



The Unified Graphics System Programming Manual (CGTM No. 170) for the IBM 360/370 may also be used for the VAX-11 computer. The VAX-11 version of the Unified Graphics System contains all of the standard subroutines in the IBM version and uses the same calling sequences as the FORTRAN version of the IBM system. There are however a few differences:

1. Arguments described in CGTM No. 170 as "character strings" must be of type CHARACTER in the VAX-11 version.
2. The terminal asterisk in the OPTNS argument of each subroutine is optional on the VAX-11.
3. A program can only control one graphic device (or one class of graphic devices). In addition, the graphic device being used by a program is selected at LINK-EDIT time and not at RUN time as in the IBM version. A mechanism does exist, however, for a program to get the effect of writing to multiple graphic devices. Two programs which are running simultaneously on the VAX-11 can communicate with each other and pass data back and forth. One of these programs can pass a graphic element, along with its scaling and scissoring limits, to the second program and this second program can then call subroutine UGEPUT to transmit the graphic element to a different graphic device than the one being used by the first program.
4. The character stroke generator is selected at LINK-EDIT time and not at RUN time. This, of course, means that a program cannot use more than one character generator.
5. The hexadecimal equivalents of the extended character set are different than the ones given in Section 2.7 of CGTM No. 170. The character pairs are the same but the hexadecimal equivalents are an extension of ASCII.
6. A few subroutines like UGSLCT and UGCSET cannot perform the function that they do on the IBM computers. The VAX-11 version of the Unified Graphics System does, however, provide these subroutines for compatibility and these subroutines check their arguments for correctness. The VAX-11 version of subroutine UGCSET will generate an error message with an index of 99 and a level of 2 when a program requests a character generator that was not loaded at LINK-EDIT time.
7. UGRATN is not exactly the same on the VAX-11 computers. On the VAX-11, the options item LAST will not work, and the argument TIME returns a zero instead of the unexpired time when a wait for a specific length of time is requested.
8. Recursive error processors are not permitted. Because of this, the user should try to keep the error processor simple and minimize the calls to Unified Graphics subroutines; if a Unified Graphics subroutine is called from the error processor and that subroutine detects an error, then the program will terminate.
9. The error messages do not include a description of the problem; only the subroutine name and error index are given on the VAX-11. You will have to look the error message up in the Programming Manual to identify the problem. In addition, a level 4 error will not produce a

memory dump. The error messages are normally written to FORTRAN unit 6. It is possible, on the VAX-11, to cause these messages to be written to another unit.

### LINK-EDITing a Program on the VAX-11

To use the Unified Graphics System, the LINK command will take the form:

```
$ LINK ... main-prog+ -
  [ RCBSYS ]UGX000+[ RCBSYS ]UGX103+[ RCBSYS ]device-code, -
  [ RCBSYS ]UGVAXLIB/LIBRARY
```

The module UGX000 is the BLOCK-DATA initialization for a common block and must be present. UGX103 is the character stroke generator for the BASIC character set; the EXTENDED and DUPLEX character sets are also available and are contained in other modules. The module shown as "device-code" is the device-dependent modules for the graphic device you intend to use (for example TEK4013 or VEP12FF). The names of these device-dependent modules are the same as the options item in UGOPEN. Finally UGVAXLIB is a library containing most of the subroutines in the Unified Graphics System; the LINK-EDITOR will select the necessary modules from this library.

A number of the modules in this system have alternates that may be used instead of the default. The alternates provide either expanded or restricted capability. Except for the EXTENDED and DUPLEX character generators, it is probably best for the user to ignore these modules except when very special circumstances arise. These alternate modules are:

- UGX102Z: A restricted version of the line segment generator which does not generate line structure.
- UGX103A: The module containing the EXTENDED character set.
- UGX103B: The module containing the DUPLEX character set.
- UGX103Z: A dummy character stroke generator which does not produce any characters.
- UGX104Y: A restricted version of the hardware character generator module which only processes text at an angle of zero degrees and does not eliminate redundant blanks.
- UGX104Z: A dummy version of the hardware character generator module which will ignore all requests to use the hardware character generator.
- UGX105Z: A dummy version of the module which processes device-dependent picture data. All requests to transmit device-dependent picture data will be ignored.
- UGX112Z: A dummy version of the line scissoring module: line segments are not scissored. Use of the module can cause serious distortion of a picture if scissoring is actually required.

In general the modules whose name contains a terminal letter from the beginning of the alphabet provide expanded functions beyond the default module. Those modules whose name contains a terminal

letter from the end of the alphabet provide restricted capability and should be used with care; these modules can, however, reduce the size of the load module and, in some cases, reduce execution time.

### The Supported Graphic Devices

On the VAX-11 computers, graphic devices are supported at three levels instead of the two levels on the IBM 360/370. These three levels are:

1. Non-Interactive Devices: The pictures are written to a data set and the data set must later be transmitted to the graphic device.
2. Directly Writable Devices: The pictures are written directly to the device but the interactive routines (UGEATN, UGDATN, UGRATN, UGKPUT, and UGKGET) are not supported. The user must program his own interactive control. This mode is not available on the IBM computers under SVS.
3. Fully Interactive Devices: The pictures are written directly to the device and all of the interactive subroutines are available.

The following sections describe each of the devices that are currently supported.

#### SEQ4013: Non-Interactive use of the TEKTRONIX 4013

The pictures are written into a sequential data set. A program is available that enables a user to look at these pictures. The program is invoked by the command:

```
$ RUN [RCBSYS]DTEKPICS
```

The program allows the user to select a data set and then view the pictures in the data set. When this program begins executing, it lists the instructions for its use at the terminal.

The options items acceptable to subroutine UGOPEN and their default values are:

SEQ4013: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

DDUNIT=99: Selects the output data set.

PICTSQ=PICT and PICTID=1: Used to construct the picture names. These picture names are not actually used on the VAX-11.

BAUDRATE=9600: Indicates the data transmission rate that will be used by the terminal when the pictures are transmitted to it. The only thing this item controls is the number of null characters after the screen clear order; the graphic orders are never optimized on the VAX-11.

PULSCR: Makes the full screen available for drawing

pictures.

DWT4013: Directly Writable use of the TEKTRONIX 4013

The pictures are written directly to the TEKTRONIX but the subroutines for interactive control are not available.

The options items acceptable to subroutine UGOPEN and their default values are:

DWT4013: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

CHANNEL=TT: Gives the channel identification for the users terminal.

FULSCR: Makes the full screen available for drawing pictures.

Since the device-dependent code on the VAX-11 does not try to optimize the graphic orders, the BAUDRATE option is unnecessary.

TEK4013: Interactive use of the TEKTRONIX 4013

The pictures are written directly to the TEKTRONIX and the interactive control subroutines are available for use.

The options items acceptable to subroutine UGOPEN and their default values are:

TEK4013: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

CHANNEL=TT: Gives the channel identification for the users terminal.

FULSCR: Makes the full screen available for drawing pictures.

Since the device-dependent code on the VAX-11 does not try to optimize the graphic orders, the BAUDRATE option is unnecessary.

The KBRD and SPTR attentions will be recognized by subroutines UGEATN and UGDATN. The hardware does not allow both attentions to be enabled at once; if you do try to enable both at once, the effect is as if only SPTR was enabled. The option RDSPTR in subroutine UGCTRL may not be used.

VEP12PF: The VERSATEC Electrostatic Printer/Plotter Model 1200 using Fan Fold Paper

The pictures are written to a pseudo-print data set which must be sent to the Printer/Plotter at a later time. The command to send the data to the Printer/Plotter is:

\$ PRINT/NOFEED data-set-name

The NOFEED option on the PRINT statement is important; unpredictable things can happen if it is missing.

The options items acceptable to subroutine UGOPEN and their default values are:

- VEP12FF: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.
- DDUNIT=99: Selects the output data set.
- MAXNSA=4096: Defines the size of the blocks used to save the picture internally.
- FULSCR: Makes the full page available for drawing pictures.

The user should be aware that the formatting of a picture for this device requires more memory space and more time than any other device. The use of more memory will probably not cause any problems, but it is important to keep the time problem in mind. It takes approximately 10-20 seconds to format a picture for the VERSATEC; the corresponding time for other devices on the VAX-11 is at most 1-2 seconds.

CALDRSM: The CALCOMP Drum Plotter Model 936 with 10 Inch Paper

The pictures are written to a data set which must be put on tape and sent to the Campus Computing Facility at Stanford for plotting. One way to get the data set on tape is to write it to a temporary disk data set and then use the following commands to transfer the data set to tape:

- \$ ALLOCATE MTA0:
- \$ INITIALIZE/DEN=800 MTA0: tape-name
- \$ MOUNT/DEN=800/RECORD=480/BLOCK=480 MTA0: tape-name
- \$ COPY data-set-name MTA0:
- \$ DISMOUNT MTA0:
- \$ DEALLOCATE MTA0:

A similar set of commands should allow a program to write directly to the tape.

The options items acceptable to subroutine UGOPEN and their default values are:

- CALDRSM: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.
- DDUNIT=99: Selects the output data set.
- TITLE=<value>: The default value is the first 8 characters of the User Identification in characters 1-8 and the first 7 characters of the Account Identification in characters 10-16.
- PEN2=<value>: Pen selection data for pen number 2.
- PEN3=<value>: Pen selection data for pen number 3.
- INCHGRID: Indicates that paper with a one-inch grid will be used on the plotter.

CALDRLG: The CALCOMP Drum Plotter Model 936 with 33 Inch Paper

The pictures are written to a data set which must be put on tape and sent to the Campus Computing Facility at Stanford for plotting. The commands to transfer the data set to tape are the

same as when using 10 inch paper.

The options items acceptable to subroutine UGOPEN and their default values are:

CALDRLG: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.  
 DDUNIT=99: Selects the output data set.  
 TITLE=<value>: The default value is the first 8 characters of the User Identification in characters 1-8 and the first 7 characters of the Account Identification in characters 10-16.  
 PEN2=<value>: Pen selection data for pen number 2.  
 PEN3=<value>: Pen selection data for pen number 3.  
 INCHGRID: Indicates that paper with a one-inch grid will be used on the plotter.

CAL16MU: The CALCOMP Microfilm Plotter Model 1675 with 16 Millimeter Unsprocketed Film

The pictures are written to a data set which must be put on tape and given to the COM Technician in the SLAC Computing facility for plotting. One way to get the data set on tape is to write it to a temporary disk data set and then use the following commands to transfer the data set to tape:

```
$ ALLOCATE MTA0:
$ INITIALIZE/DEN=1600 MTA0: tape-name
$ MOUNT/DEN=1600/RECORD=1480/BLOCK=1480 MTA0: tape-name
$ COPY data-set-name MTA0:
$ DISMOUNT MTA0:
$ DEALLOCATE MTA0:
```

A similar set of commands should allow a program to write directly to the tape.

The options items acceptable to subroutine UGOPEN and their default values are:

CAL16MU: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.  
 DDUNIT=99: Selects the output data set.  
 LEADER=20: Defines the number of frames of leader on the beginning and end of the picture sequence.  
 FULSCR: Makes the full plotting area available for drawing pictures.  
 TITLE=<value>: The default value is the first 8 characters of the User Identification in characters 1-8 and the first 7 characters of the Account Identification in characters 10-16.

CALFICH: The CALCOMP Microfilm Plotter Model 1675 with 105 Millimeter Microfiche Film

The pictures are written to a data set which must be put on tape and given to the COM Technician in the SLAC Computing Facility

for plotting. The commands to transfer the data set to tape are the same as when using 16 millimeter unsprocketed film.

The options items acceptable to subroutine UGOPEN and their default values are:

- CALFICH: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.
- DDUNIT=99: Selects the output data set.
- FULSCR: Makes the full plotting area available for drawing pictures.
- TITLE=<value>: The default value is the first 8 characters of the User Identification in characters 1-8 and the first 7 characters of the Account Identification in characters 10-16. A total of 24 characters may be specified.

#### SLACXSS: The SLAC Experimental Slave Scopes

This is a directly writable device. An unusual aspect of the device-dependent code for this device is that a program can control the pictures on as many as four different slave scopes. The pictures on the different slave scopes may be the same or different. Graphic elements may be fully manipulated; individual elements may be put into the include or omit state, and individual elements may be deleted.

The options items acceptable to subroutine UGOPEN and their default values are:

- SLACXSS: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.
- JORWAY: Indicates that the display scopes are connected through a Jorway CAMAC controller. The default is to assume that the SLAC designed CAMAC controller is being used.
- GENCR: Currently, only black and white monitors are connected to the controller. However, the controller can support a color CRT. If color scopes ever become available, this item will instruct the Unified Graphics System to generate data for a color CRT.
- UNIT1=<value>: This gives the address bits required to access a display unit designated as unit 1. The value must be given as a string of bits (zeros and ones). For the SLAC designed CAMAC controller, the form is UNIT1=BBBBBBBCCMMMMM and for the Jorway controller the form is UNIT1=BBBCCCCCCCCMMMMM where the B's represent the low order bits of the branch address, the C's give the crate address, and the M's give the module address.
- UNIT2=<value>: This gives the address bits required to access a display unit designated as unit 2.
- UNIT4=<value>: This gives the address bits required to access a display unit designated as unit 4.
- UNIT8=<value>: This gives the address bits required to access a display unit designated as unit 8.

The maximum number of graphic elements that can be in a picture

is 32 and this number cannot easily be changed.

An additional options item will be recognized by subroutines UGEPUT, UGPICT, and UGCTRL. This item is UNITS=<value> where the value is an integer which is the sum of the display units that the subroutine call is to apply to. Thus, if a subroutine call is to apply to display units 1 and 4, the options list should contain UNITS=5. If this options item is omitted, the operation specified by the subroutine applies to all of the display units that were opened.

Another new options item will be recognized by subroutine UGEPUT. This item is PEEK and indicates that a partial element is acceptable. Normally when graphic order overflow (error type 11) or display file overflow (error type 12) is encountered, the error processor is entered and the entire element is ignored. If this options item is present, however, as much of the graphic orders as possible will be added to the display file when you return from the error processor.

The Unified Graphics subroutines transmit their data to the graphic units by calling subroutines CAMDIO and CAMIOP. It is the users responsibility to assure that the correct version of these subroutines are LINK-EDIT'ed into the executable module.

#### SEQ4027: Non-Interactive use of the TEKTRONIX 4027

The pictures are written into a sequential data set. A program is available that enables a user to look at these pictures. The program is invoked by the command:

```
$ RUN [RCBSYS]DTEKPICS
```

The program allows the user to select a data set and then view the pictures in the data set. When this program begins executing, it lists the instructions for its use at the terminal.

The options items acceptable to subroutine UGOPEN and their default values are:

SEQ4027: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

DDUNIT=99: Selects the output data set.

PICTSQ=PICT and PICTID=1: Used to construct the picture names. These picture names are not actually used on the VAX-11.

GENCH: Indicates that the hardware character generator is to be used when appropriate. The default is to always use the stroke generator to draw the characters. The reason for this is described below.

FULSCR: Makes the full screen available for drawing pictures.

DLINES=26: Specifies the number of lines of text on the face of the CRT to be allocated to the workspace. The graphic area then uses one fewer line. The maximum that this parameter may be set to is 33 and the minimum is 10.

COMCHR='!': This item allows the command character to be

specified as any printable character. If the device is not set to accept this command character, unpredictable things may occur.

COMBTS=00100001: This is an alternate to COMCHR which allows the command character to be set to any 8 bit pattern. 00100001 is the bit pattern for the character '!'.  
 '!'.  
 '!'.

When the hardware character generator is used, the character sizes available on this device are:

VLRG SPACING=0.02292 44 Characters/Line(80 with PULSCR)  
 The programmer and device scaling and scissoring limits without PULSCR are:

0.0	1.0	145	494
0.0	1.0	0	349

when PULSCR is used, the values are:

-0.41547	1.41547	0	639
0.0	1.0	0	349

Note that the numbers given above are valid only when the default DLINEs value is used in subroutine UGOPEN. This graphic device has a color display. The color options items in the Unified Graphics System have the following meaning:

Not specified or COL1: White.

COL2: Red.

COL3: Green.

COL4: Blue.

COL2,COL3: Yellow.

COL2,COL4: Magenta.

COL3,COL4: Cyan.

COL2,COL3,COL4: Black.

Any other combination of color options items will result in white being used. The color "black" can be used in two ways. The first way is to use it to draw black figures in solid rectangles of color and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

Rectangles of solid color are produced with two calls to subroutine UGEDTA. The first call should give the X and Y coordinates of one corner of the rectangle with a character string of 'SR0' for the DATA argument. The second call should give the diagonally opposite corner of the rectangle with a value of 'SR1' for DATA.

The NOOPT option may be used in subroutine UGEPUT. Normally, when data supplied by UGETXT is transmitted to the graphic device, blanks at the beginning and end of the character string are deleted. The NOOPT option in UGEPUT will cause the blanks to be transmitted.

There are a number of serious difficulties involved with using this device as a graphics display. Some of these problems are:

1. The device can get hung in innumerable un-documented states. The only way to get out of many of these states is to push the Master Reset button. The Master Reset button is located on the back of the CRT unit and is probably the most important button on the device.
2. It is impossible to use the full screen for a graphics display. Of the 34 lines of text on the face of the CRT, at most 33 can be used for graphics. Display units that only have the minimum amount of display memory can not use much more than 25 lines for the picture.
3. It is very difficult to use the hardware character generator in the graphics mode. First, the characters cannot be positioned arbitrarily on the screen; they can only be put in the positions or "cells" that they would occupy when the terminal is being used as a text-only device. Second, when a character occupies a cell, no line may go through that cell; this means that if you get a label too close to an axis, you will wipe out part of the axis. Finally, the characters produced by the hardware character generator cannot be colored arbitrarily; all characters on the screen at one time must be of the same color. This color will normally be white.
4. The terminal processes graphic data at a very slow rate. When the device is used in this simple non-interactive mode, it appears to be unable to run at much more than 300 baud. This problem is exacerbated by small amounts of display memory, but any amount of memory could be swamped by a complicated picture. As a result, this method of using the TEKTRONIX 4027 is not practical and the user should refer to the next two sections on Directly Writable and Interactive use of this device.

#### DWT4027: Directly Writable use of the TEKTRONIX 4027

The pictures are written directly to the TEKTRONIX but the subroutines for interactive control are not available.

The options items acceptable to subroutine UGOPEN and their default values are:

DWT4027: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

CHANNEL=TT: Gives the channel identification for the users terminal.

GENCH: Indicates that the hardware character generator is to be used when appropriate. The default is to always use the stroke generator to draw the characters.

FULSCR: Makes the full screen available for drawing pictures.

DLINES=26: Specifies the number of lines of text on the face of the CRT to be allocated to the workspace. The graphic area then uses one fewer line. The maximum that



There are a number of serious difficulties involved with using this device as a graphics display. The user should refer to the first three points made at the end of the description for SEQ4027.

TEK4027: Interactive use of the TEKTRONIX 4027

The pictures are written directly to the TEKTRONIX and the interactive control subroutines are available for use.

The options items acceptable to subroutine UGOPEN and their default values are:

- TEK4027: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.
- CHANNEL=TT: Gives the channel identification for the users terminal.
- PROMPT=>: Gives the prompt that will be put on the screen in the Monitor scroll when UGRATN is entered with the keyboard enabled.
- GENCH: Indicates that the hardware character generator is to be used when appropriate. The default is to always use the stroke generator to draw the characters.
- FULSCR: Makes the full screen available for drawing pictures.
- DLINES=26: Specifies the number of lines of text on the face of the CRT to be allocated to the workspace. The graphic area then uses one fewer line. The maximum that this parameter may be set to is 33 and the minimum is 10.
- COMCHR='!': This item allows the command character to be specified as any printable character. If the device is not set to accept this command character, unpredictable things may occur.
- COMBTS=00100001: This is an alternate to COMCHR which allows the command character to be set to any 8 bit pattern. 00100001 is the bit pattern for the character '!'.  
 '!'

When the hardware character generator is used, the character sizes available on this device are:

VLRG SPACING=0.02292 44 Characters/Line (80 with FULSCR)

The programmer and device scaling and scissoring limits without FULSCR are:

[	0.0	1.0	]		[	145	494	]
	0.0	1.0				0	349	
L			J		L			J

when FULSCR is used, the values are:

[	-0.41547	1.41547	]	[	0	639	]
	0.0	1.0			0	349	
L			J	L			J

Note that the numbers given above are valid only when the default DLINES value is used in subroutine UGOPEN. This graphic device has a color display. The color options items in the Unified

Graphics System have the following meaning:

Not specified or COL1: White.

COL2: Red.

COL3: Green.

COL4: Blue.

COL2,COL3: Yellow.

COL2,COL4: Magenta.

COL3,COL4: Cyan.

COL2,COL3,COL4: Black.

Any other combination of color options items will result in white being used. The color "black" can be used in two ways. The first way is to use it to draw black figures in solid rectangles of color and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

Rectangles of solid color are produced with two calls to subroutine UGEDTA. The first call should give the X and Y coordinates of one corner of the rectangle with a character string of 'SR0' for the DATA argument. The second call should give the diagonally opposite corner of the rectangle with a value of 'SR1' for DATA.

The NOOPT option may be used in subroutine UGEPUT. Normally, when data supplied by UGETXT is transmitted to the graphic device, blanks at the beginning and end of the character string are deleted. The NOOPT option in UGEPUT will cause the blanks to be transmitted.

The KBRD and SPTR attentions will be recognized by subroutines UGEATN and UGDATN. The hardware does not allow both attentions to be enabled at once; if you do try to enable both at once, the effect is as if only SPTR was enabled. The option RDSPTR in subroutine UGCTRL may also be used but remember that the cross-hairs are not put on the screen until UGRATN is called. The SPTR attention is generated by striking any normal printing key although it is sometimes necessary to follow this by striking the cross-hair key (the cross-hair key is the "0" key in the numeric pad).

Subroutine UGKPUT works differently on this device than it does on most other devices; the X and Y coordinates cannot be honored and the keyboard input buffer will be in the Monitor scroll at the bottom of the screen.

There are a number of serious difficulties involved with using this device as a graphics display. The user should refer to the first three points made at the end of the description for SEQ4027.

DWTGRIN: Directly Writable use of the GRINNELL Display Systems

The GRINNELL Display System consists of a controller which can have a number of television monitors connected to it. The controllers can be purchased in a wide variety of configurations. It is possible for the monitors connected to a controller to have the same or different capabilities. The Unified Graphics System treats each monitor of differing capability as a distinct type. The things that distinguish one monitor type from another are: (1) the number of memory planes allocated to the monitor, (2) the number of raster units in a memory plane, (3) the meaning of a bit in a memory plane, and (4) the presence or absence of a look-up table. So far, SLAC has eight (8) distinct types.

When a program is writing to a controller, it may write to more than one monitor as long as all of the monitors are of the same type. The monitors may then have the same or different pictures on them.

The options items acceptable to subroutine UGOPEN and their default values are:

DWTGRIN: Checks that the proper device-dependent modules have been loaded at LINK-EDIT time.

TYPE=1: Selects which of the seven types of GRINNELL system is to be used.

EXTCHR: Indicates that the controller can produce the extended character set. This extended character set has 128 characters instead of the default 64.

BIGCHR: Indicates that the controller produces characters in a 7 by 9 dot matrix instead of the usual 5 by 7 dot matrix.

UNITS=1: Selects the television monitors connected to the controller which are to be used. The value of this item is an integer which is the sum of the display units to be used where the units are numbered 1, 2, 4, 8,... Thus, if the first and third television monitors are to be used, this parameter should have a value of 5.

CHANNEL=GRA0: Gives the channel identification for the GRINNELL controller.

The properties of the Type 1 device are the following: There are four memory planes with 512 by 256 raster units allocated to a television monitor. A look-up table is present. The memory planes are used to define seven colors of two intensity levels. When the hardware character generator is used, the character sizes available on this device are:

SMAL	SPACING=0.01370	74 Characters/Line
LARG	SPACING=0.02740	37 Characters/Line
VLRG	SPACING=0.02740	37 Characters/Line

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

[	0.0	1.0	]	[	0	511	]
	0.0	1.0			0	255	
]			]	]			]

The intensity level options VDIM or DIMM will result in a lesser

intensity level than the normal one. The color options items in the Unified Graphics System have the following meaning:

Not specified or COL1: White.

COL2: Red.

COL3: Green.

COL4: Blue.

COL2,COL3: Yellow.

COL2,COL4: Magenta.

COL3,COL4: Cyan.

COL2,COL3,COL4: Black.

Any other combination of color options items will result in white being used. The color "black" can be used in two ways. The first way is to use it to draw black figures in solid rectangles of color and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 2 device are the following: There is one memory plane with 1024 by 1024 raster units allocated to a television monitor. No look-up table is present. When the hardware character generator is used, the character sizes available on this device are:

SMAL SPACING=0.01370 74 Characters/Line

LARG SPACING=0.02740 37 Characters/Line

VLRG SPACING=0.02740 37 Characters/Line

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

[	0.0	1.0	]	[	0	1023	]
	0.0	1.0			0	1023	
]			]	]			]

All items are displayed at a single intensity level. Color options will be ignored except that the color "black", specified by "COL2,COL3,COL4", can be used in two ways. The first way is to use it to draw black figures in solid rectangles and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 3 device are the following: There are two memory planes with 512 by 512 raster units allocated to a television monitor. No look-up table is present. The memory planes are used to define three intensity levels. When the hardware character generator is used, the character sizes available on this device are:

SMAL SPACING=0.01370 74 Characters/Line

LARG SPACING=0.02740 37 Characters/Line

VLRG SPACING=0.02740 37 Characters/Line

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

[	0.0	1.0	]	[	0	511	]
	0.0	1.0			0	511	
]			]	]			]

The intensity level option VBRT will result in a brighter than normal display item, while VDIM or DIMM will give a lesser intensity. Color options will be ignored except that the color "black", specified by "COL2,COL3,COL4", can be used in two ways. The first way is to use it to draw black figures in solid rectangles and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 4 device are the following: There is one memory plane with 512 by 512 raster units allocated to a television monitor. No look-up table is present. When the hardware character generator is used, the character sizes available on this device are:

```
SMAL  SPACING=0.01370  74 Characters/Line
LARG  SPACING=0.02740  37 Characters/Line
VLRG  SPACING=0.02740  37 Characters/Line
```

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

```

[ 0.0  1.0 ]
| 0.0  1.0 |
[ 0.0  1.0 ]

[ 0  511 ]
| 0  511 |
[ 0  511 ]
```

All items are displayed at a single intensity level. Color options will be ignored except that the color "black", specified by "COL2,COL3,COL4", can be used in two ways. The first way is to use it to draw black figures in solid rectangles and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 5 device are the following: There are four memory planes with 512 by 512 raster units allocated to a television monitor. A look-up table is present. The memory planes are used to define seven colors and allow blinking of any of the colors. When the hardware character generator is used, the character sizes available on this device are:

```
SMAL  SPACING=0.01370  74 Characters/Line
LARG  SPACING=0.02740  37 Characters/Line
VLRG  SPACING=0.02740  37 Characters/Line
```

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

```

[ 0.0  1.0 ]
| 0.0  1.0 |
[ 0.0  1.0 ]

[ 0  511 ]
| 0  511 |
[ 0  511 ]
```

The color options items in the Unified Graphics System have the following meaning:

```
Not specified or COL1:  White.
COL2:  Red.
COL3:  Green.
COL4:  Blue.
COL2,COL3:  Yellow.
COL2,COL4:  Magenta.
```

COL3,COL4: Cyan.

COL2,COL3,COL4: Black.

Any other combination of color options items will result in white being used. The color "black" can be used in two ways. The first way is to use it to draw black figures in solid rectangles of color and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 6 device are the following: There are two memory planes with 512 by 512 raster units allocated to a television monitor. A look-up table is present. The memory planes are used to generate three intensity levels. When the hardware character generator is used, the character sizes available on this device are:

```
SMAL  SPACING=0.01370   74 Characters/Line
LARG  SPACING=0.02740   37 Characters/Line
VLRG  SPACING=0.02740   37 Characters/Line
```

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

```
[ 0.0  1.0 ]      [ 0  511 ]
| 0.0  1.0 |      | 0  511 |
[       ]          [       ]
```

The intensity level option DIMM will result in a dimmer than normal display item and VDIM will result in a still dimmer display item. Color options will be ignored except that the color "black", specified by "COL2,COL3,COL4", can be used in two ways. The first way is to use it to draw black figures in solid rectangles and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 7 device are the following: There are three memory planes with 512 by 256 raster units allocated to a television monitor. A look-up table is present. The memory planes are used to define a number of colors and control the blinking of some colors. When the hardware character generator is used, the character sizes available on this device are:

```
SMAL  SPACING=0.01370   74 Characters/Line
LARG  SPACING=0.02740   37 Characters/Line
VLRG  SPACING=0.02740   37 Characters/Line
```

The VLRG characters are twice as high as the LARG ones. The programmer and device scaling and scissoring limits are:

```
[ 0.0  1.0 ]      [ 0  511 ]
| 0.0  1.0 |      | 0  255 |
[       ]          [       ]
```

The color options items in the Unified Graphics System have the following meaning when WINK is not present:

Not specified or COL1: White.

COL2: Red.

COL3: Green.

COL4: Blue.

COL2,COL3: Yellow.

COL2,COL3,COL4: Black.

Any other combination of color options items without WINK will result in white being used. If white is specified with VDIM or DIMM, a dimmer than normal item will be drawn. If WINK is used, the item will be red and blinking. The color "black" can be used in two ways. The first way is to use it to draw black figures in solid rectangles of color and the second way is to draw figures in black to erase previously drawn figures. The user should remember that either of these uses is very device-dependent and the result may be quite different on other graphic devices.

The properties of the Type 8 device are the same as the Type 5 units except that the look-up table must be loaded differently (the LPA order must be ZB000 instead of ZB030).

Rectangles of solid color are produced with two calls to subroutine UGEDTA. The first call should give the X and Y coordinates of one corner of the rectangle with a character string of 'SR0' for the DATA argument. The second call should give the diagonally opposite corner of the rectangle with a value of 'SR1' for DATA.

An additional options item will be recognized by subroutines UGEPUT, UGPICT, and UGCTRL. This item is UNITS=<value> where the value is an integer which is the sum of the display units that the subroutine call is to apply to. Thus, if a subroutine call is to apply to display units 1 and 4, the options list should contain UNITS=5. If this options item is omitted, the operation specified by the subroutine applies to all of the display units that were opened.