as a delimiter or in text (except within a delimited string).
- The keyword must immediately follow the command character with no spaces or other characters between them.
- A non-numeric parameter must be separated from the keyword or preceding parameter by one or more commas or spaces; a numeric parameter need not be separated from the keyword or a non-numeric parameter. Non-numeric parameters may be truncated (e.g., y = yes).
- Each command must be terminated with a (;), a (CR), or the command character of another command. A series of commands can be sent in a continuous string, with each command terminated by the command character of the next and the entire string terminated by a (CR).

When a command is explained in this manual, the following conventions are used:

- The (!) is always used as the command character.
- The keyword is completely spelled out as a memory aid. The shortest acceptable truncation (first three characters) is shown upper case, but may be entered as either upper-case or lower-case characters.

- A space separates the keyword from the first parameter.
- A comma separates each parameter from the next.
- The name given to each required parameter is shown in parentheses; the name of each optional parameter is shown in square brackets.
- The single-letter truncation for each non-numeric parameter is shown upper case, but may be entered either upper or lower case.
- The (CR) terminator is always shown at the end of a command or string of commands.

EXAMPLES:

```
!ENTry 1(CR)
!PARity E!SAVE(CR)
!WORKspace 30,H(CR)
!VECTor 0,0,100,100,0,200,100,300,0,400,100,500(CR)
```

Execution of commands from the host computer begins on receipt of the command character; execution of commands from the keyboard does not begin until RETURN is pressed. Commands from the host are not displayed on the screen; commands from the keyboard are displayed in the monitor before execution.

When the terminal does not recognize a keyboard-entered command, it displays the WHAT? message; when it does not recognize a command from the host, it displays the invalid command in the monitor.

Valid Tektronix 4027 commands not emulated by the terminal are accepted without response.

4.1.2 4027 Coordinate Systems

The 4027 coordinate system is based on the resolution of the Tektronix 4027 display: 640 pixels horizontally by 480 pixels vertically. At least one line of monitor must be defined for display of commands and messages; the range of graphics coordinates that can be displayed is 0-640 and 0-461. The 4027 is also capable of using the Tektronix 4010 coordinate system: 1024 pixels horizontally by 780 pixels vertically. Again, there must be one line of monitor; the actual grid of 4010 coordinates that can be displayed at one time is 1024 by 749.

In 4027 MODE the terminal can be set to draw using any of three coordinate systems: 4027, 4010, or screen coordinates. 4027 or 4010 coordinates are scaled to screen coordinates for display according to a setting made with the !SHRink command. Figure 4-1 shows the scaling factors used in each case.

Assuming the terminal is set up with the maximum possible space allocated for graphics (graphics region), any of the following commands will draw a box around the entire graphics region:

```
!SHRink NVECTOR 0,0, 639,0, 639,461, 0,461, 0,0(CR)
!SHRink YVECTOR 0,0, 1023,0, 1023,739, 0,739, 0,0(CR)
!SHRink DVECTOR 0,0, 639,0, 639,230, 0,230, 0,0(CR)
```

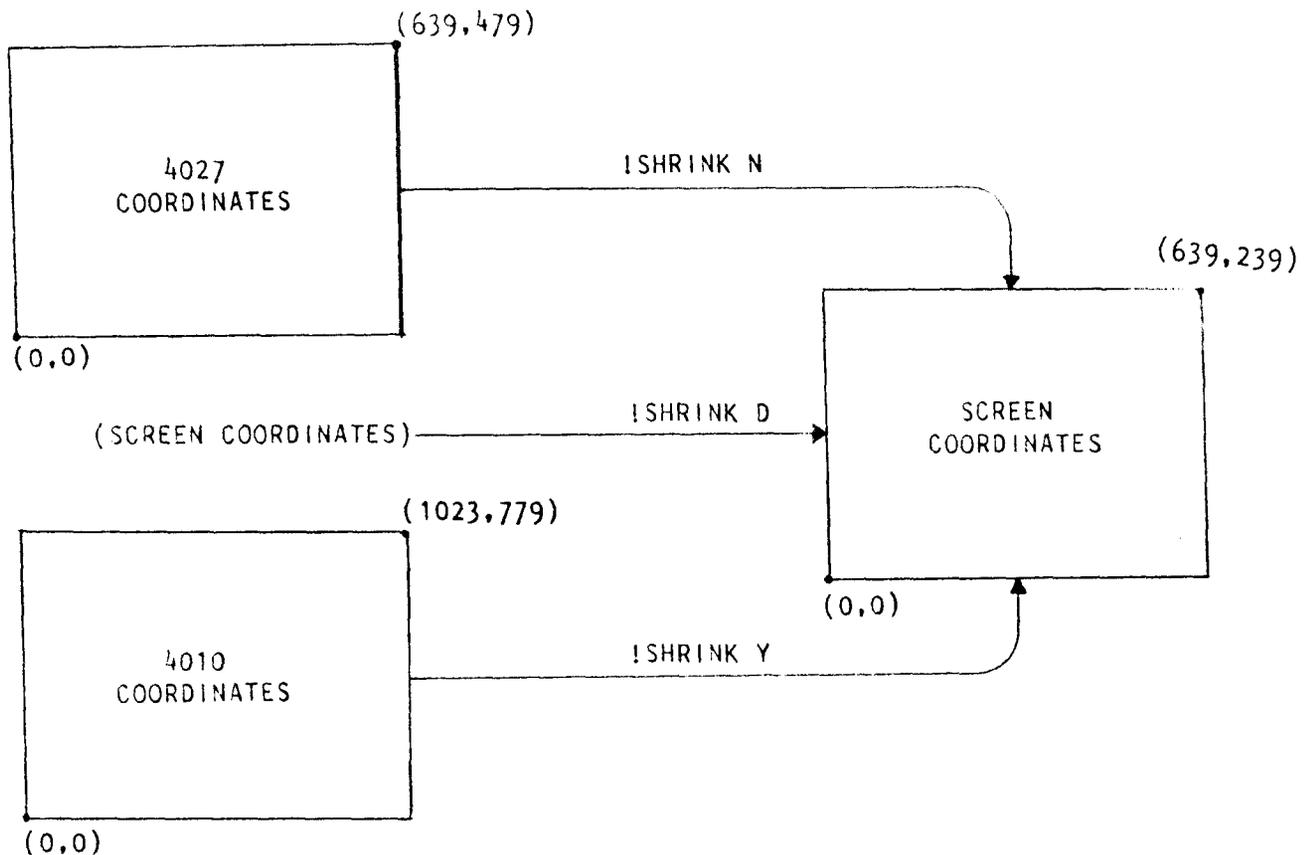


Figure 4-1. Coordinate Scaling

4.1.3 4027 Display

In 4027 MODE the display is divided into two regions: workspace and monitor. The workspace is the area that displays graphics and text; the monitor is the area that displays commands entered from the keyboard and messages from either the host computer or the Retro-Graphics enhancement. The workspace and monitor must be defined before a graphics display can be created (Section 4.3 describes how to do this). Figure 4-2 shows the 4027-MODE display with one line of monitor and the rest of the display defined as workspace.

NOTE

The Tektronix 4027 can draw beyond the vertical limits of the screen and scroll up or down to display graphics that are off the screen. The Retro-Graphics enhanced terminal is limited to a single-screen nonscrolling display.

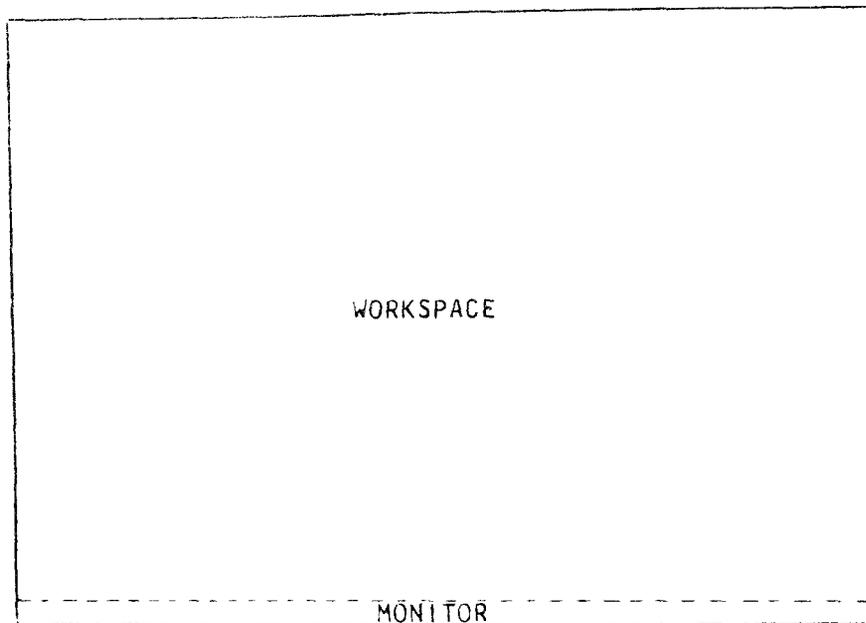


Figure 4-2. 4027-MODE Display

4.2 ENTERING AND LEAVING 4027 MODE

The terminal enters 4027 MODE in any of the following ways:

- If 4027 MODE is the "entry mode" setting saved in nonvolatile memory, the terminal automatically enters 4027 MODE at power on. Entry mode is set with the !ENTRY command (4027 MODE is the default setting).
- Pressing the F2 key while in TRANSPARENT or 4010 MODE enters 4027 MODE; pressing it again exits to TRANSPARENT MODE (PF keys must be set to "local").
- Pressing (CTRL B) while in any mode of operation displays the Key Mode menu. Positioning the cursor at "4027" with the arrow keys and pressing RETURN selects 4027 MODE.
- An (ESC)"6g sequence from the host enters 4027 MODE from 4010 MODE; a (GS)(ESC)"6g sequence from the host enters 4027 MODE from TRANSPARENT MODE.

The (GS)(ESC)"6g sequence enters 4027 MODE via 4010 MODE. The (GS) character is the only host-controllable means of leaving TRANSPARENT MODE, minimizing the chance of accidental transitions out of TRANSPARENT MODE. Unless echo is set to "local" the (ESC)"6g or (GS) cannot be used from the keyboard.

To determine the mode of operation at any time, press (CTRL B) to display the Key Mode menu. The current mode is shown to the right of the menu. Press (CTRL B) again to exit Key Mode.

4.3 PREPARING FOR GRAPHICS AND TEXT

It is necessary to make several definitions and selections before beginning a graphics display. First the workspace and monitor must be defined. Then a graphics region must be created within the workspace. Other definitions and selections that affect the display can also be made:

- Scaling for input coordinates
- Complement Mode
- Line type for vectors and boundaries
- "Color" (shading pattern) for area fill
- Character font for text
- Definitions for use of vector characters

4.3.1 Defining the Workspace and Monitor

When the terminal enters 4027 MODE, no workspace is defined (the entire screen is monitor). The size of either the workspace or the monitor may be explicitly defined; the other comprises the remainder of the screen. Size is defined in terms of text lines (0-34). There must be at least one line of monitor. Either of the following commands will define the largest possible workspace:

```
!WORKspace 33(CR) = 33 lines of workspace, 1 line of monitor
!MONitor 1(CR)    = 1 line of monitor, 33 lines of workspace
```

When 4027 MODE is first entered, text (characters that are not part of a command) from the host is displayed in the monitor and text from the keyboard is sent to the host. The disposition of text can, however, be changed by adding a source parameter to either command:

```
!WORKspace 33,K(CR) = Keyboard text is displayed in the
                    33-line workspace (not sent to the
                    host); the disposition of text from the
                    host is unchanged.
!MONitor 10,H(CR)   = Host text is displayed in the 10-line
                    monitor; the disposition of text from
                    the keyboard is unchanged.
```

Whenever the size of the workspace or monitor is specified, as in the preceding examples, the screen is erased when the region is redefined. The disposition of text can be changed without erasing the screen by specifying only the source parameter in either command:

```
!WORKspace K(CR)   = Keyboard text is displayed in the
                    workspace.
!MONitor H,K(CR)   = Host text is displayed in the monitor
                    and keyboard text is sent to the host.
```

To see how many lines are allocated to the workspace and what sources are selected for text, use the !SYStat command (see Section 4.8). Figure 4-3 illustrates the workspace/monitor display and the sources of text for each.

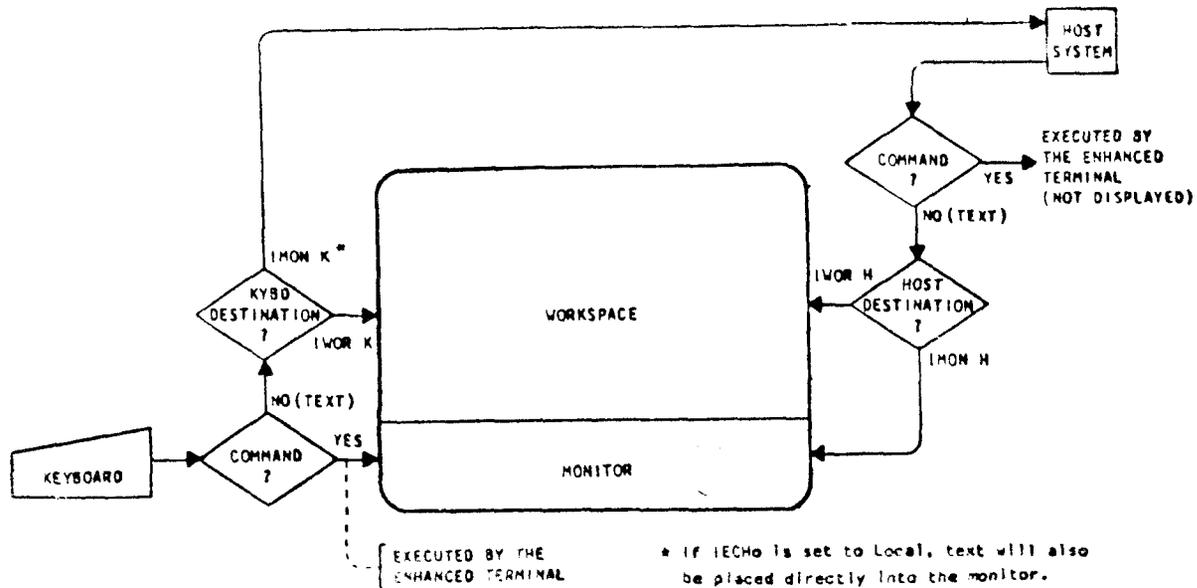


Figure 4-3. Workspace/Monitor Display

4.3.2 Defining a Graphics Region

A graphics region must be defined within the workspace before the enhanced terminal will execute commands to draw graphics. The graphics region, like the workspace, is defined in terms of lines of text. The following command defines a graphics region that starts at line 1 (top line) and ends at line 20 of the workspace:

```
!Graphic 1,20(CR)
```

The left and right limits of the graphics region default to columns 1 and 80, respectively, but they may be specified with additional (optional) parameters. (X,Y) coordinates refer to the most recently defined graphics region. The following command defines a graphics region with the same vertical limits as the previous example, but the left side is at text column 10 and the right side is at column 70:

```
!Graphic 1,20,10,70(CR)
```

More than one graphics region can be defined, but graphics are drawn only in the one most recently defined. Graphics coordinates identify locations in relation to the lower left corner of the current graphics region (0,0). For example, the following commands divide the display into quarters and draw graphics in the center of each region as shown in Figure 4-4:

```
!WORKspace 30!Graphic 1,15,1,40!VECTOR 160,120!CIRCLE 50(CR)
!Graphic 1,15,41,80!VECTOR 160,120!PIE 50(CR)
!Graphic 16,30,1,40!VECTOR 110,70,110,170,210,170,210,70,110,70(CR)
!Graphic 16,30,41,80!POLYgon 110,70,110,170,210,170,210,70(CR)
```

The graphics regions in the preceding example did not overlap. Because a graphics region is erased when it is defined, any previously drawn graphics that fall within its boundaries will be erased.

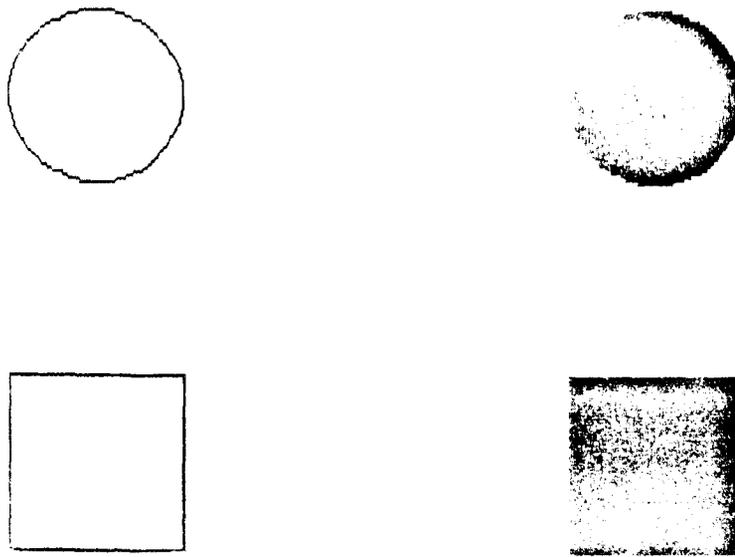


Figure 4-4. Multiple Graphics Regions

4.3.3 Setting Coordinate Scaling

At power on the enhanced terminal is set to scale Tektronix 4027 coordinates to screen coordinates. Some applications may use 4010 coordinates or screen coordinates. Change the scaling factor as required with the !SHRink command and the Yes, Direct, or No parameter:

```
!SHRink Y(CR)      scale 4010 coordinates to screen coordinates
!SHRink D(CR)      use screen coordinates directly (no scaling)
!SHRink N(CR)      scale 4027 coordinates to screen coordinates
```

!SHRink Y and !SHRink N are Tektronix 4027 commands. !SHRink D, an additional Retro-Graphics command, would only be used in graphics applications designed specifically for use with the Retro-Graphics enhanced terminal.

4.3.4 Selecting the Line Type

The default line type at power on is the "normal" solid line. Other line types can be selected with the !LINE command. Available selections are:

```
!LINE 1  _____
!LINE 2  .....
!LINE 3  - - - - -
!LINE 4  . - . - .
!LINE 5  _ _ _ _ _
!LINE 6  - - - - -
!LINE 7  - - - - -
!LINE 8  - - - - -
!LINE 9  (user defined)
!LINE e  (erasing line)
!LINE p  (endpoints only)
```

If a line type other than those provided by 1-8 above is needed, the user can define line 9 as a pattern of "on" and "off" pixels. See the !DfLine command in Appendix A for details about this command.

4.3.5 Selecting the "Color" for Graphics

At power on the default "color" for all graphics is white. Other "colors" can be selected with the !COLor command and color numbers C0 through C7. At power on C0 is white, C2 through C6 are a selection of shading patterns that simulate colors, and C7 is black. The following command selects the shading pattern that corresponds to color number C6:

```
!COLor C6(CR)
```

After entry of the preceding command, the C6 pattern will be used to shade the interior areas of filled shapes (polygons and "pies"). Vectors and boundaries will be drawn in white using the currently selected line type.*

Boundaries of filled shapes can be separately defined by adding a second parameter to the !COLor command. The first color number then defines the color of vectors and area fill, the second defines the color of boundaries. The following command selects C3 for vectors and area fill, and C7 (black) for boundaries:

```
!COLor C3,C7(CR)
```

For compatibility with full-color graphics applications, all color numbers are accepted. The "color" (pattern) represented by any color number can be changed with the !MAP, !RMAP, and !MIX commands. See Appendix A for details about these commands.

4.3.6 Setting Complement Mode

At power on the terminal is set to "write" graphics and text without regard for what is already displayed at the same locations. A solid line is drawn in white by turning each pixel "on" regardless of its previous state. Sometimes, however, it is desirable to take into account the existing state of each pixel when entering new graphics or text. This is done by setting Complement Mode with the command !CMODE Y. The new state of each pixel being written over is determined by comparing its current state with the new data using the EXCLUSIVE OR function. When in Complement Mode, writing data that would normally turn on a series of pixels actually reverses the current state of each pixel. Drawing something and then redrawing it in Complement Mode effectively erases it. The command !CMODE N resets Complement Mode.

* Vectors and boundaries can be drawn only in black or white (not shading patterns); any color number selected for vectors and boundaries will result in white unless it is defined as solid black. This color limitation applies to all graphics commands (!VECTOR, !RVECTOR, !PIE, !FONT, etc.). C7 is normally the only color number that is defined as black, but the definition of any color number can be changed with the !MAP, !RMAP, or !MIX commands. See Appendix A for details about these commands.

The following series of commands creates the display shown in Figure 4-5:

```
!WORKspace 30!GRAPHic 1,30!COLor C0!POL 0,0,0,199,599,199,599,0!CMode Y(CR)
!COLor C2!POLYgon 49,0,49,250,149,250,149,0(CR)
!COLor C4!POLYgon 249,0,249,180,349,180,349,0(CR)
!COLor C6!POLYgon 449,0,449,310,549,310,549,0!COLor C0!CMode N(CR)
```

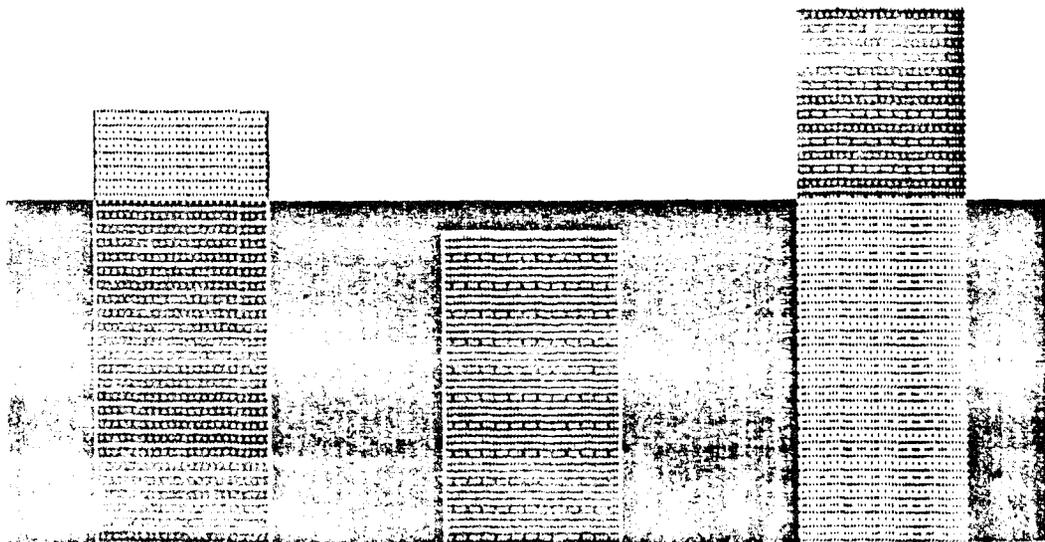


Figure 4-5. Sample Display Using Complement Mode

4.3.7 Selecting a Character Font

At power on the standard dot matrix ASCII character font (font 0) is selected for workspace text. The font can be changed to any of the following selections with the !ATTRIBUTE command:

!ATTRIBUTE 0(CR)	= font 0 (ASCII dot matrix)
!ATTRIBUTE 1(CR)	= font 1 (APL dot matrix)
!ATTRIBUTE 2(CR)	= font 2 (user-defined dot matrix)*
!ATTRIBUTE 32(CR)	= font 32 (ASCII vector character)
!ATTRIBUTE 33(CR)	= font 33 (user-defined vector character)*

* Any font number from 2 to 30 can be used to select the user-defined dot matrix font; 33 is the only number that selects the user-defined vector character font. See Section 4.5.3 and Appendix A, Table A-1, for details about defining characters in the user-defined fonts.

At power on white is selected for workspace text. A second (optional) parameter for the !ATTRIBUTE command is used to change the "color" used for text. The "color" may be any color number C0 through C7 or any "inverted color" IC0 through IC7. If a normal color number is selected, dot matrix characters will be displayed against a black background; if an inverted color number is selected, the characters will be displayed in reverse video.* The following examples illustrate selecting the "color" of text:

```
!ATTRIBUTE 1(CR)    selects font 1 without changing the "color"
!ATTRIBUTE C3(CR)  selects "color" C3 without changing the font
!ATTRIBUTE 0,IC0   selects font 0, displayed black-on-white
!ATTRIBUTE 32,C7   selects font 32 (vector characters), drawn
                   in black
```

Note that text and background are displayed in either white or black; only a color number that is defined as black (normally C7) will actually result in anything but white characters or background. All color numbers are accepted for compatibility with full-color graphics applications.

4.4 DRAWING GRAPHICS

When initial definitions and selections have been made (Section 4.3), graphics may be drawn in the graphics region with the following commands:

```
!VECTOR    draw vectors using absolute coordinates
!RVECTOR   draw vectors using relative coordinates
!POLYGON   draw a filled polygon using absolute coordinates
!RPOLYGON  draw a filled polygon using relative coordinates
!CIRCLE    draw an unfilled arc or regular polygon
!PIE       draw a filled arc or regular polygon
(GS)       draw "4010 style" vectors
!INK       "ink" vectors with the crosshair cursor
```

This section addresses all the preceding commands except the !INK command, which is covered in Section 4.7. If the reader defines a workspace and graphics region with !WORKSPACE 33!GRAPHIC 1,33(CR) and enters the examples given for each command, the resulting display should be similar to Figure 4-6.

The concept of "graphics beam position" should be understood before using the graphics commands. The Retro-Graphics enhancement keeps track of a point in the display called the graphics beam position. The initial graphics beam position when a graphics region is defined is coordinate (0,0). After each graphics command the beam position is the point at which execution ends. A graphics command that does not specify starting coordinates begins at the graphics beam position.

* Vector characters are not drawn in a character cell, so there is no "background." Selecting an "inverted color" just inverts the color of the character (selecting IC0 gives the same result as selecting C7).

4.4.1 Drawing Lines with the !VECTOR Command

The !VECTOR command draws a line or series of connected lines in the currently selected line type (if the current line type is "p" only the endpoints will be plotted). Endpoint coordinates are the only parameters used with the !VECTOR command. Lines are drawn from each pair of coordinates to the next. For example, the following command draws an unfilled box starting and ending at (X,Y) coordinate (200,100):

```
!VECTOR 200,100,200,200,300,200,300,100,200,100(CR)
```

The !VECTOR command is also commonly used to move the graphics beam position in preparation for another command. The !VECTOR command and a single pair of coordinates causes a "move" to be performed.

4.4.2 Drawing Lines with the !RVECTOR Command

The !RVECTOR command performs the same functions as the !VECTOR command, but each pair of coordinates is relative to the current graphics beam position. Relative coordinates can be positive or negative. The following command moves up 50 units and draws a diamond:

```
!RVECTOR 0,50,50,50,-50,-50,-50,-50,50(CR)
```

When only one pair of coordinates is specified, the !RVECTOR command moves the graphics beam position without drawing.

4.4.3 Drawing a Filled Polygon with the !POLYGON Command

The !POLYGON command draws a polygon filled with the currently selected vector/fill color. The boundary is drawn white (in the current line type) or black, according to the selected boundary color. The following commands draw a triangle filled with the C2 shading pattern and outlined in black:

```
!COLOR C2,C7!POLYGON 225,150,275,150,250,125(CR)
```

Note that the closing edge is automatically drawn; the beginning coordinates need not be repeated. The !POLYGON command with one pair of coordinates executes a move; the command with two pairs of coordinates draws a line.

4.4.4 Drawing a Filled Polygon with the !RPolygon Command

The !RPolygon command performs the same functions as the !POLYgon command, but each pair of coordinates is relative to the current graphics beam position. Relative coordinates can be positive or negative. The following commands draw a triangle (starting at the current graphics beam position) filled with the C5 shading pattern:

```
!COLor C5!RPolygon 0,0,25,25,25,-25(CR)
```

4.4.5 Drawing an Unfilled Arc or Regular Polygon

The !CIRcle command draws an unfilled arc or complete circle around the current graphics beam position. To draw a circle, only the radius need be specified. The following commands move the graphics beam and draw a circle:

```
!VECTor 250,50!CIRcle 50(CR)
```

To draw an arc (less than a complete circle), the radius and start/stop angles must be given. The arc is drawn counterclockwise from the start angle. The following command draws a 180-degree arc:

```
!CIRcle 40,90,270(CR)
```

An arc is actually drawn as a series of short segments. The increment between segments can be specified in degrees. If a "circle" is drawn with a large increment angle, the result is a regular polygon. An increment angle of 90 degrees results in a square. The following command draws an octagon:

```
!CIRcle 30,0,360,45(CR)
```

Start and stop angles must be specified if the increment angle parameter is used.

4.4.6 Drawing a Filled Arc or Regular Polygon

The !PIE command draws a filled arc (like a slice of pie), filled circle, or filled regular polygon. Parameters for the !PIE command are the same as for the !CIRcle command. The following commands move to the right and draw a white-filled circle:

```
!COLor C0!VECTor 290,50!PIE 10(CR)
```

The !ERASE W(CR) command clears the workspace.

4.4.7 Using "4010 Style" Vectors in 4027 MODE

In some applications it may be desirable to use the Tektronix 4010 method of drawing vectors while in 4027 MODE. For complex graphics (such as arcs and filled shapes) 4027 commands make efficient use of host computer time and I/O, but the 4010 method of drawing vectors requires transmission of fewer characters from the host than the 4027 !VECTor command.

A (GS) control character initiates 4010 vector drawing. The (GS) is followed by a series of characters representing 4010 coordinates; a (US) ends the sequence and returns to 4027 MODE (4010 vector drawing is not ended by a carriage return as it is in 4010 MODE). 4027-MODE settings such as !SHRink and !CMoDe remain in effect.

NOTE

4010 vector drawing is not possible if the enhanced terminal is in "Snoopy Mode" (!SNOopy Y). Control characters such as the (GS) and (US) are displayed as text and not acted upon by the RG1000.

The following examples show how the same series of vectors are drawn using the 4027 method and the 4010 method (!SHRink Y):

```
!VEctOr 100,50,100,600,950,600,950,50,100,50(CR)
(GS) #D!r#D2x=V2x=V!r#D!r(US)
```

The total number of characters transmitted for 4010 vectors can be reduced even further in some cases where one or more coordinates remains the same for several vectors in a series. See Section 5.4.2 for details about 4010 vectors.

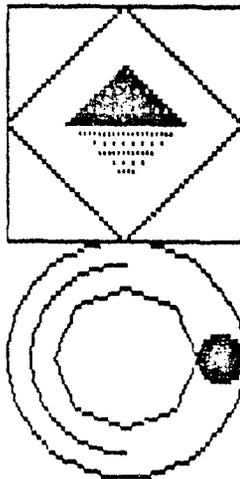


Figure 4-6. Sample Graphics Display

4.5 ADDING TEXT TO THE DISPLAY

The Retro-Graphics enhanced terminal can add strings of text to a graphics display, such as labels on a graph, or the entire display can be text. Dot matrix text may be entered directly into workspace from the source(s) designated in the !WORKspace command (host or keyboard). Dot matrix or vector character text may be entered from either source using the !STRing command. Text entered directly begins at the workspace cursor location; text entered with the string command begins at the current graphics beam position. The following paragraphs describe basic text usage.

4.5.1 Entering Text Directly into the Workspace

When dot matrix text (fonts 0, 1, and 2) is added to the display at the workspace cursor location, it is normalized to a grid of character cells (similar to the rows and columns of characters displayed in TRANSPARENT MODE). Directly entered text is not limited to the graphics region; the entire workspace is available for text, subject to any limitations imposed by the !MARGin settings. Workspace text entry can be set to any of the following configurations:

```
!WORKspace H   host sends text to the workspace
!WORKspace K   keyboard sends text to the workspace
!WORKspace H,K host and keyboard send text to the workspace
!MONitor H     host sends text to the monitor
!MONitor K     keyboard sends text to the host
!MONitor H,K   host sends text to the monitor; keyboard sends text to the
               host
```

The workspace cursor, like the graphics beam position, is a reference location; it is not visible in the display. When the workspace is initially defined, the cursor is located in the upper left corner. When a graphics region is defined, the cursor is moved to the workspace line below it, if there is one, or to the last line of the graphics region if there is not. If the reader enters the examples given for each command, the resulting display should be similar to Figure 4-7.

The following commands set the margins, define a workspace, and enter reverse video ASCII text at the top of the display:

```
!MARGin 1,80!WORKspace 30,!ATTtribute 0,!CO(CR)this is the upper left corner
```

The workspace cursor can be moved in any direction with cursor-control commands:

```
!RIGHT (count)(CR)           !UP (count)(CR)
!LEFT (count)(CR)           !DOWN (count)(CR)
```

The following commands move the cursor and enter text in the upper and lower right corners (note that the first string ends in the last column; the cursor automatically wraps to line 2, column 1):

```
!RIGHT 21(CR)this is the upper right corner
!DOWN 23!RIGHT 50(CR)this is the lower right corner
```

A carriage return (other than a carriage return that terminates a command) brings the cursor to the left margin of the current line. After entering the commands in the preceding example, the following sequence enters text in the lower left corner:

```
(CR)this is the lower left corner
```

The cursor can also be moved directly to any row/column location in the workspace with the !JUMp command. Rows and columns are numbered in relation to the top left corner of the workspace. The following command moves the cursor and enters text across the center of the workspace:

```
!JUMp 15,22(CR)this is the center of the workspace
```

Another way to move the cursor is with the !TAB and !BACKtab commands. The number of tabs stops to move is specified in the command. The cursor can tab forward from one line to the next, but it will not backtab beyond the left margin. The following commands illustrate use of tab stops for text entry:

```
!STops 10,20,30,40,50,60,70!ATtribute CO!JUMp 20(CR)!TAB(CR)10!TAB(CR)20
!TAB(CR)30!TAB(CR)40!TAB(CR)50!TAB(CR)60!TAB(CR)70
```

When the cursor reaches the end of a line it automatically wraps to the next line. The cursor does not wrap from the bottom line back to the top and it does not backtab beyond the left margin.

```
this is the upper left corner
```

```
this is the upper right corner
```

```
this is the center of the workspace
```

```
10      20      30      40      50      60      70
```

```
this is the lower left corner
```

```
this is the lower right corner
```

Figure 4-7. Sample Text Display

4.5.2 Entering Text with the !STRING Command

Character strings can be entered into the display with the !STRING command. When a dot matrix font is selected, entry of text strings is similar to direct entry of text, except entry begins at the current graphics beam position instead of the cursor position. Dot matrix text entered with the !STRING command is normalized to character-cell rows and columns; vector character strings begin at the coordinates of the graphics beam position. Dot matrix text may start or end outside the graphics region; it automatically wraps to a new line (left margin) if necessary.

Text entered with the !STRING command may be specified as delimited strings, series of ASCII decimal equivalent values (ADEs), or combinations of both. Any of the following characters can be used to delimit a string:

```
@#%&*( )_+= [ ]:,. ?/
```

The following example displays characters from the ASCII dot matrix font, beginning at the character cell containing coordinates (100,100):

```
!ATTRIBUTE 0,C0!VECTOR 100,100!STRING *[This is a test]*(CR)
```

The next example displays the same test, but uses a combination of ADEs and a delimited string:

```
!VECTOR 400,100!STRING 91,*This is another test!*,93(CR)
```

When a vector character font is selected, some differences must be taken into account. Because vector characters are drawn as "graphics" they cannot be displayed outside the graphics region. Strings that extend beyond the graphics region are clipped at the boundary. Also, vector characters are not drawn in a "cell" so there is no background color; they are drawn against the background of the graphics region.

```
!VECTOR 0,200!ATTRIBUTE 32!STRING $Sample vector character string?$(CR)
```

Several characteristics of the vector characters can be modified by the user. The following commands are detailed in Appendix A:

!CITalics	italicize (slant) vector characters
!CSCale	specify the size of vector characters
!CPSpace	enable/disable proportional spacing
!CROtate	rotate the axis along which vector characters are displayed
!CVECTOR	specify vector character advance distance

4.5.3 Defining and Deleting User-Defined Fonts

Two fonts are reserved for definition by the user: a dot matrix font and a vector character font. Each symbol in these fonts can be individually defined. Either of the standard dot matrix fonts can be "downloaded" to the user-defined font with the !FONT command for modification of selected characters. Any font number from 2 to 30 can be used to identify the user-defined font. The following command downloads the standard ASCII font into the user-defined font:

```
!FONT 0,2(CR)
```

Suppose the only difference desired in the new font is to change character 124 to a box. The new symbol is defined with the !SYMBOL command, with parameters specifying the character number, font, background color, symbol color, and the binary value of each row of pixels in a character cell* (Figure 4-8):

```
!SYMBOL 124,2,C7,C0,255,255,129,129,129,129,129,129,129,129,129,255,255(CR)
```

Symbols in the user-defined vector character font are defined with the !CVSYMBOL command. The first parameter specifies the character number. The next two parameters indicate how far to advance horizontally before and after drawing the symbol. Each subsequent (X,Y) pair of values locates the endpoint for a move or draw (relative to the symbol origin). A "64,64" indicates that a move follows; otherwise each (X,Y) pair indicates a draw. The following command defines character #35 as a British pound symbol (Figure 4-8):

```
!CVSYMBOL 35,7,7,4,-7,3,-8,2,-8,-2,-6,-4,-7,-2,-8,0,-7,0,6,
2,8,4,6,64,64,-2,0,2,0(CR)
```

The !DFONT command deletes a user-defined font. For example, !DFONT 33 deletes the user-defined vector character font. The user-defined patterns (also stored as a "font") are deleted by specifying font 31.

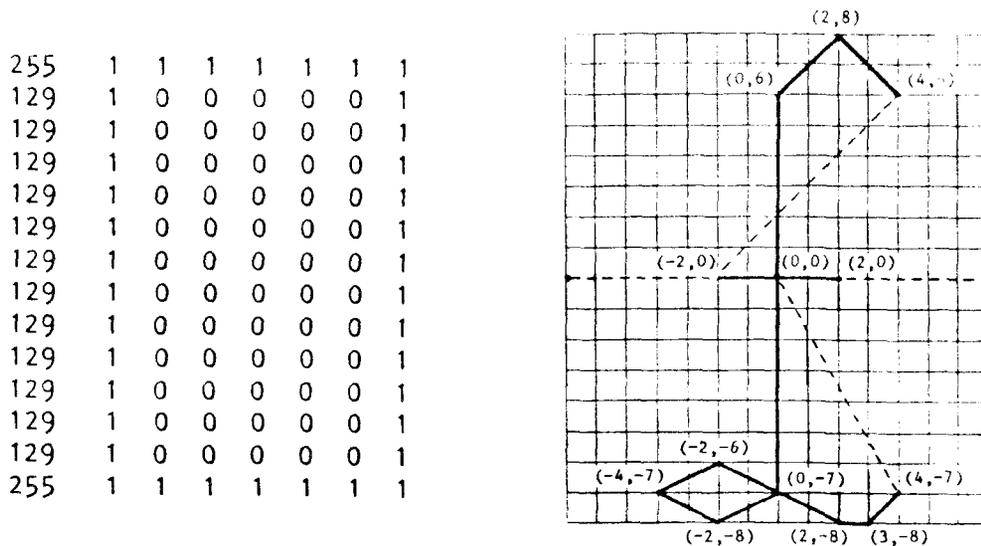


Figure 4-8. Sample User-Defined Characters;

* A 4027 character is defined in a 7-row/8-column character cell (row values are 0-255); the enhanced terminal displays the character in a 7-row/8-column cell. If !SHRINK D is selected, a dot matrix symbol is defined using 8 columns (row values are 0-225).

4.6 ERASING GRAPHICS AND TEXT

Either the F1 key or the Key Mode CLR function clears the entire screen; the workspace and monitor remain defined.

The !ERase command clears the contents of the workspace or monitor, depending on the parameters included with the command:

!ERase W(CR) clear the contents of the workspace

!ERase M(CR) clear the contents of the monitor

The !ERase G command erases the graphics region and leaves it with a black background. If a color or pattern number is added to the !ERase G command, the graphics region is cleared and filled with the specified color or pattern:

!ERase G(CR) erase the graphics region (black)

!ERase G,C0(CR) fill the graphics region solid white

!ERase G P6(CR) fill the graphics region with pattern P6

The !ERase W command clears the workspace and leaves it with no graphics region defined. If !ERase is entered with no parameter, the source of the command determines which part of the display is erased (if the workspace receives text from the keyboard, an !ERase command from the keyboard erases the workspace; if the monitor receives text from the host, an !ERase command from the host erases the monitor, etc.).

Individual graphics elements can be erased by redrawing them in the opposite color. Example: if a polygon was drawn in white (!COLor C0), it can be erased by entering !COLor C7 and redrawing the polygon. When a graphics element crosses other graphics or text, erasing it can leave breaks in the remaining elements.

Text can be erased by re-entering the characters in the opposite color. Example: if text was entered in white characters (!ATTRibute C0), it can be erased by changing to !ATTRibute C7 and re-entering the characters in whatever manner they were originally entered (directly or with the !STRing command). Text can sometimes be erased without changing colors by writing over it with spaces. This does not work if the background color of the text is not the same as the color of the area in which it is written. Example: if !ATTRibute C0 is selected and text is written inside a white-filled polygon, characters will be white within black character cells. Writing spaces over them will leave the black character cells.

NOTE

Text written with !ATTRibute C0 selected is protected. Writing over it with spaces may appear to erase it, but this leaves protected spaces in which graphics cannot be drawn.

4.7 USING GRAPHICS INPUT MODE (CROSSHAIR CURSOR)

4027 Graphics Input (GIN) Mode is used for interactive graphics applications in which graphics coordinates must be transmitted to the host system. GIN Mode is also used to "ink" vectors between operator-selected points. The crosshair cursor is the standard method of identifying points to be transmitted or inked.

In GIN Mode the enhanced terminal displays the crosshair cursor and waits for the operator to indicate a point in the display. The !ENable command enters GIN Mode for a specific number of points or until disabled:

```
!ENable(CR)           Enable GIN Mode indefinitely
!ENable 10(CR)       Enable GIN Mode for 10 transmissions
```

GIN Mode is automatically terminated when the specified number of points has been transmitted or a !DISable command is entered.

The four keyboard arrow keys move the crosshair; tapping an arrow key moves the crosshair one pixel at a time and holding it down moves the crosshair continuously. To transmit the coordinates of the crosshair, press any key that transmits a character to the host. A message is sent to the host in standard 4027 format:

```
!DAT 03,(character),(x coordinate),(y coordinate),(CO);
```

The (character) sent to the host in the !DAT statement is an ASCII Decimal Equivalent (ADE).

The !INK command enables inking of vectors in GIN Mode. When "inking" is enabled, the enhanced terminal automatically draws a vector from the current graphics beam position to the crosshair location each time a key is pressed (in addition to sending the GIN message to the host).

Valid commands are accepted and executed without terminating GIN Mode or sending GIN messages to the host. For example, the following series of commands enters GIN Mode, selects the crosshair, enables inking, rings the bell, and leaves the terminal waiting for the operator to select a point:

```
!ENable!INPut 1!INK Y!BEL1(CR)
```

The !INK command enables inking of vectors in GIN Mode. In addition to sending the GIN message to the host, the enhanced terminal automatically draws a vector from the current graphics beam position to the crosshair location each time a key is pressed.

4.8 DISPLAYING AND REPORTING STATUS

Two status functions are available in 4027 MODE. The !SYStat command displays a five-line status message in the monitor (at least six lines of monitor must be available to view the entire status message). The !REPort command requests a status message be sent to the host.

The following is a typical !SYStat display:

```
TB=4800 RB=4800 LM=1 RM80 WL=0 V1.0
TS= 10 20 30 40 50 60 70
CC=! SN=N KB=M CM=M PA=E RS=Y DU=F
CO 63 C1 03 C2 12 C3 48 C4 15 C5 16 C6 51 C7 00

TB = Transmit baud           RB = Receive baud
LM = Left margin             SN = Snoopy Mode
RM = Right margin            CM = Computer data destination
WL = Workspace lines         KB = Keyboard data destination
V = Firmware version         PA = Parity setting
RS = Remote start/stop       DU = Duplex/modem control
TS = Tab stops               CO - C7 = Color (equiv. pattern)
CC = Command character
```

The !REPort command requests any of the following status reports:

REQUEST	RESPONSE	DESCRIPTION
!REPort -1(CR)	!ANS-1,#VX.X,R1000;	Firmware version, model#
!REPort 00(CR)	!ANS00,0000,000;	Dummy report
!REPort 01(CR)	!ANS01,(X),(Y),(SP);	Text cursor position
!REPort 02(CR)	!ANS02,(X),(Y),(col),001;	Graphics beam position, current color or pattern#
!REPORT 03(CR)	!ANS03,(code),(X),(Y),001;	Crosshair position (code)=1 crosshair enabled (code)=0 crosshair disabled
!REPORT 04(CR)	!ANS04,0,00,0000;	Dummy response
!REPORT 05(CR)	!ANS05,0,00,0000;	Dummy response
!REPORT 06(CR)	!ANS06,0,00,0000;	Dummy response
!REPORT 07(CR)	!ANS07,0,00,0000;	Dummy response
!REPORT 12(CR)	!ANS12,0,000000;	Dummy response
!REPORT 13(CR)	!ANS13,0,000000;	Dummy response
!REPORT 14(CR)	!ANS14,0,F,000;	Dummy response

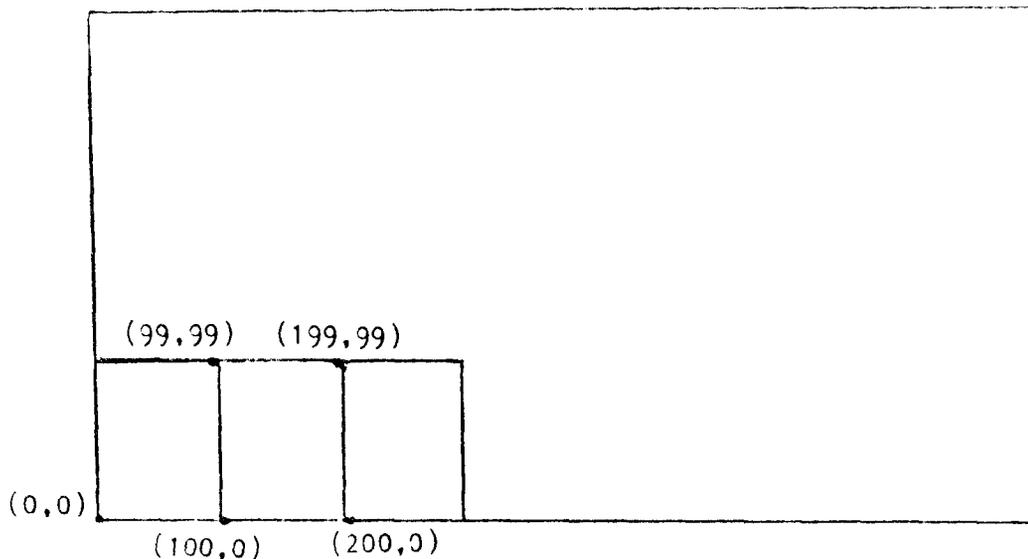
4.9 TRANSFERRING BLOCKS OF GRAPHICS DATA

Three "block transfer" functions are available in 4027 MODE: copying one rectangular part of the display to another location in the graphics region, reading part or all of the display back to the host, and loading display data from the host.

The !MOVE command copies data from one location in the graphics region to another. Parameters specify the lower left and upper right corners of the rectangle from which data will be copied and the lower left corner of the rectangle that will receive the data.

For example, the following commands will copy data as shown below:

```
!MOVE 0,0,99,99,100,0!MOVE 100,0,199,99,200,0(CR)
```



Overlapping the "from" and "to" regions can produce unintended results (part of the "from" region can be overwritten by the "to" region before that part has been copied).

The !REAdback command transfers part or all of the graphics region to the host computer. Data transfer starts at the current graphics beam position and continues to the right (incrementing the X coordinate) until the end of a line is reached, at which point the Y coordinate is incremented by one to move up one line. Repeated bytes are always in compressed format; 1530(AB) represents the data (AB) repeated 1530 times. A question mark (?) is used for the (DEL) character in the !REAdback command. Data transfer continues until the specified number of pixels has been sent or the top right corner of the display is reached. If more than 32,767 pixels are to be sent, the !REAdback command must be entered more than once (32,767 is the largest integer the RG1000 can accept). 32,000 pixels is the equivalent of 40 raster lines in the display, so the largest graphics region (!GRAphic 1,33) can be sent to the host with the following commands:

```
!VEctOr 0,0!REAdback 32000!REAdback 32000!REAdback 32000
!REAdback 32000!REAdback 32000!REAdback 32000!REAdback 32000
!REAdback 32000!REAdback 32000!REAdback 32000!REAdback 32000
!REAdback 16800(CR)
```

The number of pixels sent in each byte is normally six, but this can be changed with the !BITs command (see Appendix A, Table A-1). An eight-bit byte normally defines six pixels:

```
P      1      X      X      X      X      X      X
        PIXEL6 PIXEL5 PIXEL4 PIXEL3 PIXEL2 PIXEL1
```

If the !BITS setting is other than (1), the extra bits are set to zero. For example, with a !BITS setting of (3), a byte of video data comprises two pixels:

```

P      1      0      0      X      0      0      X
          -----          -----
          PIXEL 2          PIXEL 1

```

The !RAster command transfers graphics data from the host computer to the display. The RG1000 interprets the data according to the !BITS setting and writes it into the graphics region beginning at the current graphics beam position. A maximum of six bits per byte represents video data and the seventh bit is normally a "1," so each byte corresponds to an ASCII character between (@) and (DEL). If the user's system does not transmit the (DEL) character, the RG1000 will accept the (?) character instead. Repeated groups of bytes can be compacted with a positive integer; for example, ABABABABABABABABABABABAB is sent as 12(AB). Only one level of parentheses can be used when compacting data. The command character must not be one that will occur as video data. If the !BITS setting is other than (1), the extra bits are ignored in the !RAster command; only the low bit is used as data.

4.10 PROGRAMMING KEYS AND MACROS

Keyboard keys, macros, and other programmed functions are defined with the !LEArn command. All keys programmable on the Tektronix 4027 can be programmed and used with the enhanced terminal. This provides up to 185 programmed functions (or a total of 1024 bytes, the amount of memory allocated for storage of programmed keys and macros).

The !LEArn command specifies the key or macro number to be defined and one or more strings of data that make up that definition. Any of the following may be used to identify the key or macro:

<u>PARAMETER</u>	<u>KEY OR MACRO DEFINED</u>
M1-M16	One of 16 internal macros
ASCII character or ADE	Any ASCII key
F1-F13 or 128-140	Mnemonic or pseudo-ADE for a 4027 function key
S1-S13 or 144-156	Mnemonic or pseudo-ADE for a shifted 4027 function key
P0-P9/P.,/PT/PE/PS/PB or 160-174	Mnemonic or pseudo-ADE for a 4027 pad key

The key or macro definition may be a delimited string of ASCII characters, one or more ADE or pseudo-ADE values, or a combination of both. ADE values must be separated by commas or spaces. Any of the following characters can be used to delimit a string:

```
@#$$% &*()_+={}[]~:"',.<>?/\^
```

The command character cannot be used as a delimiter, but it may be used within the delimited string; the command character can also be used if specified by its ADE value. Control characters must also be specified by ADE. For example, each of the following commands program the # key to initialize a workspace of 33 lines (text from the keyboard):

```
!LEArn #,/!WORKspace 33,k/13
!LEArn 35,33,/wor 33,k/13
!LEArn 35,33,119,111,114,32,51,51,44,107,13
```

The !EXPand command executes a macro:

```
!EXPand M1(CR)
```

To execute a programmed ASCII key, press the appropriate key. To execute a programmed 4027 function key, shifted function key, or pad key, enter Key Mode with (CTRL B) or the user-selected control code, move the cursor with the arrow keys to any of the selections shown below, and press return:*

```
F1234567890123 SF1234567890123 PD0123456789.TESB
```

A shifted 4027 function key or pad key can be executed only by entering Key Mode and selecting the appropriate mnemonic:

```
SF1234567890123 PD0123456789.TESB
```

4.11 PRODUCING HARDCOPY OUTPUT

If the enhanced terminal is equipped with an optional printer interface (RG30-PI or RG31-PI), it can dump the display to a graphics printer. A hardcopy dump is initiated in two ways: by pressing the F4 key (if PF keys are enabled for local use) or by entering the !HARdcopy command. To abort printing, press F4 while printing is in progress.

Several printer option settings that affect hardcopy output can be defined with the !LPRint command. These include identification of the printer model, choice of two I/O channels, proportional compensation (needed with some printers), image rotation, full size or reduced image, leading or trailing form feed, and alphanumeric printing from the host and/or keyboard. These settings are listed under the !LPRint command in Appendix A, Table A-1.

4.12 PROGRAMMING THE HOST

The following 4027-MODE demonstration program in BASIC code creates a bar graph using the information given in the problem statement. The same sequence of graphics commands can be coded in FORTRAN, PL/1, or any other high-level language supported by the user's host computer system. Figure 4-9 illustrates the completed bar graph as it appears on the terminal screen. Coordinate values refer to the standard Tektronix 4027 display (640 by 480).

* The keyboard function keys retain their standard functions; they cannot be used to execute 4027 "function keys" programmed with the !LEArn command).

PROBLEM Draw a bar graph comparing the net sales of each quarter of 1977 with the net sales of each corresponding quarter in 1976. Input sales figures for 1977 are, in thousands of dollars: first quarter 210, second quarter 240, third quarter 150, and fourth quarter 260. Figures for 1976 are 180, 260, 130, and 200 respectively.

```

100  REM
110  REM      4027-MODE DEMONSTRATION PROGRAM
120  REM
130  REM      ERASE THE SCREEN
140  PRINT "!ERase"
150  REM      DEFINE WORKSPACE
160  PRINT "!WORKspace 30"
170  REM      DEFINE GRAPHICS REGION
180  PRINT "!GRaphic 1,30"
190  REM      SET VECTOR DRAWING COLOR
200  PRINT "!COLor C0"
210  REM      DRAW X AND Y AXES
220  PRINT "!VEctOr 50,350 50,50 600,50"
230  REM      SET FILL, BOUNDARY COLORS FOR 1977 BARS
240  PRINT "!COLor C1,C0"
250  REM      DRAW 1977 BARS
260  PRINT "!POLygon 100,50 100,260 135,260 135,50"
270  PRINT "!POLygon 200,50 200,290 235,290 235,50"
280  PRINT "!POLygon 300,50 300,200 335,200 335,50"
290  PRINT "!POLygon 400,50 400,310 435,310 435,50"
300  REM      SET FILL, BOUNDARY COLORS FOR 1976 BARS
310  PRINT "!COLor C5,C0"
320  REM      DRAW 1976 BARS
330  PRINT "!POLygon 135,50 135,230 170,230 170,50"
340  PRINT "!POLygon 235,50 235,310 270,310 270,50"
350  PRINT "!POLygon 335,50 335,180 370,180 370,50"
360  PRINT "!POLygon 435,50 435,250 470,250 470,50"
370  REM      RESET VECTOR DRAWING COLOR
380  PRINT "!COLor C0"
390  REM      DRAW Y AXIS TIC MARKS
400  PRINT "!VEctOr 40,50 50,50"
410  PRINT "!VEctOr 40,100 50,100"
420  PRINT "!VEctOr 40,150 50,150"
430  PRINT "!VEctOr 40,200 50,200"
440  PRINT "!VEctOr 40,250 50,250"
450  PRINT "!VEctOr 40,300 50,300"
460  REM      LABEL Y AXIS
470  PRINT "!VEctOr 35,50 !STRing/0/"
480  PRINT "!VEctOr 20,150 !STRing/100/"
490  PRINT "!VEctOr 20,250 !STRing/200/"
500  PRINT "!VEctOr 20,350 !STRing/300/"
510  PRINT "!VEctOr 0,380 !STRing/$ THOUSANDS/"
520  REM      LABEL X AXIS
530  PRINT "!VEctOr 110,40 !STRing/1ST QTR/"
540  PRINT "!VEctOr 200,40 !STRing/2ND QTR/"
550  PRINT "!VEctOr 310,40 !STRing/3RD QTR/"
560  PRINT "!VEctOr 410,40 !STRing/4th QTR/"
570  REM      LABEL OVERALL GRAPH
580  PRINT "!VEctOr 135,0 !STRing/NET SALES COMPARISON: 1976-1977/"
590  REM      SET COLORS, DRAW AND LABEL 1977 KEY IN LEGEND

```

```
600 PRINT "!COLor C1,C0"
610 PRINT "!POLYgon 520,335 520,350 545,350 545,335"
620 PRINT "!VECTor 555,340 !STRing/1977/"
630 REM      SET COLORS, DRAW AND LABEL 1976 KEY IN LEGEND
640 PRINT "!COLor C5,C0"
650 PRINT "!POLYgon 520,310 520,325 545,325 545,310"
660 PRINT "!VECTor 555,320 !STRing/1976/"
670 REM      LABEL LEGEND
680 PRINT "!VECTor 520,360 !STRing/LEGEND/"
690 REM      DRAW BOX AROUND LEGEND
700 PRINT "!COLor C0"
710 PRINT "!VECTor 495,370 495,300 595,300 595,370 495,370"
720 END
```

(TO BE SUPPLIED)

Figure 4-9. Display Created by 4027-MODE Demonstration Program

SECTION 5 - 4010 MODE

In 4010 MODE the enhanced terminal emulates a Tektronix 4010 Computer Display Terminal. Programs written according to 4010 protocol should run correctly with the Retro-Graphics enhancement.

4010-MODE operation may be thought of as a group of functional modes:

Mode	Function
Vector	Draw lines
Point Plot	Plot points with absolute coordinates
Text	Display alphanumerics
Graphics Input (GIN)	Input coordinates to host system

Control codes control transitions from one mode to another. The major functions performed in 4010 MODE are:

- Setting up the terminal for display of 4010 graphics
- Plotting (drawing) lines and points
- Entering dot matrix text into the graphics display
- Transmitting selected points for interactive applications
- Reporting status to the host
- Printing the graphics display (an optional printer interface is required)

The following topics are covered in this section:

- 5.1 Using 4010-MODE Control Sequences and Coordinates
- 5.2 Entering and Leaving 4010 MODE
- 5.3 Preparing for Graphics and Text
- 5.4 Drawing and Erasing Graphics
- 5.5 Adding Text to the Display
- 5.6 Using Graphics Input Mode (Crosshair Cursor)
- 5.7 Reporting Status
- 5.8 Producing Hardcopy Output
- 5.9 Programming the Host

The first topic is an overview of the 4010-MODE control sequences and coordinate system. It is not intended that the user perform any 4010-MODE functions on the terminal while reading Section 5.1. Subsequent topics are written so the user can try each function from the keyboard as it is presented. Each 4010-MODE control sequence is briefly explained and, in most cases, illustrated with an example. Appendix A (Table A-2) summarizes 4010-MODE control sequences.

5.1 USING 4010-MODE CONTROL SEQUENCES AND COORDINATES

In 4027 MODE the enhanced terminal expects input from the keyboard or host to follow Tektronix 4010 protocol. The next few paragraphs summarize 4010 functional modes and the 4010 coordinate system for readers who have not previously used them.

5.1.1 4010-MODE Control Sequences

All 4010-MODE functions are controlled by control codes and "escape" sequences. Control sequences that involve drawing graphics include characters that represent 4010 coordinates. For example, a (GS) character enters 4010 MODE and, if it is followed by a string of characters, draws one or more vectors.

4010-MODE displays are normally created by host programs rather than from the keyboard. The necessary control sequences and coordinates can be entered from the keyboard (Table E-1 identifies the keyboard keys that send each control character), but the control characters will not be received and acted upon unless they are echoed back to the RG1000; this usually requires using "local echo" with the host or replacing the host I/O cable with a loopback connector.

The following conventions are used in this manual:

- ASCII mnemonics for control codes are shown in parentheses; e.g., (GS) and (ESC)(FF)
- Printable characters that are part of an escape sequence are shown without parentheses; e.g., (ESC)"6g.
- For keyboard-entered control sequences, two or more keys pressed simultaneously are shown within parentheses; e.g., (CTRL B).

5.1.2 4010-MODE Coordinate System

The 4010-MODE coordinate system is based on the resolution of the Tektronix 4010 display: 1024 pixels horizontally by 780 pixels vertically. These coordinates are automatically scaled to screen coordinates.

Any 4010 coordinate value can be coded as 10 binary digits (bits). The 4010 convention is to send each five-bit "half" of a coordinate value, with two tag bits as the most significant bits, making a seven-bit ASCII character code. The 4010 coordinate tag bits are listed below:

```
High-X/Y tag = 01
Low-Y tag    = 11
Low-X tag    = 10
```

Each set of (X,Y) coordinates is sent as a series of four ASCII characters in the following order: HIGH Y, LOW Y, HIGH X, LOW X.

EXAMPLE: Coordinates (500,250) 250 = 00111 11010 500 = 01111 10100
 High-X/Y tag and high Y bits = 0100111 = (')
 Low-Y tag and low Y bits = 1111010 = (z)
 High-X/Y tag and high X bits = 0101111 = (/)
 Low-X tag and low X bits = 1010100 = (T)

The coordinates (500,250) would be sent as ('z/T).

The coordinates for plotting points, drawing lines, etc. are usually generated by a graphics applications program. The process can be done manually, however, for keyboard entry of coordinates. Rather than convert the coordinates to binary, divide each in half, and add tag bits as shown above. Use the following procedure and Table 5-1 to convert 4010 coordinates to ASCII characters (Appendix E contains a more detailed breakdown of ASCII character codes). The coordinate pair (500,250) is again used as an example.

1. Divide each coordinate by 32 (shift the binary value right five bits) to obtain a seven-digit decimal number: NN.MMMMM

250 divided by 32 = 07.81250 500 divided by 32 = 15.62500

2. Find the ASCII characters that correspond to high value "NN" in each number:

High Y = 07 = (') High X = 15 = (/)

3. Multiply the low value ".MMMMM" by 32 (shift the binary value left five bits). Find the ASCII characters that correspond to each number:

Low Y = 0.81250 X 32 = 26 = (z) Low X = .62500 X 32 = 20 = (T)

4. Put the characters in high Y, low Y, high X, low X order for transmission:

(500,250) = ('z/T)

Characters that remain the same from one four-byte value to the next usually need not be repeated, as shown in the following example. The low X value must always be sent; if the high x value changes, the low y value must be sent.

(GS)!h!H!w!H!w!W!h!W!h!H = (GS)!h!HwHwHwH

5.1.3 4010 Display

The 4010-MODE display devotes the entire screen to graphics. Since there is no monitor region in 4010 MODE, the RG1000 responds to each control sequence without feedback to the operator (other than any changes in the display).

Table 5-1. Conversion of 4010 Coordinates to ASCII Characters

<u>NN</u>	<u>HIGH X/Y</u>	<u>.MMMMM X 32</u>	<u>LOW Y</u>	<u>.MMMMM X 32</u>	<u>LOW X</u>
0	SP	0		0	@
1	!	1	a	1	A
2	"	2	b	2	B
3	#	3	c	3	C
4	\$	4	d	4	D
5	%	5	e	5	E
6	&	6	f	6	F
7		7	g	7	G
8	(	8	h	8	H
9	)	9	i	9	I
10	*	10	j	10	J
11	+	11	k	11	K
12	,	12	l	12	L
13	-	13	m	13	M
14	.	14	n	14	N
15	/	15	o	15	O
16	0	16	p	16	P
17	1	17	q	17	Q
18	2	18	r	18	R
19	3	19	s	19	S
20	4	20	t	20	T
21	5	21	u	21	U
22	6	22	v	22	V
23	7	23	w	23	W
24	8	24	x	24	X
25	9	25	y	25	Y
26	:	26	z	26	Z
27	;	27		27	[
28		28		28	
29	=	29		29]
30		30		30	
31	?	31	DEL	31	_

5.2 ENTERING AND LEAVING 4010 MODE

The terminal enters 4010 MODE in any of the following ways:

- If 4010 MODE is the "entry mode" setting saved in nonvolatile memory, the terminal automatically enters 4010 MODE at power on. Entry mode is set in 4027 MODE with the !ENTry command and saved with the !SAVe command.
- Pressing the F3 key while in TRANSPARENT or 4027 MODE enters 4010 MODE; pressing it again exits to TRANSPARENT MODE (PF keys must be set to "local").
- Pressing (CTRL B) while in any mode of operation displays the Key Mode menu. Moving the cursor to "4010" with the arrow keys and pressing RETURN selects 4010 MODE.
- An (ESC)"7g sequence from the host enters 4010 MODE from 4027 MODE; a (GS) control code from the host enters 4010 MODE from TRANSPARENT MODE.

The (GS) character is the only host-controlled means of leaving TRANSPARENT MODE, minimizing the chance of accidental transitions out of TRANSPARENT MODE. The (ESC)"7g or (GS) can be used only from the keyboard if "local echo" is set.

To determine the mode of operation at any time, press (CTRL B) to display the Key Mode menu. The current mode is shown to the right of the menu. Press (CTRL B) again to exit Key Mode.

5.3 PREPARING FOR GRAPHICS AND TEXT

Definitions and settings that affect the 4010-MODE display are made in two ways: with control sequences in 4010 MODE or with commands in 4027 MODE. Some settings can be made only in 4027 MODE.

5.3.1 Settings that Carry Over from 4027 MODE

In addition to communications settings, the following definitions and selections carry over from 4027 to 4010 MODE:

- | | |
|---------------------|-------------------|
| ● Vector "color" | ● Font** |
| ● Line type* | ● PF key setting |
| ● User-defined line | ● GIN source |
| ● Complement Mode | ● Printer options |

* Except line types "P" (point) and "E" (erase); the last numerical (1-9) line type selected in 4027 MODE carries over to 4010 MODE.

** Font 0 (ASCII) or font 1 (APL) are carried over; if a vector character font was selected in 4027 MODE, the ASCII font is selected in 4010 MODE.

5.3.2 Settings Made in 4010 MODE

The following selections can be made while in 4010 MODE:

- drawing color
- GIN source
- line type

Drawing color is set to "black" with the (ESC)(DEL) sequence; there is no sequence dedicated specifically to setting the color back to white, but any of the following do so in addition to their primary functions:

(CR)	enter Text Mode--return to left margin if in Text Mode
(EM)	clear screen
(ESC)(FF)	clear screen, enter Text Mode with cursor at home position, reset line type

Drawing color can also be changed (black, white, or Complement Mode) by changing to 4027 MODE, making the selection, and changing back to 4010 Mode.

The following escape sequences select the line type for vector drawing:

(ESC)'	Solid	(ESC)d	Dash/long-dash
(ESC)a	Dotted	(ESC)e	Long-dash/three dot
(ESC)b	Dash	(ESC)f	Long-dash
(ESC)c	Dot/long dash	(ESC)g	Long-dash/three-dash
		(ESC)x	User-defined line

Two escape sequences select Graphics Input (GIN) source and enter GIN Mode:

(ESC)"4g	Select crosshair cursor and enter GIN Mode
(ESC)"5g	Select light pen and enter GIN Mode

5.4 DRAWING AND ERASING GRAPHICS

When initial selections have been made, graphics can be drawn by entering either of the following functional modes:

(GS)	Vector Mode
(FS)	Point Plot Mode

Graphics elements can be erased by redrawing them in the opposite color.

The concept of "graphics beam position" should be understood before using the graphics commands. The Retro-Graphics enhancement keeps track of a point in the display called the graphics beam position. The initial graphics beam position when 4010 MODE is entered is coordinate (0,0). Thereafter the graphics beam position is the point at which drawing last ended.

5.4.1 Plotting Points

In 4010 Point Plot Mode the enhanced terminal displays specific points in the graphics display. Point Plot Mode is entered with the (FS) control character. The enhanced terminal then interprets all characters it receives (except control characters) as 4010 coordinates for point locations. See Section 5.1.2 for a description of the 4010 coordinate system.

Each set of coordinates following the (FS) designates a point for display.

EXAMPLE - To plot the four points shown below, enter:

(FS)!r#D6z#D6z=B!r=B

6z#D
(100,730)

6z=B
(930,730)

.

.

.
!r#D
(100,50)

.
!r=B
(930,50)

Point Plot Mode is terminated by a control code that causes entry into another functional mode (Vector, Text, or Graphics Input), or an escape sequence that causes a transition to TRANSPARENT or 4027 MODE.

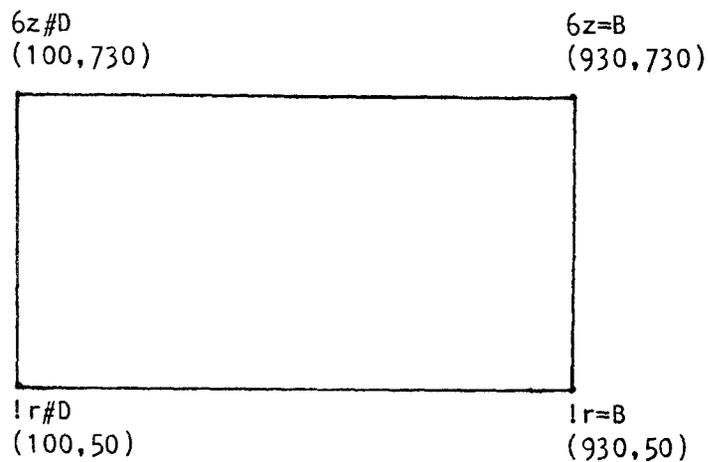
5.4.2 Drawing Lines

In 4010 Vector Mode the enhanced terminal draws lines in the graphics display. Vector Mode is entered with a (GS) control character. The enhanced terminal then interprets all characters it receives (except control characters) as 4010 coordinates for vector endpoints. See Section 5.1.2 for a description of the 4010 coordinate system.

The first set of coordinates following the (GS) determines the starting point of the first line. A line is drawn from there to the next set of coordinates, and so forth for as many interconnected lines as necessary.

EXAMPLE - The following entry draws the box shown below:

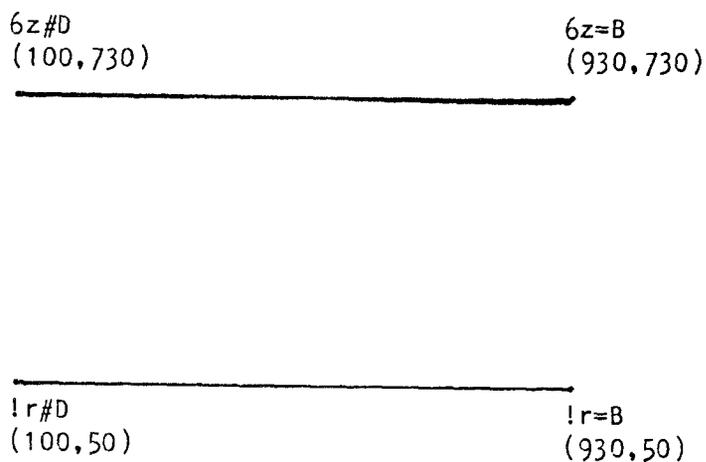
```
(GS)!r#D6z#D6z=B!r=B!r#D
```



To start a new line or series of lines that do not connect to a previous line, reinitiate vector drawing with a new (GS) character.

EXAMPLE - The following entry draws two unconnected lines:

```
(GS)!r#D!r=B(GS)6z#D6z=B
```



The graphics beam position can be moved in Vector Mode without drawing. This is done by sending a (GS) and only one pair of coordinate.

Vector Mode is terminated by any control code that causes entry into another functional mode (Point Plot, Text, or Graphics Input) or a control sequence that causes a transition to TRANSPARENT or 4027 MODE.

NOTE

At baud rates of 1200 or more, remote start/stop (XON/XOFF) should be used or readback requests issued periodically with the control sequence (ESC)(ENQ). This prevents loss of data from input buffer overflow when drawing a series of long vectors. See Section 5.7 for details about status reports.

5.4.3 Erasing Graphics

Individual graphics elements can be erased by redrawing them in the opposite color. Example: a rectangle was created by drawing vectors in white. It can be erased by selecting "black" as the drawing color with the sequence (ESC)(DEL), then redrawing the vectors. If two lines cross and one is erased, however, a break will be left in the second line. Complement Mode can also be used to erase graphics; incomplete erasing will result if two white lines cross and both are redrawn in Complement Mode, because the point that is drawn twice will be white.

5.5 ADDING TEXT TO THE DISPLAY

In Text Mode the enhanced terminal places alphanumeric characters into the graphics display. 4010 Text Mode can be entered in any of four ways:

- (ESC)(FF) – an (ESC)(FF) sequence clears the screen and enters Text Mode with the cursor at home position (top left corner).
- F1 or Key Mode CLR selection – same as (ESC)(FF).
- (CR) – a carriage return enters Text Mode with the cursor at the left margin, across from the current graphics beam position.
- (US) – a (US) control character enters Text Mode with the cursor at the current graphics beam position.

Once Text Mode has been entered, any displayable ASCII characters received by the enhanced terminal are added to the graphics display beginning at the cursor location. Text is normalized to a grid of character cells. When the right margin of a line is reached, characters automatically wrap to the beginning of the next line or from the bottom line to the beginning of the top line. A carriage return (CR) brings the cursor to the beginning of the current line.

The following control characters move the cursor one space at a time:

(BS) = move one space left
 (HT) = move one space right
 (VT) = move one space up
 (LF) = move one space down

The cursor can also be moved directly to any location in the display with a (GS) control character, followed by the coordinates of the desired location and a (US) control character to re-enter Text Mode at that location.

EXAMPLE - The word "TEST" can be displayed at coordinates (495,390), near the center of the screen, with the following sequence:

```
(GS),f/0(US)TEST
```

The text cursor is normally nondestructive; it can be moved over existing graphics and alphanumerics without affecting them. The user can, however, make the BACKSPACE destructive with the !BACKspace Y command in 4027 MODE.

The enhanced terminal emulates the Tektronix Margin 0/Margin 1 function to facilitate entry of dual-column text. After the 34th line of the first column has been entered, enter a carriage return (CR) and line feed (LF) to position the cursor at the top of Margin 1 (center of the page) to start the second column. Margin 1 automatically becomes the left margin for the second column of text. Text in the first column that extends past Margin 1 is overwritten by text in the second column.

Text Mode is terminated by a control code that causes entry into another functional mode (Point Plot, Vector, or Graphics Input) or a sequence that causes a transition to TRANSPARENT or 4027 MODE.

5.6 USING GRAPHICS INPUT MODE (CROSSHAIR CURSOR)

In 4010 Graphics Input (GIN) Mode the enhanced terminal displays the crosshair cursor and waits for the operator to indicate a point in the display. The (ESC)(SUB) enters GIN Mode. Position the crosshair cursor with the four keyboard arrow keys. Tapping an arrow key moves the crosshair one pixel at a time; holding it down moves it continuously. Terminate GIN Mode by pressing any key that transmits a character to the host. The character sent by that key and the coordinates of the crosshair are transmitted to the host computer in the format shown below:

CHARACTER (KEY PRESSED)	BIT							
	7	6	5	4	3	2	1	0
HIGH X	P	X	X	X	X	X	X	X
LOW X	P	0	1	X	X	X	X	X
HIGH Y	P	0	1	X	X	X	X	X
LOW Y	P	0	1	X	X	X	X	X
TRAILER (e.g., CR)	P	X	X	X	X	X	X	X
TRAILER (e.g., LF)	P	X	X	X	X	X	X	X

While in GIN Mode the enhanced terminal is in a Bypass Condition, ignoring data from the host until it receives any control code. This prevents the GIN data, if echoed, from being accepted as graphics coordinates or text. The host system automatically clears the Bypass Condition if it echoes the trailer codes in the GIN report. Termination of GIN Mode leaves the enhanced terminal in Text Mode with the cursor at the left edge of the display (or at Margin 1), across from the current graphics beam position.

If the terminal is equipped with an optional light pen or digitizing tablet, either can be used in GIN Mode. Selection of either the light pen or digitizing tablet must be made in 4027 Mode with the !INPut command (see Appendix A, Table A-1). Instructions accompany each optional device.

5.7 REPORTING STATUS

The host system requests graphics status with the control sequence (ESC)(ENQ). The enhanced terminal responds with graphics status, graphics beam position, and trailer codes (if defined). The response to (ESC)(ENQ) is shown below:

BYTE	BIT							
	7	6	5	4	3	2	1	0
GRAPHICS/TEXT STATUS	P	0	1	1	0	†	S	1
GRAPHICS BEAM POSITION HIGH X	P	0	1	X	X	X	X	X
GRAPHICS BEAM POSITION LOW X	P	0	1	X	X	X	X	X
GRAPHICS BEAM POSITION HIGH Y	P	0	1	X	X	X	X	X
GRAPHICS BEAM POSITION LOW Y	P	0	1	X	X	X	X	X
TRAILER (e.g., CR)	P	X	X	X	X	X	X	X
TRAILER (E.G., LF)	P	X	X	X	X	X	X	X

† 0 = Point or Vector Mode
1 = Text Mode

S 0 = Margin 0 set
1 = Margin 1 set

After receiving an (ESC)(ENQ) sequence, the enhanced terminal enters a Bypass Condition, ignoring data from the host until it receives any control code. This prevents the status data, if echoed, from being accepted as graphics coordinates or text. The host system automatically clears the Bypass Condition if it echoes the trailer codes in the terminal's response status report.

5.8 PRODUCING HARDCOPY OUTPUT

If the enhanced terminal is equipped with an optional printer interface (Model RG30-PI or RG31-PI), it can dump the display to a graphics printer. A hardcopy dump is initiated in two ways: by pressing the F4 key (if PF keys are enabled for local use) or by entering the sequence (ESC)(ETB). To abort printing, press F4 while printing is in progress.

Several printer option settings, defined in 4027 MODE, affect hardcopy output. These include identification of the printer model, choice of two I/O channels, proportional compensation (needed with some printers), image rotation, full size or reduced image, leading or trailing form feed, and alphanumeric printing from the host and/or keyboard. These settings are listed under the !LPrint command in Appendix A, Table A-1.

5.9 PROGRAMMING THE HOST

Most existing 4010-series applications programs require no modification to be used on the enhanced terminal. New programs may be written that make use of the 4010-MODE functions described in the preceding sections. The following demonstration program, written in FORTRAN code, shows how a simple rectangle can be drawn with corner-point coordinates of (200,300), (200,400), (600,400), and (600,300). Figure 5-1 illustrates the resulting display (axes and coordinate values, included for reference, are not part of the display).

```

100 C
110 C   4010-MODE DEMONSTRATION PROGRAM
120 C
130   CALL CLR
140   CALL MOV (200,300)
150   CALL DRW (200,400)
160   CALL DRW (600,400)
170   CALL DRW (600,300)
180   CALL DRW (200,300)
190   STOP
200   END
210 C
220 C   END MAIN PROGRAM
230 C
240 C
250   SUBROUTINE MOV (X,Y)
260 C
270 C   MOVES CURSOR TO THE ABSOLUTE COORDINATE (X,Y)
280 C
290 C   MOV SENDS 'GS' CHARACTER (29), PUTTING TERMINAL IN 4010 VECTOR MODE,
300 C   THEN CALLS DRW TO SCALE COORDINATES AND SEND THEM TO TERMINAL.
310 C
320   INTEGER X,Y
330   CALL PUTC (29)
340   CALL DRW (X,Y)
350   RETURN
360   END
370 C
380 C
390   SUBROUTINE DRW (X,Y)
400 C
410 C   DRAWS VECTOR FROM CURRENT POSITION TO ABSOLUTE COORDINATES (X,Y).
420 C
430 C   DRW DERIVES THE HIY, LOY, HIX, LOX SEQUENCE FROM THE COORDINATES
440 C   AND SENDS THE RESULTING 4010 COORDINATES TO THE TERMINAL.
450 C
460   INTEGER X,Y
470   IHY = ((Y/32) .AND. 31)+32
480   ILY = (Y .AND. 31)+96
490   IHX = ((X/32) .AND. 31)+32
500   ILX = (X .AND. 31)+64
510   CALL PUTC (IHY)
520   CALL PUTC (ILY)
530   CALL PUTC (IHX)
540   CALL PUTC (ILX)
550   RETURN

```

```

560      END
570 C
580 C
590      SUBROUTINE PUTC (IC)
600 C
610 C      SENDS THE TERMINAL A CHARACTER IN THE LOW BYTE OF IC.
620 C
630 C      PUTC OUTPUTS ONE CHARACTER AT A TIME; IF USER'S COMPUTER REQUIRES
640 C      LARGER BLOCKS FOR EFFICIENT DATA TRANSMISSION, OUTPUT SHOULD BE
650 C      BUFFERED FIRST, THEN TRANSMITTED TO THE TERMINAL, REMEMBERING TO DUMP
660 C      BUFFER AT END OF PROGRAM TO AVOID LOSING DATA. (A '+' CARRIAGE CONTROL
670 C      IS USED TO OMIT THE CR AND LF CHARACTERS ON SOME COMPUTERS.)
680 C
690      INTEGER IC
700      WRITE (7,100) IC
710 100  FORMAT ('+',A1)
720      RETURN
730      END
740 C
750 C
760      SUBROUTINE CLR
770 C
780 C      CLEARS THE SCREEN
790 C
800 CC   SEND 'GS','ESC','FF'
810 C
820      CALL PUTC (29)
830      CALL PUTC (27)
840      CALL PUTC (12)
850      RETURN
860      END

```

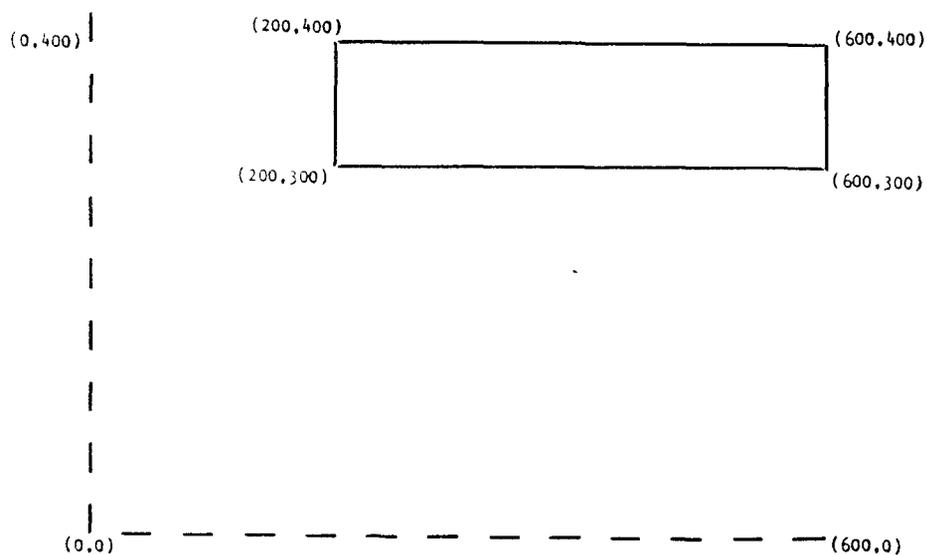


Figure 5-1. Display Created by 4010-MODE Demonstration Program

APPENDIX A - COMMAND REFERENCE

This section provides detailed information about each command, control sequence, and parameter. Table A-1 lists 4027-MODE commands alphabetically by keyword, Table A-2 lists 4010-MODE control sequences by initial control character, Table A-3 lists miscellaneous control sequences that affect more than one mode of operation, and Table A-4 lists the RG1000 settings that are used if a NOVRAM ERROR occurs during the power-on sequence.

Table A-1

Required parameters for 4027-MODE commands are shown in parentheses and optional parameters are shown in square brackets. Defaults that apply when optional parameters are omitted are shown in square brackets. Power-on defaults are shown when applicable (NOVRAM indicates the power-on value is from the nonvolatile memory). Codes in the left margin have the following meanings:

- TY (Tektronix, Yes) identifies a Tektronix command or parameter that is emulated.
- TN (Tektronix, No) identifies a Tektronix command or parameter that is not emulated (accepted but not executed).
- TP (Tektronix, Partial) identifies a Tektronix command that is partially emulated (see the codes for each parameter).
- RG (Retro-Graphics) identifies a new Retro-Graphics command or parameter.

Table A-2

The control codes and sequences shown in this table emulate functions of the Tektronix 4010, as well as the VT640 Retro-Graphics enhancement. Settings made in 4027 MODE carry over to 4010 MODE and affect these functions.

Table A-3

The control sequences in this table perform mode transitions and mode-independent functions.

Table A-4

If the set-up values stored in the RG1000 nonvolatile memory cannot be read correctly when power is applied, the values in this table will be used. Depending on the configuration of the host system, the enhanced terminal may or may not be operable.

Table A-1. 4027-MODE Commands

COMMAND	PARAMETERS	PURPOSE
TN ALLocate		NOT USED
TP ATtribute	[font][logical][visual[-visual]]	SET TEXT ATTRIBUTES
TY	[font] = 0	Standard ASCII font
RG	1	APL font
RG	2	User-defined font
TN	3-31	Not used
RG	32	Vector character font
RG	33	User-defined font
	[no parameter=no change] power-on default=0	
TN	[logical] =	Not used
TY	[visual] = C0-C7 IC0-IC7 [no parameter=no change] power-on default=C0	Text Color Inverted color
TN	[-visual] =	If used, replaces the [visual] parameter
TY BACKtab	[count](CR)	TAB BACKWARD
	[count] = positive integer [no parameter=1]	Number of tab stops
TY BAUD	(transmit)[receive]	SET BAUD RATE
	(transmit) = 50/75/110/134/150/300/ 600/1200/1800/2000/2400/ 3600/4800/7200/9600/19200 power-on default=NOVRAM	Transmit rate
	[receive] = must be same as transmit rate power-on default=NOVRAM	Receive rate
TY BEL1	[count]	SOUND TONE
	[count] = positive integer [no parameter=1]	Number of times

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
RG BITS	[number] [number] = 1/2/3/6 (4 or 5 rounded up to 6) [no parameter=1] power-on default=1	SET BITS PER PIXEL Number of bits
TN BUfFered		NOT USED
TY CIRcle	(radius)[start[end[increment]]] (radius) = positive integer [start] = integer [no parameter=0] [end] = integer [no parameter=360] [increment] = positive integer [no parameter=4]	DRAW AN ARC Radius in pixels Start angle in degrees End angle in degrees Vertex increment
RG CITalics	[angle] [angle] = integer [no parameter=0] power-on default=0	SET VECT CHAR ITALICS Slant in degrees (neg. value = slant right)
TY CLear		CLEAR KEY DEFINITIONS
RG CMODE	[setting] [setting] = Y N [no parameter=Y] power-on default=N	SET COMPLEMENT MODE Yes, Complement Mode No, normal drawing

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY COLor	(vector)[boundary] (vector) = C0-C7 P0-P119 power-on default=C0 [boundary] = C0-C7 P0-119 [no parameter=no change] power-on default=C0	SELECT GRAPHICS COLORS Vector/fill color Fill pattern Boundary color Boundary pattern
TY COMmand	(character) (character) = char. or decimal equiv. power-on default=!	SET COMMAND CHARACTER Any ASCII character
TN COPy		NOT USED
RG CROtate	[angle] [angle] = integer [no parameter=0] power-on default=0	SET VECT CHAR ROTATION Rotation in degrees
RG CSCale	[x size][y size] [x size] = positive integer [no parameter=100] power-on default=100 [y size] = positive integer [no parameter=100] power-on default=100	SET VECT CHAR SCALING % of normal x size % of normal y size
RG CSPace	[setting] [setting] = N Y [no parameter=Y] power-on default=N	SET VECT CHAR ADVANCE No, use !CVector values Yes, use font values

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
RG CVEctor	(x distance)[y distance] (x distance) = integer power-on default=26 [y distance] = integer [no parameter=0] power-on default=0	SET VECT CHAR ADVANCE X advance distance Y advance distance
RG CVSymbol	(char)(a1)(a2)(x)(y)[x[y]][x[y....]]] (char) = 32-127 (a1) = positive integer (a2) = positive integer each (x) = integer between -63 and 63 each (y) = integer between -63 and 63 (64,64) indicates next coordinates are a <u>move</u> rather than a <u>draw</u>	DEFINE VECTOR CHARACTER Character number (ADE) Advance before char. Advance after char. Horiz. move/draw dist. Vert. move/draw dist.
TN DChar		NOT USED
TN DELay		NOT USED
RG DFLine	(on)(off)[on[off[on[off[on[off]]]]]] each (on) = positive integer up to 63 each (off) = positive integer up to 63	DEFINE LINE TYPE 9 Number of pixels ON Number of pixels OFF

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TP DFont	(font)	DELETE FONT
TN	(font) = 1	Not used
TY	2-30	Dot matrix font
TY	31	Patterns P0-P119
RG	33	Vector character font
RG DIGitizer	[format][scale][coordinates][cursor]	SET DIGITIZER OPTIONS
	[format] = F V H	Full Vertical Horizontal
	[scale] = T B	Tektronix (or direct) Bit pad
	[coordinates] = E M	English Metric
	[cursor] = C N	Crosshair cursor No cursor
	[no parameter=same as power-on default] power-on defaults=F,T,E,C	
TN DIRectory		NOT USED
TY DISable		EXIT GIN MODE
TN DISConnect		NOT USED (If used = DISable)
TN DLIne		NOT USED
TY DOWn	[count]	MOVE CURSOR DOWN
	[count] = positive integer [no parameter=1]	Number of rows

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TP DUPlEx	(duplex)	SET DUPLEX
TY	(duplex) = F	Full duplex, no modem
RG	F,M	Full duplex, modem
TY	H	Half duplex
	power-on default=NOVRAM	
TY ECHo	[echo]	SELECT ECHO
	[echo] = L	Local echo
	R	Remote echo
	[no parameter=L]	
TY ENABle	[count]	ENABLE GIN MODE
	[count] = positive integer	Number of points
	[no parameter=no limit]	
RG ENTRy	[mode]	SELECT ENTRY MODE
	[mode] = 1	TRANSPARENT MODE
	2	4027 MODE
	3	4010 MODE
	[no parameter=1]	
	power-on default=NOVRAM	
TN EOL		NOT USED
TY ERAsE	[display]	ERASE WORKSPACE/MONITOR
	[display] = W	Workspace
	M	Monitor
	[no parameter=erase display that receives text from the source of the command (keyboard or host)]	
TY ERAsE G	[background]	ERASE GRAPHICS REGION
	[background] = C0-C7	Background color
	P0-P119	Background pattern
	[no parameter=C0]	

Table A-1. 4027-MODE Commands (continued)

COMMAND		PARAMETERS	PURPOSE
TY	EXPand	(macro#) (macro#) = M1-M16	EXECUTE A MACRO Macro number
TN	FIELD		NOT USED
TP	FONT	[from font](to font)	DOWNLOAD A FONT
TY		[from font] = 0 or 1	Firmware font
TN		2-31 [no parameter=0]	Not used
TN		(to font) = 1	Not used
TY		2-30	User-defined font 2
TN		31	Not used
TN	FORm		NOT USED
TY	GRAPHic	(beg row)(end row)[beg col][end col] (beg row) = positive integer (end row) = positive integer greater than beg row; (end row) minus (beg row) must be less than 53 [beg col] = 1-80 [no parameter=1] [end col] = 1-80 [no parameter=80]	DEFINE GRAPHICS REGION Top workspace row Bottom workspace row Left workspace column Right workspace column
RG	HERtz	(frequency) (frequency) = 50 60	SET OPERATING FREQUENCY 50 hertz operation 60 hertz operation
TY	GTEst		TEST GRAPHICS MEMORY
TP	HCOpy		PRINT GRAPHICS (Parameters not used)
TN	HRUle		NOT USED

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TN ICHar		NOT USED
TN ILine		NOT USED
TY INK	[setting] [setting] = Y N [no parameter=Y] power-on default=N	INK WITH THE CROSSHAIR Yes, ink in GIN Mode No inking in GIN Mode
RG INPut	[source] [source] = 1 2 3 [no parameter=1]	SELECT GIN SOURCE Crosshair cursor Light pen Digitizing tablet
TY JUMP	[row[column]] [row] = positive integer [no parameter=1] [column] = 1-80 [no parameter=1]	SPECIFY CURSOR LOCATION Workspace row Workspace column
TN KILL		NOT USED
TY LEArn	(key/macro)[string] (key/macro) = printable character ASCII decimal equiv M1-M16 F1-F13 S1-S13 P0-P9/P./PT/PE/PS/PB Pseudo-ADE	PROGRAM A KEY OR MACRO ASCII key ASCII key or CTRL char. Internal macro 4027 function key Shifted function key 4027 pad key Function or pad key
	[string] = delimited character string one or more ADE values any combination of ADEs and delimited strings [no parameter=clear key or macro]	Printable characters ASCII characters

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY LEFT	[count] [count] = positive integer [no parameter=1]	MOVE CURSOR LEFT Number of columns
TY LINE	[type]	SELECT A LINE TYPE
TY TN	[line] = 1-8 9 E P [no parameter=1]	Standard line types User-defined line Erasing line Endpoints only
RG LPrint	[prt][chan][sq][rot][rdc][line][ff] [prt] = 1-25 [chan] = A B [sq] = D S [rot] = H V [rdc] = F R [line] = C K E N [ff] = L T [no parameter=no change for all settings] power-on default=NOVRAM for all settings	SET PRINTER OPTIONS Printer number I/O channel A I/O channel B Direct Square (compensation) Horizontal Vertical Full size Reduced Computer (host) Keyboard Either Neither (graphics only) Leading form feed Trailing form feed

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY MAP	(color#)(hue)[lightness][saturation] (color#) = C0-C7 (hue) = 0-360 [lightness] = 0-100 [no parameter=100] [saturation] = 0-100 [no parameter=100]	DEFINE A COLOR Color number (Tektronix color std) (Tektronix color std) (Tektronix color std)
TY MARGins	[left[right]] [left] = 1-79 [no parameter=1] [right] = 2-80 [no parameter=80]	SET WORKSPACE MARGINS Left margin Right margin
TY MIX	(color#)[red[green[blue]]] (color#) = C0-C7 [red] = 0-100 [no parameter=100] [green] = 0-100 [no parameter=100] [blue] = 0-100 [no parameter=100]	DEFINE A COLOR Color number % red % green % blue
TY MONitor	[lines][source][source] [lines] = 1-34 [no parameter=no change] 34 when 4027 MODE entered [source] = H K [no parameter=source of the command becomes the source of monitor text] H,K when 4027 MODE entered	DEFINE A MONITOR Number of lines Host Keyboard

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
RG MOVE	(LL x)(LL y)(UR x)(UR y)(to x)(to y)	COPY VIDEO DATA
	(LL x) = integer	Lower left x (from)
	(LL y) = integer	Lower left y (from)
	(UR x) = integer	Upper right x (from)
	(UR y) = integer	Upper right y (from)
	(to x) = integer	to x (lower left)
	(to y) = integer	to y (lower left)
RG NBits	(bits)	SET NUMBER OF BITS
	(bits) = 7	7 bits per byte
	8	8 bits per byte
	power-on default=NOVRAM	
TN PAD		NOT USED
TP PARity	[parity]	SET PARITY
TY	[parity] = E	Even
TY	O	Odd
TY	H	High
RG	L	Low
TY	N	None
TN	D	Same as "none"
	[no parameter=N]	
	power-on default=NOVRAM	
TN PASS		NOT USED

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY PATtern	(pat#)[bg][fg[values[fg[values....]]]] (pattern#) = P0-P119 [bg] = C0-C7 [no parameter=C7] [fg] = C0-C7 [values] = (val),(val),(val)... [no [fg[values]]=solid background]	DEFINE A PATTERN Pattern number Background color Foreground color Binary values defining the pixels in each row of the pattern cell to be displayed in the foreground color
RG PAUse	[delay] [delay] = 0 - 127 [no parameter=0] power-on default=NOVRAM	SET TRANSMISSION DELAY Delay between bytes (in tics) transmitted by the enhanced terminal
RG PBAud	(baud) (baud) = 50/75/110/134/200/300/600 1200/1800/2000/2400/3600/ 4800/9600 power-on default=NOVRAM	SET PRINTER BAUD RATE Printer xmit/rcv rate
TN PERipherals		NOT USED
RG PFKey	[setting] [setting] = Y N [no parameter=L] power-on default Y	SET PF KEY USAGE Local use of PF keys Remote use of F keys

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY PIE	(radius)[start[end[increment]]] (radius) = positive integer [start] = integer [no parameter=0] [end] = integer [no parameter=360] [increment] = positive integer [no parameter=4]	DRAW A FILLED ARC Radius in pixels Start angle in degrees End angle in degrees Vertex increment
TY POLYgon	(x)(y)[x,y[x,y....[x,y]]] (x) = integer (y) = integer [x] = integer [y] = integer	DRAW A FILLED POLYGON Begin x coordinate Begin y coordinate Vertex x coordinate Vertex y coordinate
TN PROMpt		NOT USED
RG RASter	(data) (data) = stream of bytes (repeating data may be compacted; e.g., 8(AB) = ABABABABABABABAB)	RECEIVE VIDEO DATA Video data
RG READback	(count) (count) = positive integer	TRANSMIT VIDEO DATA Number of pixels
TP REPort	(report id)	REPORT STATUS
RG	(report id) = -1	Firmware version
TN	00	Dummy report
TY	01	Text cursor status
TY	02	Graphics beam status
TY	03	Crosshair status
TN	04-14	Dummy reports
TN RDOWN		NOT USED

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY RIGHT	[count] [count] = positive integer [no parameter=1]	MOVE CURSOR RIGHT Number of columns
TY RMAp	(color#)(hue)[lightness[saturation]] (color#) = C0-C7 (hue) = 0-360 [lightness] = 0-100 [no parameter=0] [saturation] = 0-100 [no parameter=0]	DEFINE A COLOR (REL) Color number (Tektronix color std) (Tektronix color std) (Tektronix color std)
TY RPOLYgon	(rx)(ry)[rx,ry[rx,ry...[rx,ry]]] (rx) = integer (ry) = integer [rx] = integer [ry] = integer	DRAW A POLYGON (REL) Begin x (relative) Begin y (relative) Vertex x (relative) Vertex y (relative)
TP RSS	[start[stop][setting]	REMOTE START/STOP
TN	[start]	Not used
TN	[stop]	Not used
TP TY TN TN	[setting] = N B H T [no parameter=B] power-on default=NOVRAM	No XON/XOFF Use XON/XOFF Same as B Same as B
TN RUP		NOT USED

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY RVEctor	(rx)(ry)[rx,ry[rx,ry....[rx,ry]]] (rx) = integer (ry) = integer [rx] = integer [ry] = integer	DRAW VECTORS (RELATIVE) Begin x (relative) Begin y (relative) Endpoint x (relative) Endpoint y (relative)
RG SAVE		SAVE VALUES IN NOVRAM
RG SBits	[bits] [bits] = 1 2 4 [no parameter=1] power-on default=NOVRAM	SET STOP BITS 1 stop bit 1.5 stop bits 2 stop bits
TN SEND		NOT USED
TN SET		NOT USED
TP SHRink	[scaling]	SET THE SCALING FACTOR
TY	[scaling] = N	No, standard 4027
TY	Y	Yes, from 4010 coord
TN	H	Not used
TN	B	Not used
RG	D	Direct (screen coord)
	[no parameter=Y] power-on default=N	

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY SNOopy	[setting] [setting] = Y N [no parameter=Y] power-on default=N	ENABLE CONTROL CHAR Yes, display CTRL char No CTRL char display
TY STOps	[n[n[n[n[n[n[n[n[n[n]]]]]]]]] [n] = 1-80 [no parameters=all tabs cleared] power-on default=NOVRAM	SET TAB STOPS Tab stops (low-high)
TY STRing	(string) (string) = delimited character string; one or more ADE values; any combination of ADEs and delimited strings	ENTER STRING OF TEXT Printable characters ASCII characters
TP SYMbol	(Char#)(font)[bg][fg[values]]....	DEFINE A NEW SYMBOL
TY	(char#) = 32-127	Character number
TN	(font) = 1	Not Used
TY	2	User-defined font
TN	3-30	Same as 2
TN	31	Not used
	[bg] = C0-C7 [no parameter=C7]	Background color
	[fg] = C0-C7 [values] = (val),(val),(val)...	Foreground color Binary values defining the pixels in each row of the character cell to be displayed in the foreground color
	[no [fg[values]]=solid background]	
TY SYStat		DISPLAY STATUS
TY TAB	[count] [count] = positive integer [no parameter=1]	MOVE THE CURSOR BY TABS Number of tab stops

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
RG TERminal	(type) (type) = 1 = 2 [no parameter= 0] power-on-default=NOVRAM	IDENTIFY TERMINAL TYPE Model 925 or 950 Model 910, 912, or 920
TY TEST		CREATE TEST DISPLAY
RG TRAIler	[code][code] [code] = 0-127 [no parameter=no trailer code] power-on default=NOVRAM	DEFINE TRAILER CODES ASCII decimal equiv
TY UP	[count] [count] = positive integer [no parameter= 1]	MOVE CURSOR UP Number of rows
TY VECtor	(x)(y)[x,y[x,y]].... (x) = integer (y) = integer [x] = integer [y] = integer	DRAW VECTORS Begin x coordinate Begin y coordinate Endpoint x coordinate Endpoint y coordinate
TN VRUle		NOT USED
RG VIEW	[setting] [setting] = 0 1 [no parameter=1] power-on default=1	ENABLE/DISABLE DISPLAY Graphics display off Graphics display on

Table A-1. 4027-MODE Commands (continued)

COMMAND	PARAMETERS	PURPOSE
TY WORKspace	[lines][source][source]	INITIALIZE A WORKSPACE
	[lines] = 0-33 [no parameter=no change] 0 when 4027 MODE entered	Number of lines
	[source] = H K [no parameter=source of the command becomes the source of monitor text] H,K when 4027 MODE entered	Host Keyboard

Table A-2. 4010-MODE Control Sequences

<u>CONTROL SEQUENCE</u>	<u>PURPOSE</u>
(BEL)	Sound audible tone
(BS)	Move cursor one column left
(CAN)	Change to TRANSPARENT MODE
(CR)	Reset drawing color to white, reset line type, and enter Text Mode at start of current line
(EM)	Clear the screen and reset drawing color to white
(HT)	Move cursor one column right
(LF)	Move cursor one row down
(SUB)	Clear TRANSPARENT-MODE display
(VT)	Move cursor one row up
(ESC)	Begin escape sequence
(FS)	Enter Point Plot Mode
(GS)	Enter Vector Mode (enter 4010 MODE from TRANSPARENT MODE)
(US)	Enter Text Mode at current graphics beam position
(ESC)(ENQ)	Send status and cursor data to host
(ESC)(FF)	Erase screen, enter Text Mode at home position (top left), set Margin 1, reset line type, and reset Complement Mode
(ESC)(ETB)	Hardcopy dump (optional printer interface required)
(ESC)(SUB)	Enter Graphics Input Mode (crosshair cursor, light pen, or digitizing tablet) and set Bypass Cond.
(ESC)'	Select normal line (4027 line type 1)
(ESC)a	Select dotted line (4027 line type 2)
(ESC)b	Select dash line (4027 line type 3)
(ESC)c	Select dot/long-dash line (4027 line type 4)
(ESC)d	Select dash/long-dash line (4047 line type 5)
(ESC)e	Select long-dash/three-dot line (4027 line type 6)
(ESC)f	Select long-dash line (4027 line type 7)
(ESC)g	Select long-dash/three-dash (4027 line type 8)
(ESC)x	Select line type 9 (user-defined line)*
(ESC)"0g	Enter TRANSPARENT MODE
(ESC)"6g	Enter 4027 MODE from 4010 MODE
(ESC)"7g	Enter 4010 MODE from 4027 MODE

* The user-defined line, defined in 4027 MODE, can be selected in 4010 MODE.

Table A-3. Miscellaneous Control Sequences

<u>CONTROL SEQUENCE</u>	<u>PURPOSE</u>
(STX)	Enter/exit Key Mode, from keyboard only (unless another character is selected by the user)
(ESC)(OP)	Clear screen (F1)
(ESC)(OQ)	Enter/exit 4027 MODE (F2)
(ESC)(OR)	Enter/exit 4010 MODE (F3)
(ESC)(OS)	Hardcopy dump (F4; optional printer interface required)
(ESC)"0g	Enter TRANSPARENT MODE
(ESC)"6g	Enter 4027 MODE from 4010 MODE
(ESC)"7g	Enter 4010 MODE from 4027 MODE

Table A-4. NOVRAM ERROR Default Settings

Baud	4800,4800	Xmit/recv=4800
Echo	L	Local
Entry Mode	2	4027
GIN input source	1	Crosshair cursor
Printer options	1	Printer 1 (Others to be defined)
Left Margin	1	Column 1
Right Margin	80	Column 80
Number of bits	8	bits
Parity	N	None
Pause	0	None
PFkey	L	Local
Remote start/stop	Y	XON/XOFF (DC1/DC3)
Stop Bits	1	One stop bit
Tab stops	-	None
Terminal	0	ADM
Trailer code 1	13	(CR)
Trailer code 2	N	None

RESET

APPENDIX B - STANDARD CHARACTER FONTS

FONTS 0 & 32 (ASCII)
FONT 1 (APL)

SP	SP
	..
")
#	<
\$	≤
%	=
&	>
']
(√
)	^
*	÷
+	÷
,	,
-	+
.	.
/	/
Ø	Ø
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
:	(
:	[
<	:
=	x
>	:
?	\

FONTS 0 & 32 (ASCII)
FONT 1 (APL)

@	-
A	α
B	⊥
C	∩
D	L
E	ε
F	-
G	∇
H	Δ
I	L
J	•
K	:
L	∅
M	I
N	T
O	O
P	α
Q	?
R	P
S	∟
T	~
U	↓
V	U
W	∩
X	∩
Y	↑
Z	∩
[←
\	T
]	→
^	∩
_	-

FONTS 0 & 32 (ASCII)
FONT 1 (APL)

'	o
a	A
b	B
c	C
d	D
e	E
f	F
g	G
h	H
i	I
j	J
k	K
l	L
m	M
n	N
o	O
p	P
q	Q
r	R
s	S
t	T
u	U
v	V
w	W
x	X
y	Y
z	Z
[∩
	∩
]	∩
~	∩
DEL	DEL

APPENDIX C - MNEMONICS DISPLAYED IN SNOOPY MODE

Table C-1 lists the mnemonics that are displayed in Snoopy Mode for normally nonprintable ASCII control characters.

Table C-1. ASCII Control-Character Mnemonics

<u>Character</u>	<u>Mnemonic</u>	<u>Control Function</u>
NUL	N _U	Null (time fill character)
SOH	S _H	Start of header
STX	S _X	Start of Text
ETX	E _X	End of Text
EOT	E _T	End of Transmission
ENQ	E _Q	Enquire
ACK	A _K	Acknowledge
BEL	B _L	Bell (Sound Audible Alert)
BS	B _S	Backspace
HT	H _T	Horizontal Tab
LF	L _F	Line Feed
VT	V _T	Vertical Tab
FF	F _F	Form Feed
CR	C _R	Carriage Return
SO	S _O	Shift Out
SI	S _R	Shift In

(Continued on next page)

Table C-1. ASCII Control-Character Mnemonics (continued)

<u>Character</u>	<u>Mnemonic</u>	<u>Control Function</u>
DLE	D _L	Data Link Escape
DC1	D ₁	Device Control 1 (XON)
DC2	D ₂	Device Control 2
DC3	D ₃	Device Control 3 (XOFF)
DC4	D ₄	Device Control 4
NAK	N _K	Negative Acknowledge
SYN	S _Y	Synchronization Character
ETB	E _B	End of Transmission Block
CAN	C _N	Cancel
EM	E _M	End of Medium
SUB	S _B	Substitute
ESC	E _C	Escape (Control Sequence Introducer)
FS	F _S	Field Separator
GS	G _S	Group Separator
RS	R _S	Record Separator
US	U _S	Unit Separator
DEL	■	Delete (Not Strictly a Control Character)

APPENDIX D - FIRMWARE IDENTIFICATION

The six 2764-type ROM firmware chips located on the RG1000 Board are labeled with an identification number code. Each chip is marked with the firmware number, the version number, the ROM location number, and the hexadecimal code for the checksum associated with that chip.

Figure D-1 (below) shows a typical ROM ID number with its various fields of information. If it is necessary to know the firmware version of the ROMs installed in the RG1000, consult the figure and check the version number of the ROMs on the RG1000 Board in your terminal.

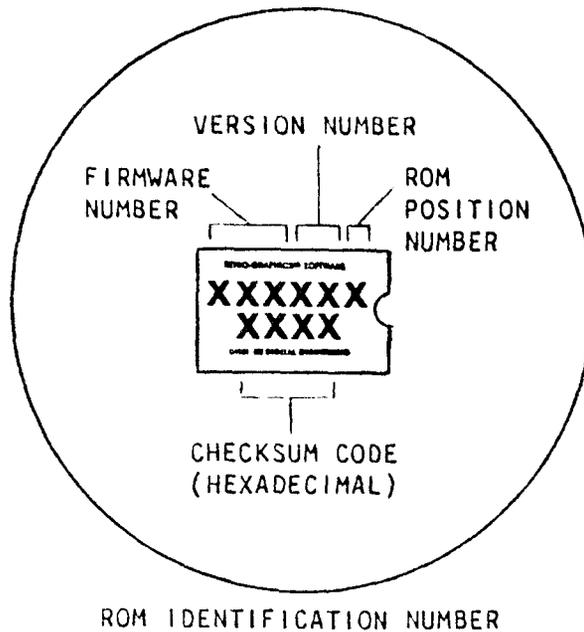


Figure D-1. ROM Identification Number

APPENDIX E - CHARACTER-CODE CHARTS

The first 32 ASCII characters are the control characters; the other 96 characters, in addition to their normal meanings, are used to represent the graphics coordinates in 4010-MODE graphics. Table E-1 lists the ASCII control characters and the keys (shifted or unshifted) used to send them. Table E-2 lists ASCII characters and the corresponding 4010 high-X or high-Y coordinate values, Table E-3 lists ASCII characters and the corresponding 4010 low-X coordinate values, Table E-4 lists ASCII characters and the corresponding 4010 low-Y coordinate values. Table E-5 lists the Pseudo-ADEs (decimal equivalents) that represent Tektronix 4027 keys simulated with the Key Mode menu.

Table E-1. ASCII Control Characters

<u>ASCII CHARACTER</u>	<u>KEYBOARD KEYS</u>	<u>BINARY CODE</u>	<u>HEXADECIMAL CODE</u>	<u>OCTAL CODE</u>	<u>DECIMAL EQUIVALENT</u>
NUL	(CTRL SPACE)	P0000000	00	000	0
SOH	(CTRL A)	P0000001	01	001	1
STX	(CTRL B)	P0000010	02	002	2
ETX	(CTRL C)	P0000011	03	003	3
EOI	(CTRL D)	P0000100	04	004	4
ENQ	(CTRL E)	P0000101	05	005	5
ACK	(CTRL F)	P0000110	06	006	6
BEL	(CTRL G)	P0000111	07	007	7
BS	(BACKSPACE)	P0001000	08	010	8
HT	or (CTRL H) (TAB) or (CTRL I)	P0001001	09	011	9
LF	(LINEFEED) or (CTRL J)	P0001010	0A	012	10
VT	(CTRL K)	P0001011	0B	013	11
FF	(CTRL L)	P0001100	0C	014	12
CR	(RETURN) or (CTRL M)	P0001101	0D	015	13
SO	(CTRL N)	P0001110	0E	016	14
SI	(CTRL O)	P0001111	0F	017	15
DLE	(CTRL P)	P0010000	10	020	16
DC1	(CTRL Q)	P0010001	11	021	17
DC2	(CTRL R)	P0010010	12	022	18
DC3	(CTRL S)	P0010011	13	023	19
DC4	(CTRL T)	P0010100	14	024	20
NAK	(CTRL U)	P0010101	15	025	21
SYN	(CTRL V)	P0010110	16	026	22
ETB	(CTRL W)	P0010111	17	027	23
CAN	(CTRL X)	P0011000	18	030	24
EM	(CTRL Y)	P0011001	19	031	25
SUB	(CTRL Z)	P0011010	1A	032	26
ESC	(ESC) or (CTRL [)	P0011011	1B	033	27
FS	(CTRL \)	P0011100	1C	034	28
GS	(CTRL])	P0011101	1D	035	29
RS	(CTRL ^)	P0011110	1E	036	30
US	(CTRL ?)	P0011111	1F	037	31

Table E-2. ASCII Characters/4010 High X or Y Coordinates

<u>ASCII CHARACTER</u>	<u>4010 HIGH X/Y</u>	<u>BINARY CODE</u>	<u>HEXADECIMAL CODE</u>	<u>OCTAL CODE</u>	<u>DECIMAL EQUIVALENT</u>
SP	0	P0100000	20	040	32
!	1	P0100001	21	041	33
"	2	P0100010	22	042	34
#	3	P0100011	23	043	35
\$	4	P0100100	24	044	36
%	5	P0100101	25	045	37
&	6	P0100110	26	046	38
'	7	P0100111	27	047	39
(	8	P0101000	28	050	40
)	9	P0101001	29	051	41
*	10	P0101010	2A	052	42
+	11	P0101011	2B	053	43
,	12	P0101100	2C	054	44
-	13	P0101101	2D	055	45
.	14	P0101110	2E	056	46
/	15	P0101111	2F	057	47
0	16	P0110000	30	060	48
1	17	P0110001	31	061	49
2	18	P0110010	32	062	50
3	19	P0110011	33	063	51
4	20	P0110100	34	064	52
5	21	P0110101	35	065	53
6	22	P0110110	36	066	54
7	23	P0110111	37	067	55
8	24	P0111000	38	070	56
9	25	P0111001	39	071	57
:	26	P0111010	3A	072	58
;	27	P0111011	3B	073	59
<	28	P0111100	3C	074	60
=	29	P0111101	3D	075	61
>	30	P0111110	3E	076	62
?	31	P0111111	3F	077	63

Table E-3. ASCII Characters/4010 Low X Coordinates

<u>ASCII CHARACTER</u>	<u>4010 LOW X</u>	<u>BINARY CODE</u>	<u>HEXADECIMAL CODE</u>	<u>OCTAL CODE</u>	<u>DECIMAL EQUIVALENT</u>
@	0	P1000000	40	100	64
A	1	P1000001	41	101	65
B	2	P1000010	42	102	66
C	3	P1000011	43	103	67
D	4	P1000100	44	104	68
E	5	P1000101	45	105	69
F	6	P1000110	46	106	70
G	7	P1000111	47	107	71
H	8	P1001000	48	110	72
I	9	P1001001	49	111	73
J	10	P1001010	4A	112	74
K	11	P1001011	4B	113	75
L	12	P1001100	4C	114	76
M	13	P1001101	4D	115	77
N	14	P1001110	4E	116	78
O	15	P1001111	4F	117	79
P	16	P1010000	50	120	80
Q	17	P1010001	51	121	81
R	18	P1010010	52	122	82
S	19	P1010011	53	123	83
T	20	P1010100	54	124	84
U	21	P1010101	55	125	85
V	22	P1010110	56	126	86
W	23	P1010111	57	127	87
X	24	P1011000	58	130	88
Y	25	P1011001	59	131	89
Z	26	P1011010	5A	132	90
[	27	P1011011	5B	133	91
\	28	P1011100	5C	134	92
]	29	P1011101	5D	135	93
^	30	P1011110	5E	136	94
_	31	P1011111	5F	137	95

Table E-4. ASCII Characters/4010 Low Y Coordinates

<u>ASCII CHARACTER</u>	<u>4010 LOW Y</u>	<u>BINARY CODE</u>	<u>HEXADECIMAL CODE</u>	<u>OCTAL CODE</u>	<u>DECIMAL EQUIVALENT</u>
\	0	P1100000	60	140	96
a	1	P1100001	61	141	97
b	2	P1100010	62	142	98
c	3	P1100011	63	143	99
d	4	P1100100	64	144	100
e	5	P1100101	65	145	101
f	6	P1100110	66	146	102
g	7	P1100111	67	147	103
h	8	P1101000	68	150	104
i	9	P1101001	69	151	105
j	10	P1101010	6A	152	106
k	11	P1101011	6B	153	107
l	12	P1101100	6C	154	108
m	13	P1101101	6D	155	109
n	14	P1101110	6E	156	110
o	15	P1101111	6F	157	111
p	16	P1110000	70	160	112
q	17	P1110001	71	161	113
r	18	P1110010	72	162	114
s	19	P1110011	73	163	115
t	20	P1110100	74	164	116
u	21	P1110101	75	165	117
v	22	P1110110	76	166	118
w	23	P1110111	77	167	119
x	24	P1111000	78	170	120
y	25	P1111001	79	171	121
z	26	P1111010	7A	172	122
{	27	P1111011	7B	173	123
|	28	P1111100	7C	174	124
}	29	P1111101	7D	175	125
~	30	P1111110	7E	176	126
DEL	31	P1111111	7F	177	127

Table E-5. Tektronix 4027 Keys/Pseudo-ADEs

<u>4027 KEY</u>	<u>PSEUDO-ADE</u>	<u>4027 KEY</u>	<u>PSEUDO-ADE</u>
Function Key 1 (F1)	128	Shift-Function Key 1 (S1)	144
Function Key 2 (F2)	129	Shift-Function Key 2 (S2)	145
Function Key 3 (F3)	130	Shift-Function Key 3 (S3)	146
Function Key 4 (F4)	131	Shift-Function Key 4 (S4)	147
Function Key 5 (F5)	132	Shift-Function Key 5 (S5)	148
Function Key 6 (F6)	133	Shift-Function Key 6 (S6)	149
Function Key 7 (F7)	134	Shift-Function Key 7 (S7)	150
Function Key 8 (F8)	135	Shift-Function Key 8 (S8)	151
Function Key 9 (F9)	136	Shift-Function Key 9 (S9)	152
Function Key 10 (F10)	137	Shift-Function Key 10 (S10)	153
Function Key 11 (F11)	138	Shift-Function Key 11 (S11)	154
Function Key 12 (F12)	139	Shift-Function Key 12 (S12)	155
Function Key 13 (F13)	140	Shift-Function Key 13 (S13)	156
Pad 0 (P0)	160	Pad 8 (P8)	168
Pad 1 (P1)	161	Pad 9 (P9)	169
Pad 2 (P2)	162	Pad . (P.)	170
Pad 3 (P3)	163	Pad Terminator (PT)	171
Pad 4 (P4)	164	Pad ERASE (PE)	172
Pad 5 (P5)	165	Pad SHIFT-ERASE (PS)	173
Pad 6 (P6)	166	Pad BK TAB (PB)	174
Pad 7 (P7)	167		

APPENDIX F - SPECIFICATIONS

The following specifications apply to the RG1000 enhancement as installed in a TeleVideo Model 910, 912, 920, 920, or 950 Video Terminal:

COMPUTER INTERFACES

EIA RS-232C

Nonvolatile memory holds settings for parity (even, odd, none, high, or low), and independent transmit and receive rates of 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, and 9600 baud (bits/second)

Limited compatibility with the following software packages:

- ISSCO's® DISSPLA® and TELLAGRAF® - ~~619 714 953 2816~~
- Precision Visuals' DI-3000™
- Tektronix' PLOT 10™
- Signal Technology's Interactive Laboratory System (ILS®)
- Megatek's Template™

273 4928
Bill
HARRIS

~~619 714 953 2816~~
SAN DIEGO 619-455-5590
714

4010 RICK
4027 FRAZIER
& SONS
MSDOS only

GRAPHICS FEATURES

Character Sets:

- Standard ASCII dot matrix
- Standard APL dot matrix
- User-defined dot matrix
- Standard ASCII vector characters
- User-defined vector characters

Enhanced text:

Vector characters are defined by height, width, line angle, fixed or proportional spacing

Vector Drawing:

Draws vectors automatically from vector endpoint coordinates.

Point Plotting:

Absolute addressing of points

Arc and Circle Drawing:

Defines arcs or circles by specifying center point, radius, and starting and ending angles

Polygon Drawing:

Defines a polygon of any shape (up to 100 sides) by specifying vertex points

Area Fill:

Automatically fills circles or polygons with one of 64 shading patterns

Line Formats:

Automatic generation of solid, dotted, dashed lines

Selective Erase:

Mode-independent selection of light, dark, or complement of data intensity level

TRANSPARENT MODE:

The Retro-Graphics PC board can be logically disconnected from the terminal to permit use of the terminal's standard alphanumeric and editing features

Interactive Crosshair Cursor:

Crosshair cursor controlled by four cursor control keys. Cursor is used to transmit X and Y coordinate information to host computer or to the terminal for drawing graphics

Light Pen (option):

Graphics interaction with optional Model DE20-LP light pen in addition to the crosshair cursor

I/O Expander Model RG10-I/O (option):

Provides connections for both a digitizing tablet and a printer (or two printers). Also provides connectors for a light pen and RS-170 video output via two dedicated RS-232 ports

Bit Pad or Printer Interface (option):

Model RG30-PI interfaces to the following printers: Epson Mx-80, Mx-100; DEC LA34RA, LA100, LA120 with Texprint DEC PLOT™; IDS Prism™ 80, Prism 132, Paper Tiger™; Datasouth 180

Model RG31-PI interfaces to the following printers: HP 2671G; Okidata Microline; TI Omni 800™ Model 810, Model 810 with Analog conversion board; Anadex DP-9000, DP-9001, DP-9500, DP-9501; Olivetti OPE TH240

RS-170 Video Output (option):

RS-170 circuitry is contained in the RG10-I/O Expander; a cable attaches the Expander box to the adapter board. RS-170 Video Output provides connection to video hardcopy devices and remote monitors

REFERENCE MANUAL

Retro-Graphics™ Terminal Enhancement, Model RG1000/TV60,61,62,63
For TeleVideo® Models 910, 912, 920, 925, and 950 Video Terminals
Part #60055530

Your comments will help us provide documentation that is technically accurate and easy to use. Please describe in as much detail as possible any errors or omissions you encounter while using this manual. General comments and suggestions for improvement are also welcome.

Is the format of this manual convenient in size, organization, and readability?

_____ Yes _____ No (please comment below)

Are the concepts clearly explained?

_____ Yes _____ No (please comment below)

Are the terminal set-up instructions easy to follow?

_____ Yes _____ No (please comment below)

Is the operation information sufficient for your applications?

_____ Yes _____ No (please comment below)

LOCATION
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PREFACE

The RG1000/TV60 Retro-Graphics™ terminal enhancement is a graphics upgrade designed and manufactured by Digital Engineering, Inc. for the TeleVideo® Model 925 or 950 video terminal. The RG1000/TV60 enhancement comprises both an RG1000 GEN.II™ Main Logic Board and a TV60 Adapter Board. For ease of reference in this manual, RG1000/TV60 designates the model number for the complete enhancement package.

This manual provides information and instructions for installing the Retro-Graphics enhancement into the TeleVideo Model 925 or 950 terminal; where differences occur, Model 925 information is indicated parenthetically. No prerequisite technical knowledge or special tools are required.

Operation instructions are contained in the RG1000-TV60/61/62/63 Reference Manual.

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SECTION 1 - INTRODUCTION

This manual contains the information necessary to install the Retro-Graphics™ terminal enhancement Model RG1000/TV60 into a TeleVideo® Model 925 or 950 video terminal. The instructions include preparing the terminal for installation, installing the RG1000/TV60 circuit boards, and connecting the RG1000/TV60 to the existing Model 925/950 circuitry.

It is recommended that the entire manual be reviewed before beginning installation.

1.1 EQUIPMENT REQUIRED

The only tools required for this installation are a small straight-edge screwdriver (such as a jeweler's screwdriver), a medium straight-edge screwdriver, a small (#1) Phillips screwdriver, a pair of diagonal cutters or other tool suitable for removing cable ties, a ruler or other suitable measuring device, and a pair of pliers.

1.2 SHIPPING CARTON CONTENTS

Before beginning installation, verify that the shipping cartons contain the following items in the installation kit (Figure 1-1).

<u>ITEM</u>	<u>DIGITAL ENGINEERING PART NUMBER</u>
Carton One (TeleVideo Adapter Kit):	
TV60 Adapter Board	80121028
Retro-Graphics Daughter (RGD) Board	80121018
Low-Profile Socket (Attached to the RGD Board)	50017321
RGD Cable	55019943
Power-to-Logic Cable	55019946
RGA Bus Cable	55019951
AC Power Cable	55019957
Video Cable Assembly	55020016
Screws, 4-40 x 3/4 (2)	60017500
Hex Nuts, 4-40, with Captive Lockwashers (2)	60013800
Standoffs, Threaded, 4-40 x 3/16 (2)	60014205
Mounting Bracket (for the RG1000 Board)	70020005
4-40 x 3/8 Screws (4)	60016600
Firmware FW033, 2764-Type ROMs (6)	10026758
Firmware FW032, Configuration ROMs (2)	10026761
DIP Jumpers, .1-Inch (10)	50018210
Washer, nylon (4)	60012510
FCC Notice	60051020
Retro-Graphics Nameplate	60054900
User Manual	60055530
Installation Manual	60055531
Carton Two (RG1000 Kit):	
RG1000 Main Logic Board	80021012
RG1000 Cover Letter	60055525

Locate the ASSY number on the TV60 Adapter Board (it will be either MA1058 or MA1145). Record this number to identify the board when ordering Retro-Graphics I/O options.

Inspect components for visible shipping damage. If there is a problem with the kit, contact Digital Engineering at one of the following Customer Service numbers:

- (800) 952-8341 (California only)
- (916) 447-7600 (West of the Mississippi River, except California, Arkansas, and Louisiana)
- (201) 575-5800 (East of the Mississippi, plus Arkansas and Louisiana)

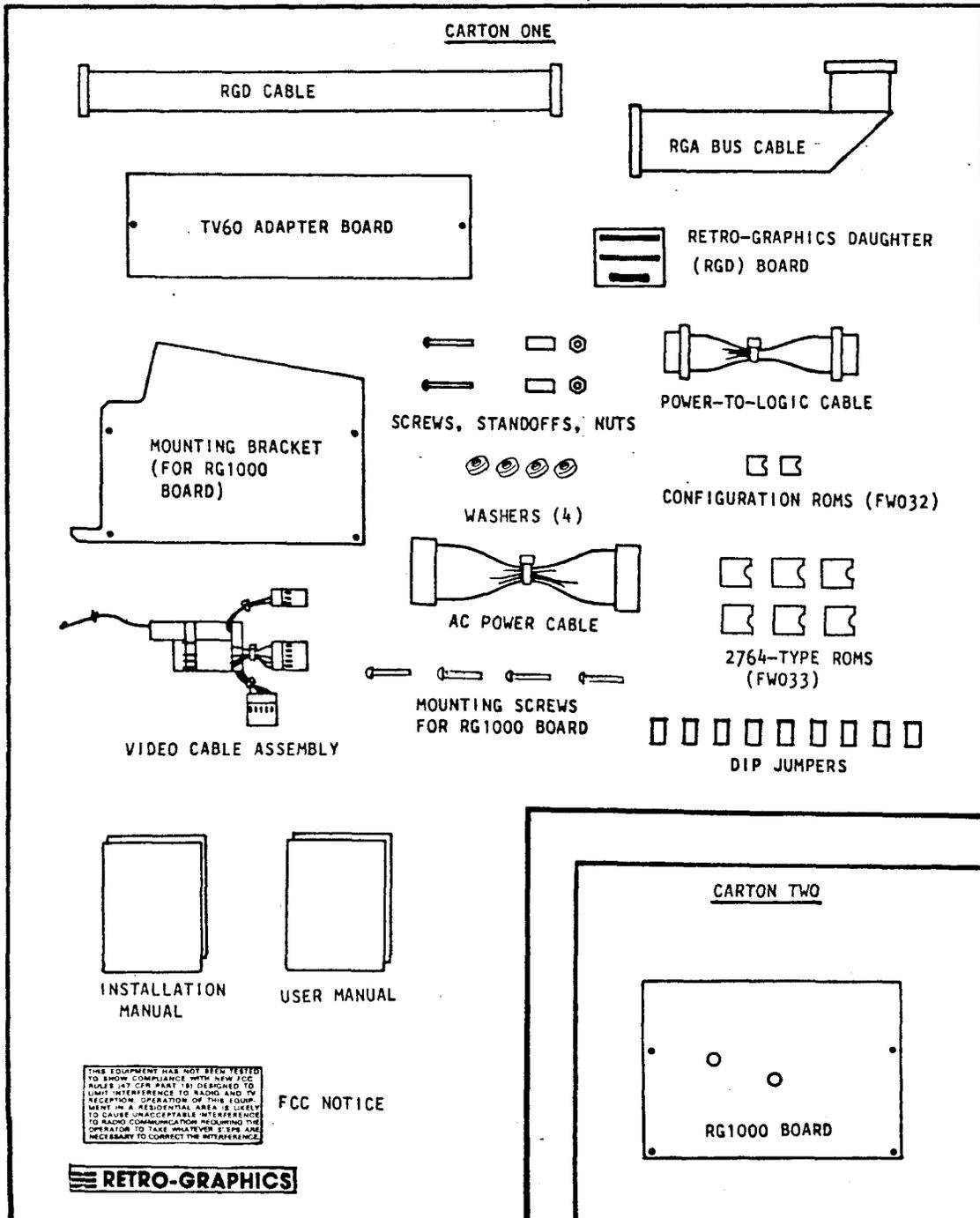


Figure 1-1. Installation Kit

SECTION 2 - INSTALLATION

Installing the RG1000/TV60 is a relatively simple process. The following procedures detail efficient installation.

2.1 PREPARATION

Prepare the terminal according to the following steps and Figure 2-1.

1. Position the Model 925/950 on a flat working surface, with the back of the terminal facing the installer. If the terminal is currently connected, turn power off and disconnect the power cord and I/O cables.
2. Remove the two short screws located underneath the front of the terminal case and the two long screws underneath the back of the terminal case. Save these screws for later use. Remove the terminal case top.

WARNING

A terminal may retain a high-voltage charge on certain components even after power has been removed. Note any manufacturer's warnings and touch only the items described in these installation procedures.

3. Cut the plastic ties (2) that secure the TeleVideo power and video cables to the right and left support structures at the back of the terminal; take care to avoid damaging the wires themselves. Allow the cables to fall loosely from the support structure. The two mounting holes are used later in installing the TV60 Adapter Board.
4. Set switches on the rear of the terminal as shown below. See the TeleVideo terminal Operator's Manual for more details about these switches. See the Setup Section of the Reference Manual for the RG1000-TV60/61/62/63 for instructions on setting up host compatibility.

Model 950—

<u>SWITCH S1</u>	<u>DESCRIPTION</u>	<u>SWITCH S2</u>	<u>DESCRIPTION</u>
S1-1 down		S2-1 up	Edit = duplex
S1-2 down	Baud = 9600	S2-2 ———	(Cursor)
S1-3 down		S2-3 down	
S1-4 down		S2-4 down	Parity = no
S1-5 down	Bits/byte = 8	S2-5 down	
S1-6 down	Stop bit = 1	S2-6 up	Video = normal
S1-7 ———		S2-7 down	Mode = full duplex
S1-8 ———		S2-8 up	
S1-9 ———	(Printer Baud)	S2-9 down/up	60 Hz/50 Hz
S1-10 ———		S2-10 ———	(Keyckick)

Model 925—same as model 950, except:

S2-1 down	Edit = duplex
S2-2 down	Emulation = 925
S2-7 up	Mode = full duplex
S2-8 down	

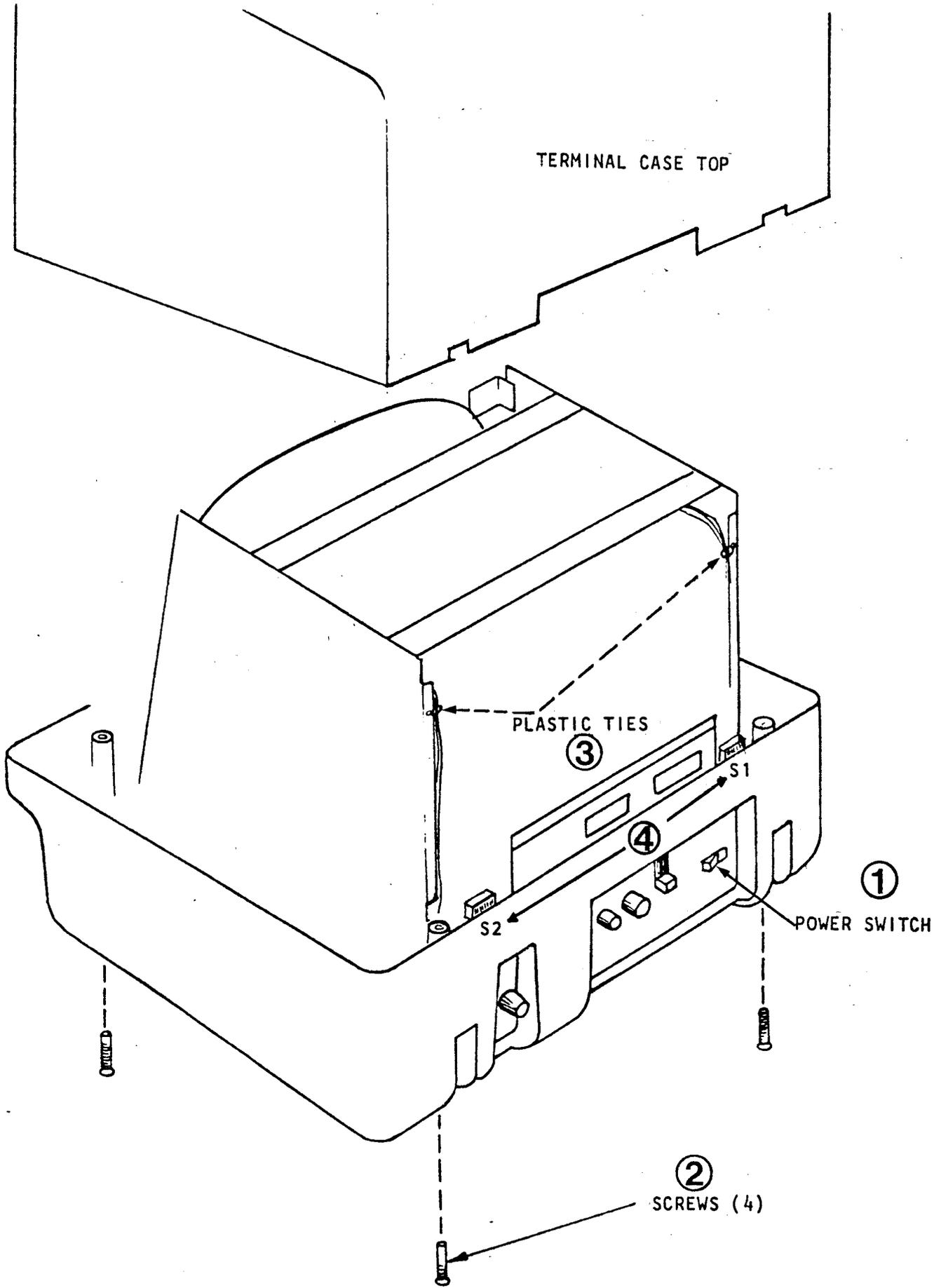


Figure 2-1. Preparing the Terminal for Installation

2.2 INSTALLATION PROCEDURES

RG1000/TV60 installation is divided into six parts:

- Installing the RG1000 firmware
- Installing the RG1000 Main Logic Board
- Installing the RGD Board
- Connecting the Video Cable Assembly
- Installing the TV60 Adapter Board
- Cabling and Adjusting the RG1000 Main Logic Board

Install the Retro-Graphics enhancement according to the steps and illustrations given in each procedure. Each item number in an illustration corresponds to a step in the associated procedure.

2.2.1 Installing the RG1000 Firmware

Install the ROM firmware onto the RG1000 Main Logic Board according to the following steps and Figure 2-2.

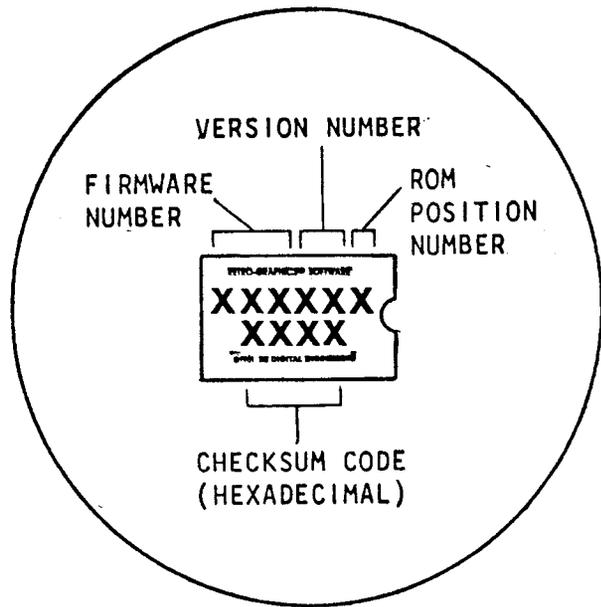
1. Locate the identification numbers on top of the two RG1000 configuration ROMs (FW032). The first three digits on the top line identify the type of firmware (032). The next two digits are the version number (10 for version 1.0). The last digit in the first line of ID numbers on each chip indicates the ROM position on the RG1000 Board. Install the ROM marked 032xx1 at U71 on the RG1000 Board; install the ROM marked 032xx2 at U72. Configuration ROMs can have either a stripe or a notch at one end. The notch or stripe in each DIP package must be oriented in the same direction as the notch illustrated in Figure 2-2.

CAUTION

Use care when installing each ROM; the leads are easily bent or broken if they do not line up properly with the holes in the socket. If the two rows of leads are slightly wider or narrower than the socket, carefully bend an entire row against a flat surface such as the edge of a table.

2. Locate the identification numbers on top of the six 2764-type ROMs (FW033). The ROMs are marked in the same manner as those in step 1. Install ROM 1 (marked 033xx1) at U1 on the RG1000 Board; ROM 2 at U2; ROM 3 at U3, ROM 4 at U4; ROM 5 at U5, and ROM 6 at U6. The notch in each DIP package must be oriented in the same direction as the notch illustrated in Figure 2-2.

Ensure that the ROMs are firmly in place.



ROM IDENTIFICATION NUMBER

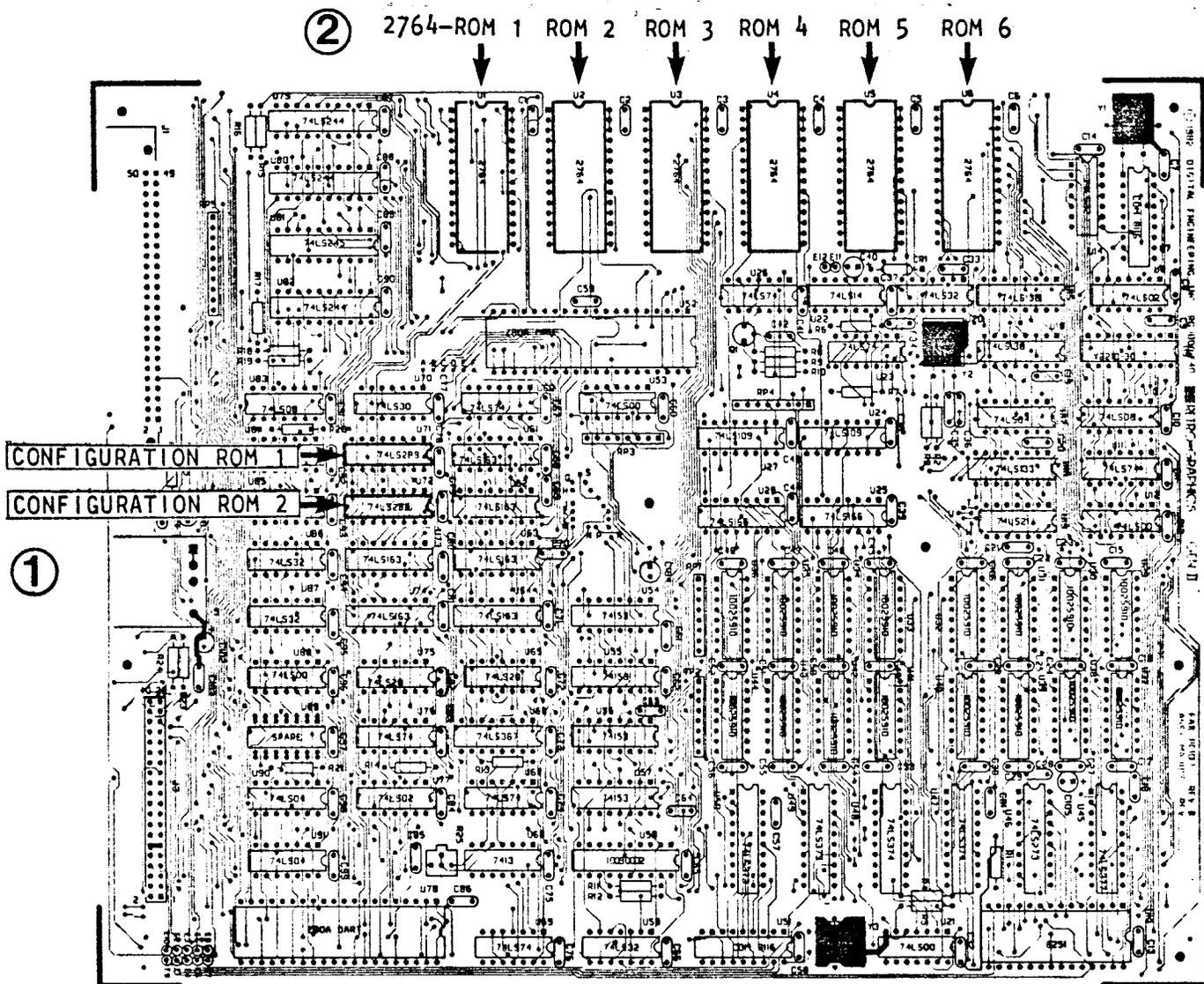
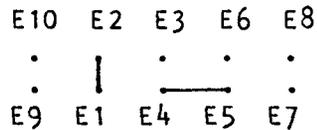


Figure 2-2. Installing the RG1000 Firmware

2.2.2 Installing the RG1000 Main Logic Board

Referring to Figure 2-3, install the RG1000 Board according to the following procedures.

1. At the front of the terminal, loosen the screw that secures the CRT at the upper right corner (three or four turns should be sufficient).
2. Attach the RG1000 Board to the mounting bracket (component side away from the bracket). Insert a nylon washer (provided in the kit) between the RG1000 Board and the mounting bracket at each of the four mounting holes. Attach in order: screw, RG1000 Board, nylon washer, mounting bracket. Connect E1 to E2 and E4 to E5 with DIP jumpers (provided in the kit) as shown below.



3. Slide the top of the mounting bracket (with RG1000 Board attached) down onto the shaft of the loosened screw on the CRT, guiding the bottom of the mounting bracket onto the two screw housings of the terminal case bottom. Ensure that the assembly is pushed down all the way. Tighten the screw loosened in the first step.

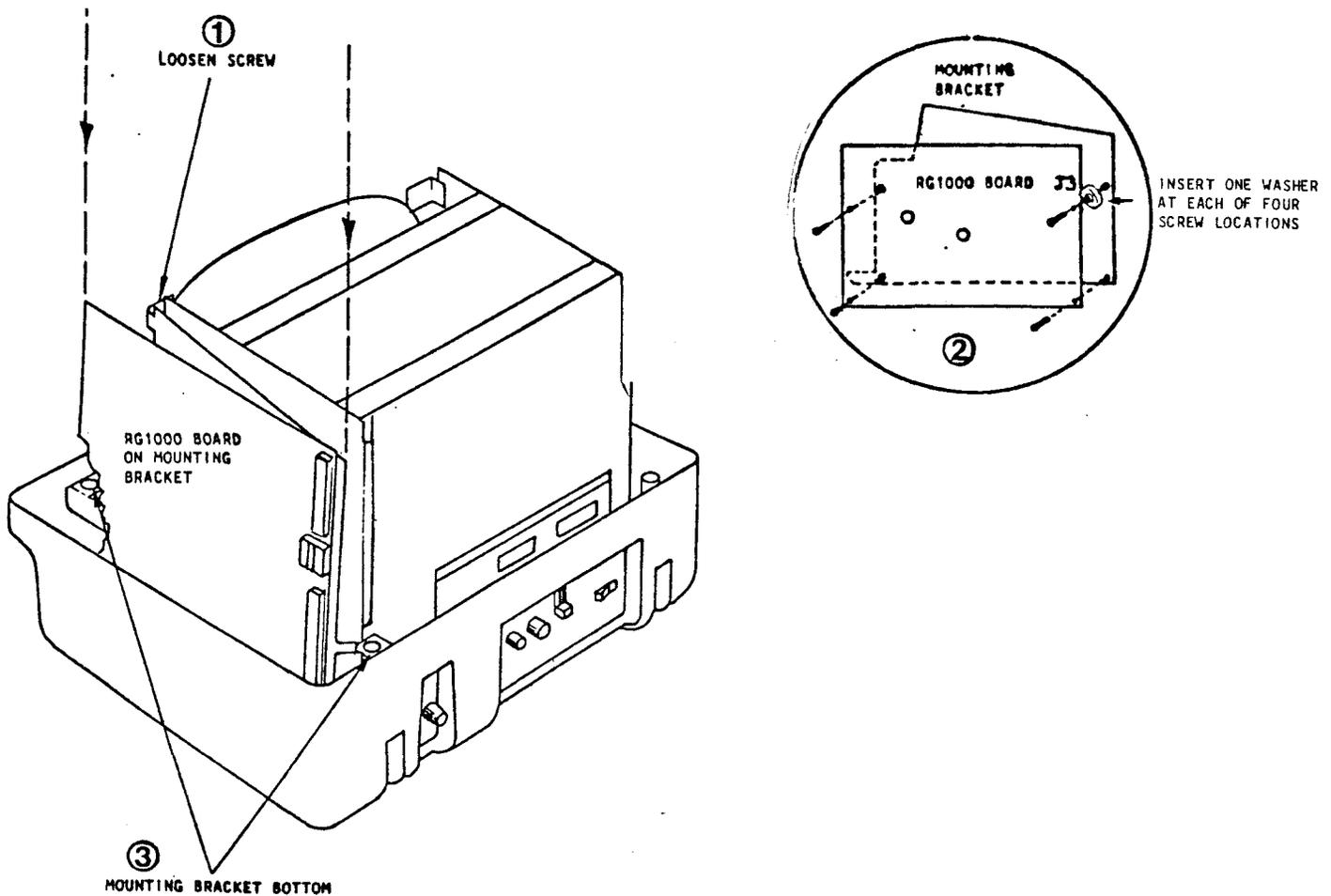


Figure 2-3. Installing the RG1000 Main Logic Board

2.2.3 Installing the RGD Board

Install and cable the Retro-Graphics Daughter (RGD) Board according to the following steps and Figure 2-4.

1. Holding the I/O interface panel attached at the rear of the TeleVideo Terminal Control Board, pull up and back to slide the Terminal Control Board approximately halfway out of the terminal.
2. Locate the UART chip on the Terminal Control Board:

<u>TERMINAL</u>	<u>CONTROL BOARD ASSEMBLY NUMBER (LOCATION)</u>	<u>SOCKET</u>
MODEL 925	B900014 (left edge, viewed from the rear)	A32
MODEL 925	B900014-002 (toward front of the terminal)	A4
MODEL 950	B900002 (left edge, viewed from the rear)	A50

3. Remove the UART chip from the Terminal Control Board and insert it into the socket on the RGD Board. Make sure the notch in one end of the chip faces the same way as the notch in the connector (underside of the RGD Board).

CAUTION

Leads are easily bent or broken when removing a chip from its socket. If an IC removal tool is not available, CAREFULLY pry the chip up with a screwdriver or similar implement. Pry each end up slightly, alternating until the chip comes out easily.

4. Attach the low-profile socket to the connector on the underside of the RGD Board (the notches in the socket and the connector should face the same way). The socket raises the RGD Board to clear Terminal Control Board components.
5. Insert the RGD Board into the socket from which the UART was removed in step 3. Make sure the notch in the UART faces the same direction it did before it was removed from the Terminal Control Board.
6. Attach the RGD Cable (the connector with an arrow on the inside face) to the 16-pin connector on the RGD Board. The arrow on the cable connector corresponds to the pin marked "1" on the RGD Board.
7. Attach the other end of the RGD Cable to J4 on the TV60 Adapter Board. The arrow on the outside face of the cable connector corresponds to the arrow on the TV60 Adapter Board connector (pin 1).

Verify that all connections are correct and all connectors are firmly seated.

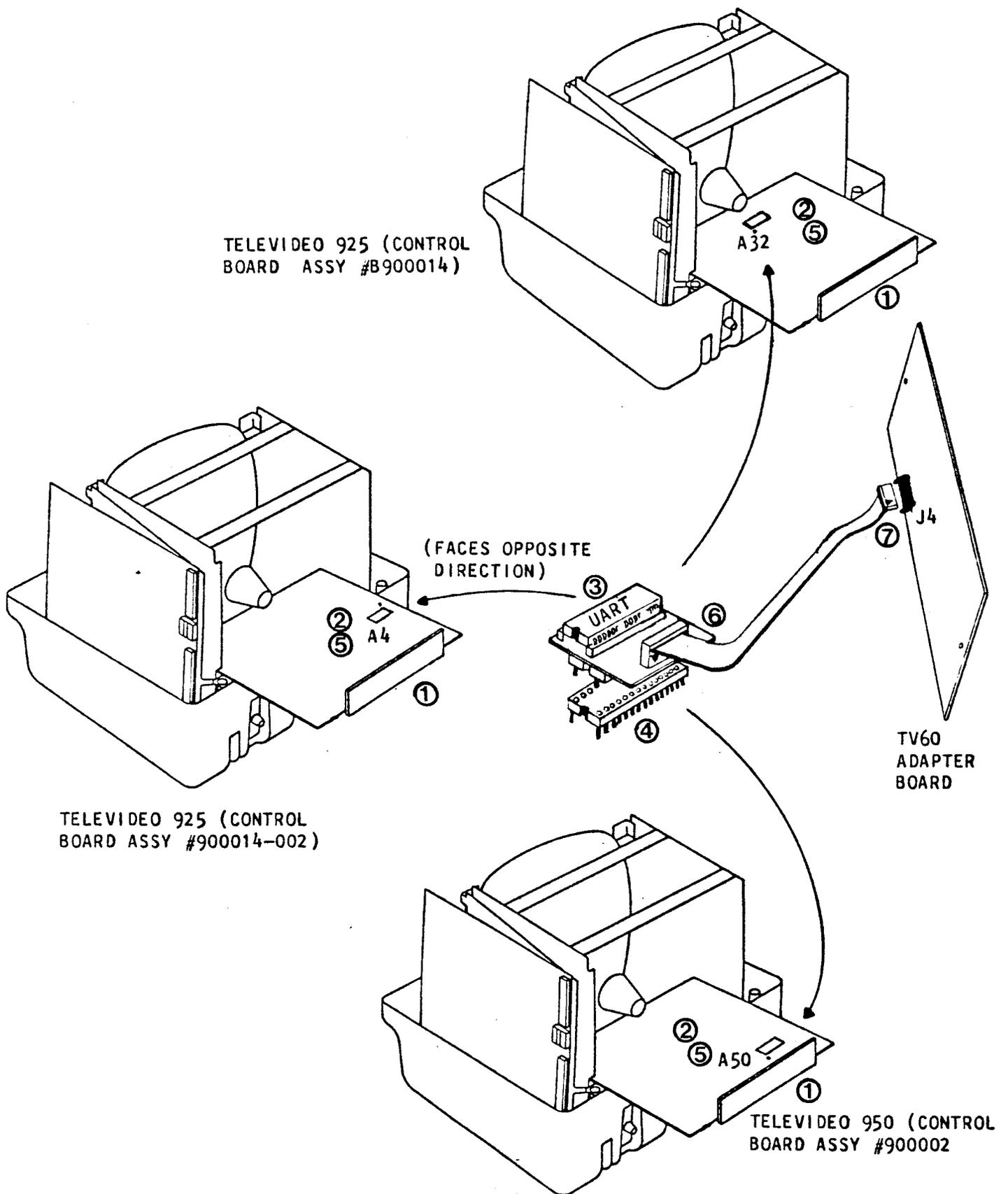


Figure 2-4. RGD Board Connections

2.2.4 Connecting the Video Cable Assembly

Refer to Figure 2-5 to make the following video connections.

1. Detach the video connector from P2 on the TeleVideo Terminal Control Board. Attach this connector to the Video Cable Assembly provided in the installation kit. The connector is keyed to attach correctly.
2. Attach Video Cable Assembly connector A to P2 on the TeleVideo Terminal Control Board. The connector is keyed for proper connection.
3. Attach Video Cable Assembly connector B to J7 on the TV60 Adapter Board; attach connector C to J6 on the TV60 Adapter Board. The connectors are keyed for proper connection.
4. Detach the connector from P10 on TeleVideo Video Control Board. Release the yellow wire by pressing the point of a small screwdriver against the clip that shows through the hole in the connector. Pull the wire out of the connector.
5. On the Video Cable Assembly, locate the connector with a single orange wire in the middle hole. Detach this connector and insert the yellow TeleVideo wire in the left-hand hole (orient the wire so the flat side of the clip faces the hole in the connector). Tug the wire gently to be sure it is seated properly in the connector. Reattach the connector to the Video Cable Assembly.
6. Insert the orange wire from the Video Cable Assembly into the hole from which the yellow TeleVideo wire was pulled (orient the wire so the flat side of the clip faces the hole in the connector). Tug gently on the wire to ensure proper seating. Reattach the video connector to P10 on the TeleVideo Video Control Board.
7. Slide the TeleVideo Terminal Control Board back into place, pulling up and pushing forward until the I/O connector panel on the back of the Terminal Control Board is flush with the back of the terminal case.

Verify that all connections are correct and all connectors are firmly seated.

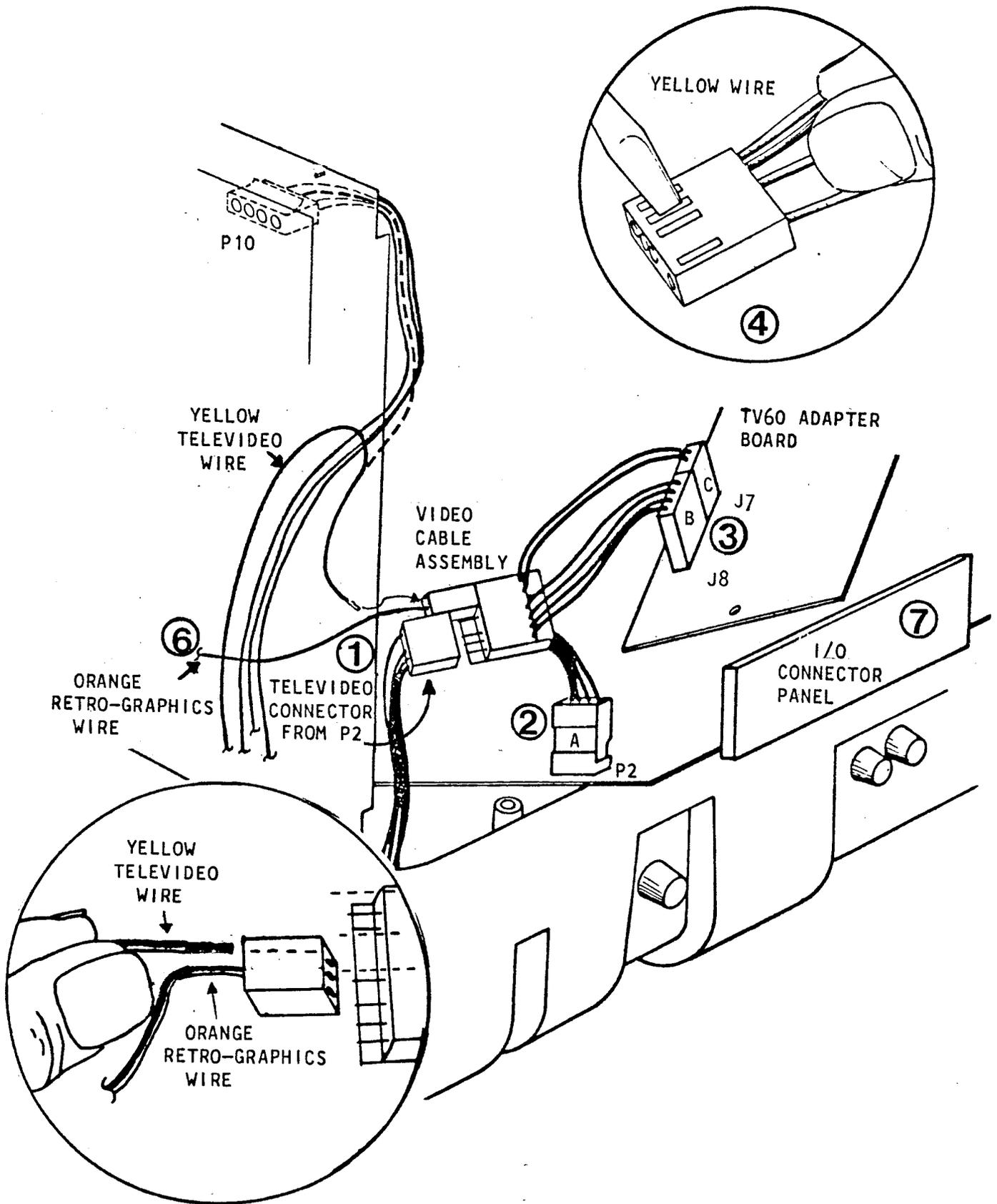


Figure 2-5. Video Connections

2.2.5 Installing the TV60 Adapter Board

Prepare and install the TV60 Adapter Board according to the following steps and Figure 2-6.

1. Locate the serial number on the TV60 Adapter Board and install DIP jumpers across the pins indicated:

MODEL 925

Level I Board (PC-1058 REV A in upper right-hand corner): E1/E2, E9/E10, TB1/TB2, TB3/TB4

Level II Board (PC-1145 REV A1 written just left of the middle of the board): E27/E28, E31/E32, E54/E56, E57/E58, E60/E62, E63/E65, E66/E68

Level III Board (PC-1045 REV A2 or PC-1145 REV A2 in upper right-hand corner): E27/E28, E31/E32, E54/E55, E57/E58, E60/E62, E63/E65, E66/E68

MODEL 950

Level I Board (PC-1058 REV A in upper right-hand corner): E1/E2, E9/E10, TB1/TB2, TB5/TB6, TB7/TB8

Level II Board (PC-1145 REV A1 written just left of the middle of the board): E27/E28, E29/E30, E33/E34, E54/E56, E57/E58, E60/E62, E63/E65, E66/E68

Level III Board (PC-1045 REV A2 or PC-1145 REV A2 in upper right-hand corner): E27/E28, E29/E30, E33/E34, E54/E55, E57/E58, E60/E62, E63/E65, E66/E68

2. Detach the power supply cable from K1 on the Televideo Power Supply Board. Attach this cable to J1 on the TV60 Adapter Board.
3. Attach the power-to-logic cable to J10 on the TV60 Adapter Board. The connector is keyed to attach correctly.
4. Install the TV60 Adapter Board to the rear support structure of the terminal with the 4-40 x 3/4 screws, threaded standoffs, and hex nuts/lockwashers. Insert the screws from the inside of the supports, assembling the hardware in the following order: screw, TeleVideo support, threaded standoff, TV60 Adapter Board, and nut/lockwasher. Before securing the TV60 Adapter Board, route the power-to-logic cable between the bottom standoff and the mounting screw (and between the adapter board and the terminal chassis). Tighten the nut with pliers to secure the TV60 Adapter Board.
5. Attach the Retro-Graphics AC power cable to K1 on the Televideo Power Supply Board and to J2 on the TV60 Adapter Board. The connectors are keyed for proper attachment.

Verify that all connectors and jumpers are correct and firmly seated.

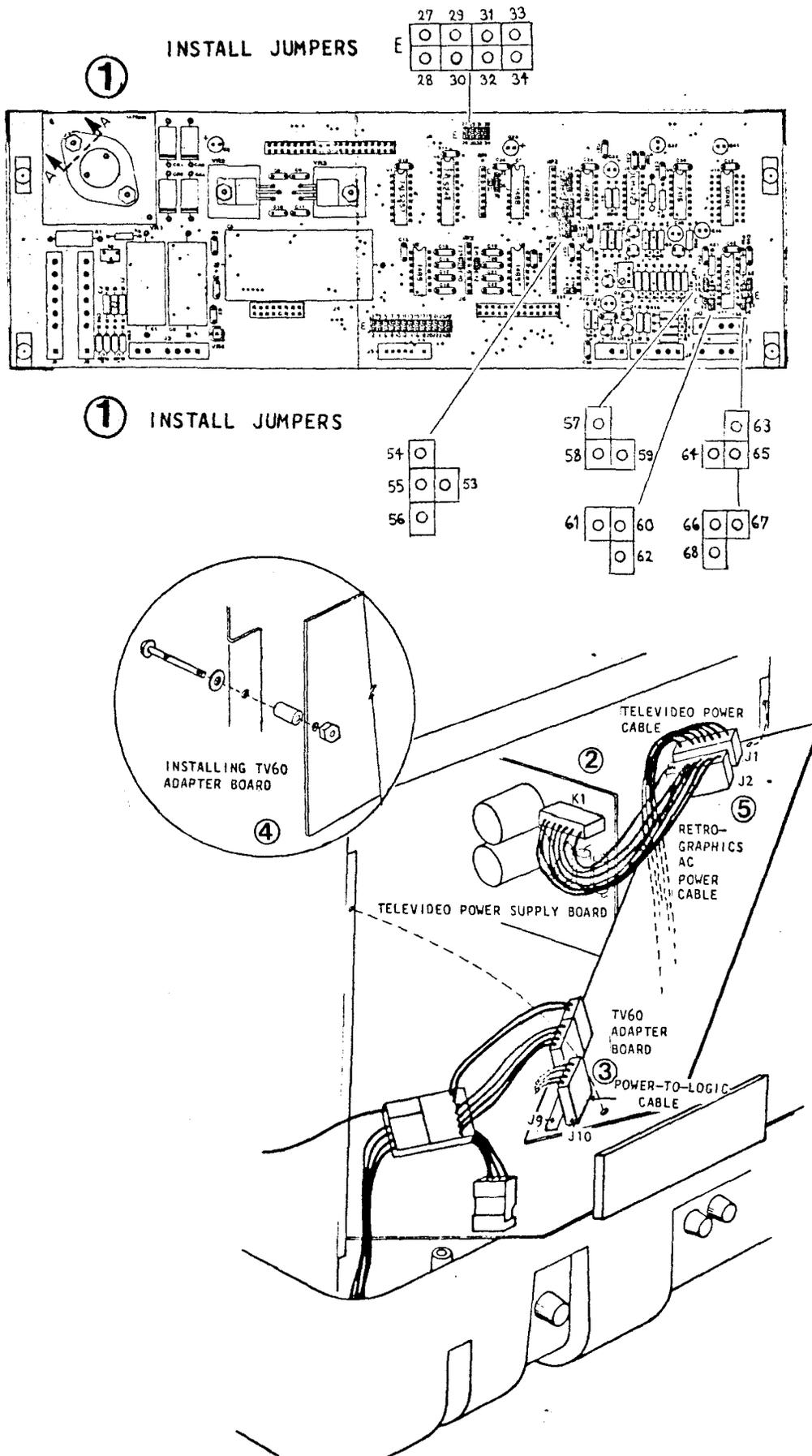


Figure 2-6. AC Power Connections and TV60 Adapter Board Installation

2.2.6 Cabling and Adjusting the RG1000 Main Logic Board

Connect and adjust the RG1000 Main Logic Board according to the following steps and Figure 2-7.

1. Connect the power-to-logic cable (from J10 on the TV60 Adapter Board) to J2 on the RG1000 Main Logic Board. The connector is keyed to attach correctly.
2. Connect the RGA Bus cable from J3 on the RG1000 Board to J3 on the TV60 Adapter Board. The cable is folded for proper attachment. The arrow on the connector to the RG1000 Board should be at the top and visible; the arrow on the connector to the TV60 Adapter Board should be at the right (toward the TeleVideo power supply) facing the CRT.
3. Verify that all connections are correct and all connectors are firmly seated. After installation of the RG1000/TV60 circuit boards (but before the terminal case is reassembled), make the following checks and adjustments:
 - a. Apply power to the terminal. To ensure that the terminal is in 4027 Mode, make the following entries from the keyboard within five seconds after power is applied:*

Press the CTRL and b keys simultaneously
Press the right arrow key once
Press RETURN**

Then type one of the following sequences to enter and save a value identifying the terminal model:

ITER 1 ISAV [RETURN] (TeleVideo 925/950)
or
ITER 2 ISAV [RETURN] (TeleVideo 910/912/9200)

Power the terminal off and back on. After a brief delay the following message should be displayed on the screen:

V1.3 (c) Copyright Digital Engineering, Inc. 1982

Type the following sequence:

IWOR 33;IGRA 1,33;IERA G CO [press RETURN]

The upper part of the screen ("workspace" part of the display) should be bright (all dots on).

* It is not abnormal for a Retro-Graphics enhanced terminal to initially power on with the message NOVDRAM ERROR. This message appears if nothing has been previously saved in nonvolatile memory. If the message occurs after one or more values have been saved, it indicates a failure of the nonvolatile RAM.

** The "(CTRL b), right arrow, RETURN" sequence enters Key Mode, then selects 4027 Mode. Ignore the display on the screen; it may not be correct until after the terminal model has been identified to the RG1000 in the next step.

- b. Locate potentiometer R20 on the TV60 Adapter Board (midway across from J6). If the adapter board has two potentiometers, locate the pot labelled R14. This "pot" adjusts the intensity of combined Televideo and Retro-Graphics video. Using a small staight-edge screwdriver, adjust R52 until the workspace is displayed at the brightness desired for graphics. Then vary the CONTRAST control at the back of the terminal until the commands at the bottom of the screen are displayed at about the same intensity (it should be possible to adjust the alphanumeric display both above and below the brightness of the graphics video). Make sure R52 is adjusted to the desired brightness; the only external adjustment after closing the terminal is the CONTRAST control, which does not affect the brightness of Retro-Graphics video.
 - c. A 4:3 aspect ratio is required to display graphics in correct proportion. This is achieved by adjusting display width with potentiometer R25 on the RG1000 Board (located about three inches from J3). Measure the height of the display with a small ruler. Multiply the height by 1.030303, then multiply the result by 4. Divide the result by 3. This calculation produces the desired width measurement. Use a small screwdriver to adjust the potentiometer until this width is achieved (horizontal measurement). Turn the screw as many turns as necessary to adjust the display.
4. When display intensity and width are properly adjusted, replace the top of the terminal case and secure it with the screws removed in Section 2.1.
 5. Affix the "FCC Notice" to the rear of the terminal and the Retro-Graphics nameplate to the front of the terminal case (lower right corner).

Installation is complete; see the RG1000-TV60/61/62/63 Reference Manual for setup and operation of the enhanced terminal.

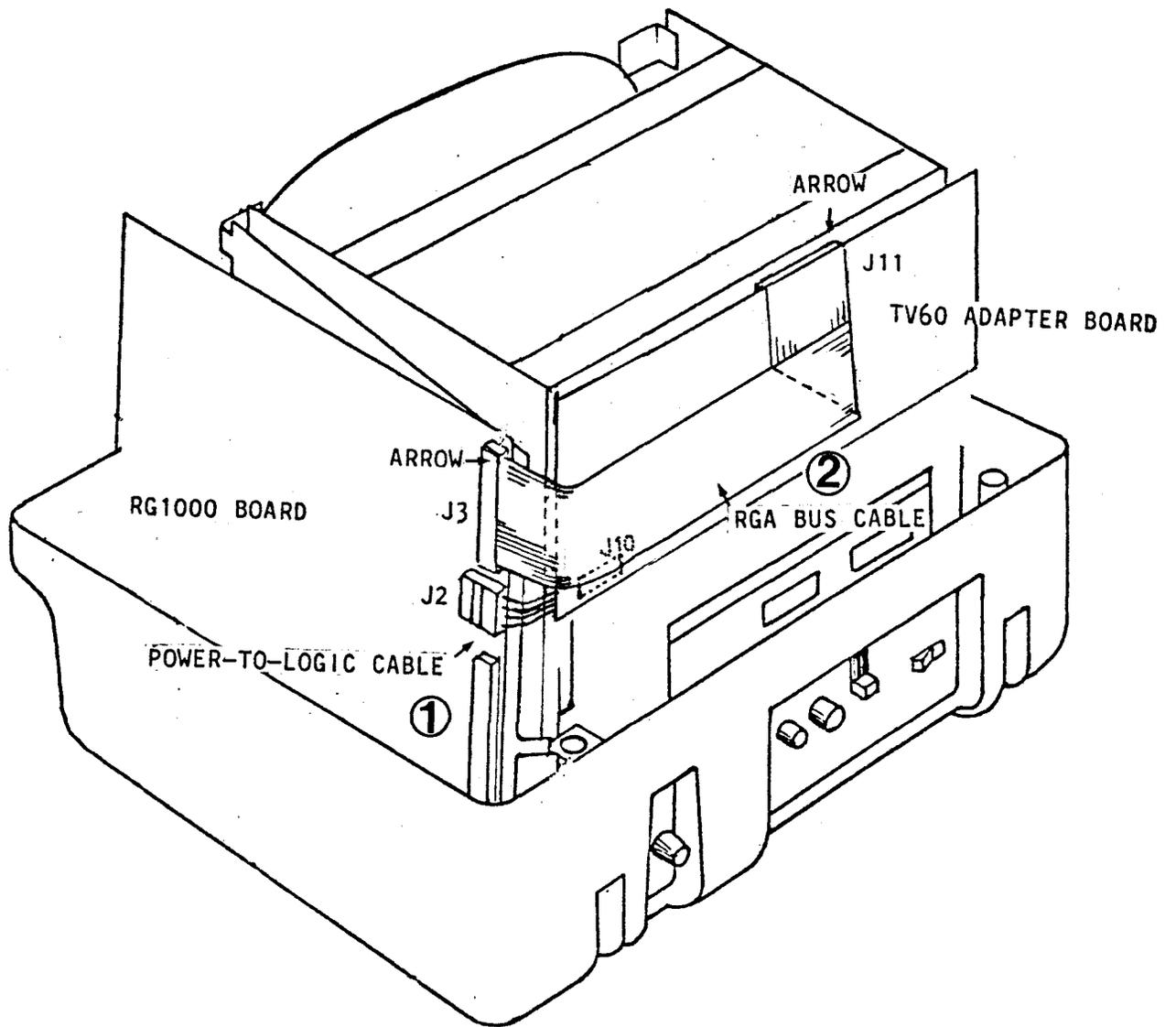


Figure 2-7. Connecting the RG1000 Main Logic Board to the TV60 Adapter Board



READER COMMENT FORM

RETRO-GRAPHICS™

INSTALLATION MANUAL
Retro-Graphics™ Terminal Enhancement, Model RG1000/TV60
For the TeleVideo® Model 925 or 950 Video Terminal
Part #60055531

Your comments will help us provide documentation that is technically accurate and easy to use. Please describe in as much detail as possible any errors or omissions you encounter while using this manual. General comments and suggestions for improvement are also welcome.

Is the format of this manual convenient in size, organization, and readability?

_____ Yes _____ No (please comment below)

Are the instructions complete and easy to follow?

_____ Yes _____ No (please comment below)

Are the illustrations clear and complementary to the text?

_____ Yes _____ No (please comment below)

Were there any cases in which the hardware did not match the instructions?

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_____ (position/department)	_____ (position/department)

630 Bercut Drive
Sacramento, CA 95814
(916) 447-7600
TWX: 910-367-2009

Dear RG1000 User:

Thank you for purchasing a GEN.II Retro-Graphics™ Terminal Enhancement. The GEN.II product line consists of two major parts, the RG1000 Main Logic Board and an adapter board, packaged and shipped separately. Please verify that this shipping carton contains the following:

One RG1000 Board, Digital Engineering Part #80121032

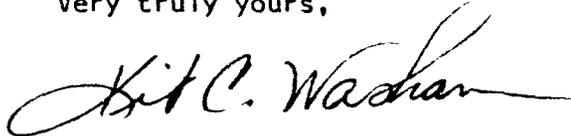
Inspect the board for visible shipping damage. If there is a problem, contact Digital Engineering at one of the following toll-free Customer Service numbers:

- (800) 952-8341 (California only)
- (800) 432-4304 (West of the Mississippi River, except California, Arkansas, and Louisiana)
- (800) 526-1125 (East of the Mississippi River, plus Arkansas and Louisiana)

Installation and operation instructions for both the adapter board and the RG1000 are contained in the adapter board shipping container. PLEASE DO NOT ATTEMPT TO INSTALL THE RG1000 BOARD BEFORE READING THE INSTALLATION INSTRUCTIONS.

Thank you for your interest in Digital Engineering products.

Very truly yours,



Ms. Kit C. Washam
Publications Manager

KCW:crc



630 Bercut Drive
 Sacramento, CA 95814
 (916) 447-7600
 TWX: 910-367-2009

Dear RG1000 User;

Thank you for purchasing a Retro-Graphics™ GEN.II™ terminal enhancement. Each RG1000-series terminal enhancement consists of two separately packaged parts:

- RG1000 Main Logic Board (for use in several terminal models)
- Adapter Board (terminal-specific, with mounting hardware)

Early firmware was different for each terminal in which the RG1000 could be installed, so it was shipped with the Adapter Board and added to the RG1000 Main Logic Board at the time of installation. Current firmware is "generic" (the same firmware is used in all RG1000-series terminal enhancements); therefore, it is installed on the RG1000 Main Logic Board at the factory.

An RG1000 Main Logic Board, serial number 1600 or above, should be matched to an Adapter Board, serial number 1600 or above. If this is not done, one of the following situations can occur:

- NO FIRMWARE (if an RG1000, serial number less than 1600, is matched with an Adapter Board, serial number 1600 or above)
- DUPLICATE FIRMWARE (if an RG1000, serial number 1600 or above, is matched to an Adapter Board, serial number less than 1600)

In either case please call Digital Engineering at one of the following Customer Service numbers:

(800) 952-8341	(California only)
(916) 447-7600	(West of the Mississippi River, except California, Arkansas, and Louisiana)
(201) 575-5800	(East of the Mississippi River, plus Arkansas and Louisiana)

NOTE: When using the Installation Manual to install the RG1000 and Adapter Board, delete the 2764-type ROMs and configuration ROMs from the list of items in the kit and ignore the steps that describe installing firmware on the RG1000.

Thank you for your interest in our products.

Very truly yours,

A handwritten signature in cursive script that reads "Kit C. Washam".

Ms. Kit C. Washam
 Publications Manager

KCW:seh

Part #60055525
 2/8/83

Installation of new cables in the televideo terminals

New televideo terminals are using coax for their video cable. This requires a change in our cable arrangement. To install the new cable set follow the original installation instructions per DEI's installation manual for Model TV512-04 for TeleVideo 925 or 950, with the following exceptions:

1. There is no longer a yellow wire on the connector at P10 on the Televideo Video Control Board. In its place is a brown wire coming from a coax cable. Both this wire and the black one next to it (the two parts of the coax cable) must be released from the connector as described in item 4 on page 2-~~4~~⁷ of the installation manual.
2. The brown wire will be installed at the same location that the yellow would have been installed. See item 5 page 2-~~4~~⁷ in manual. The black wire will be installed in the other free hole. Care should be taken in orienting these wires correctly since the cable is no longer keyed. The brown video cable will be in position 1 of the double header, closest to the outside edge. The coaxial ground will be installed at pin 3.
3. Install the orange wire where the brown wire was attached. See item 6 in manual.
4. There is a new "cable" that consists of only one wire with a molex crimp pin on one end and a lug on the other. The molex pin should be installed next to the orange wire on the connector at P10.
5. Unscrew the screw on the ground plane on the back of the terminal. Install the two ring terminals under this screw.

FOUND FUNCTION SW.

	1	2	3	4	5	6	7	8	9	10	
S2	U	U	D	D	D	U	D	U	<u>U</u>	D	FRONT "D" 50/60 HZ
S1	D	-	.		D	1/30	D	D	U	U	

201 - 575 - 5800

800 - 526 1125

TOM DE GENTE

DON

243

~~PULL~~

1. WILL GET NEW VIDEO CABLE ASSY.

2. PULL A29

NAT SALE MANAGER

PAT STRUBS

916-447-7600

PROBLEM WAS WRONG WIRE WAS PUT INTO
1A (VIDEO CABLE ASSY) & WRONG "UART" WAS
CHOSEN.