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SunCGI™ Reference Manual

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Preface

This document describes *SunCGI*, an implementation of the ANSI *Computer Graphics Interface* (CGI) by Sun Microsystems, Inc. Previously, CGI was known as the *Virtual Device Interface* (VDI) standard. Appendix A summarizes the differences between *SunCGI* and ANSI CGI.

Only certain models within CGI are supported by *SunCGI*. Specifically *SunCGI* implements input option sets 1, 2, 3, 4, and 6 and output option sets 1 through 6 of the CGI standard. CGI does not support 3D output primitives.

Controlling Document

The following document was used in interpreting the CGI standard:

[1] ANSI X3H3 84/45. *Information Processing Computer Graphics Virtual Device Interface (VDI) Functional Description.* March 1984.

Audience

The intended reader of this document is an applications programmer who is familiar with interactive computer graphics and the C programming language. This manual contains several example programs that can be used as templates for larger *SunCGI* applications.

1

Introduction

1

Introduction

SunCGI provides access to low-level graphics device functions. *SunCGI* is useful for 2D graphics programs that do not require segmentation or transformations. The absence of segmentation from *SunCGI* makes drawing diagrams faster and simpler.

SunCGI provides output primitives, attribute selection, and input device management at a level close to the actual device driver. The output primitives *SunCGI* provides include disjoint polygons, circles, ellipses, and cell arrays (which can be thought of as scaled and transformed pixel arrays). *SunCGI*'s large vocabulary of attributes include sophisticated pattern filling. *SunCGI* also provides facilities for explicitly binding virtual input devices to physical input devices as well as explicit management of an *event queue.*

1.1. Using SunCGI

Following is a *SunCGI* example application program written in C.

```
#include <cgidefs.h>

#define BOXPTS  5

Ccoor box[BOXPTS] = {   10000,10000 ,
                        10000,20000 ,
                        20000,20000 ,
                        20000,10000 ,
                        10000,10000 };

main()
{
    Cint        name;           /* name of CGI device (set by CGI)    */
    Cvwsurf     device;         /* device struct (see NORMAL_VWSURF)  */
    Ccoorlist   boxlist;        /* struct of info for list of points  */

    boxlist.n = BOXPTS;         /* set number of points               */
    boxlist.ptlist = box;       /* set pointer to list of points      */

    NORMAL_VWSURF(device, PIXWINDD);/* view surface is default window    */

    open_cgi();                 /* open CGI and the view surface      */
    open_vws(&name, &device);
```

```
    polyline(&boxlist);          /* watch the '&' here!              */
    sleep(10);

    close_vws(name);             /* close up the view surface and CGI */
    close_cgi();
}
```

SunCGI uses a variety of structures and enumerated types shown in Appendix B. The file <cgidefs.h> should be included in each *SunCGI* application program to provide necessary definitions and constants.

Here is an example of a command line for compiling `box.c` to run in the *SunView* environment:

```
% cc box.c -o box -lcgi -lsunwindow -lpixrect -lm
```

The order in which the libraries are linked to the program is important.

All *SunCGI* functions can be called by one of two names: the expanded name (default) or the C language binding name. See Appendix G for information on the list of names for the shorter C language binding.

As a final note, do not name any user-defined function or variable starting with the letters `_cgi` because doing so may disrupt the internal workings of *SunCGI*.

FORTRAN programmers can access *SunCGI* functions by using the include file in `cgidefs77.h` and linking with the `/usr/lib/libcgi77.a` library. Details of the FORTRAN interface to *SunCGI* are provided in Appendix F.

1.2. The SunCGI Lint Library

SunCGI provides a *lint* library which provides type checking beyond the capabilities of the C compiler. For example, you could use the *SunCGI lint* library to check a program called `glass.c` with a command like this:

```
% lint glass.c -lcgi
```

Note that the error messages that *lint* generates are mostly warnings, and may not necessarily have any effect on the operation of the program. For a detailed explanation of `lint`, see the *lint* chapter in the *Programmer's Tools Manuals Minibox* manual.

1.3. Overview of SunCGI

This section provides an overview of the substance of this manual. The four major sections of the manual (which correspond to chapters) are:

- view surface initialization and termination (control)
- output primitives
- attributes
- input

The overview of these chapters contains a brief introduction to the basic concepts of CGI.

Initialization and Termination

Chapter 2 describes functions for the following:

- initializing and terminating the entire *SunCGI* package and individual view surfaces
- defining the coordinate systems
- interface negotiation
- signal trapping

The first section in Chapter 2 describes functions for opening and closing view surfaces (which are either windows or screens). *SunCGI* provides facilities for writing primitives to multiple view surfaces. Output primitives can be written to a selected subset of the open view surfaces by using the `activate_vws()` and `deactivate_vws()` functions (which turn a view surface on or off without closing the view surface or affecting the display). The functions discussed in Chapter 2 also define the range of virtual device coordinates (VDC space) and device coordinates (screen space). The coordinates of most *SunCGI* functions are expressed in terms of VDC space. The limits of both VDC space and screen space can be defined by the application program.

If you are attempting to run an application program developed on another vendor's version of CGI, negotiation functions are provided that describe the capabilities of *SunCGI*. The application program can use the information obtained by using the negotiation functions to call appropriate functions in *SunCGI* to make the application program run correctly. Finally, Chapter 2 describes *SunCGI*'s option for trapping SIGWINCH signals (generated by manipulating the window environment that the application program is using).

Output Primitives

Chapter 3 describes *SunCGI* functions for drawing geometrical output primitives (for example, polymarkers, polygons, circles, and ellipses) as well as functions for performing raster operations. The coordinates of output primitives are specified in VDC space (with the exception of some raster functions). Geometrical output primitives are affected by attributes described in Chapter 4 (such as fill style and line width). All output primitives are affected by the *drawing mode*, which determines how an output primitive is affected by pixels that have been previously drawn on the screen.

Attributes

Chapter 4 describes the attribute functions that control the appearance of output primitives. Attributes can be set individually, or in groups called bundles. The use of most attributes is fairly straightforward; fill textures, however, require a word of explanation. Geometrical output primitives can be filled with textures called hatches or patterns. Hatches are simply arrays of color values with each element of the array corresponding to a pixel. Patterns are arrays of color values which can be scaled and translated.

Input

Chapter 5 describes the standard interface *SunCGI* offers for receiving input from the mouse and the keyboard. The CGI input model is based on the logical input device model in GKS. In this system, a logical input device (for example, a LOCATOR device), is bound to a physical device (for example, the *x-y* position of the mouse) called a trigger. Triggers may be associated with logical input devices by the application program. Each logical input device has an associated measure (for example, the measure of a LOCATOR device is the mouse position on the screen). Each logical input device also has a state which determines how a device handles input. Each logical input device can be in one of five states:

- RELEASED (uninitialized)
- NO_EVENTS (initialized but unable to receive input)
- REQUEST_EVENT (waiting for one event)
- RESPOND_EVENT (report one event asynchronously)
- QUEUE_EVENT (put each event at the end of the *event queue*)

Errors

Errors are reported in *SunCGI* by setting the return value of the function to a nonzero result and echoing an error message and number on the terminal. However, error trapping can be controlled by the `set_error_warning_mask()` function. An explanation of each error message (and suggestions for how to eliminate them) is presented in Appendix C.

Programming Tips

For novice C language users, the syntax of *SunCGI* may pose some initial difficulties. When a pointer is specified as an argument to a *SunCGI* function, *SunCGI* usually expects space to be allocated by the application program and the function argument to be preceded by an ampersand (&). *SunCGI* uses many enumerated types. These types are printed by the `printf()` function as integers. If you want to print out these values in English, you should use the enumerated types as indices into a character array which contains appropriate English equivalents of the enumerated types. Finally, if you are a novice programmer, copy the example programs in Appendix D and use them as templates to build your own program. Further help can be obtained by referring to the tables at the end of Appendix C. These tables list commonly encountered problems and how to solve them.

Appendices

The first four appendices are intended to make *SunCGI* easier to understand. Appendix A lists the ANSI CGI standard functions not implemented by *SunCGI* and the *SunCGI* functions not part of the ANSI CGI standard. Appendix B provides the type definitions used by the *SunCGI* functions. Appendix C lists the error messages and possible strategies for eliminating them. Appendix C also lists possible causes of simple run-time errors. Appendix D describes sample programs.

Appendices E and F describe the interfaces between *SunCGI* and other Sun software packages: *SunView* and FORTRAN. Appendix E explains how to call *SunCGI* from application programs written on top of *SunView*. This interface allows *SunCGI* to write output primitives in different windows using different attributes.

Appendix F describes the interface to the FORTRAN programming language. The behavior of each *SunCGI* function is the same in both C and FORTRAN.

The final appendix, Appendix G, describes the *SunCGI* C binding for CGI. These names are contained in the header file `<cgicbind.h>`, which must be included in an application program using the short C binding.

1.4. References

[1] ANSI X3H3. *Computer Graphics Virtual Device Interface.* March 1984.

[2] Conrac Corporation. *Raster Graphics Handbook,* Second Edition. Van Nostrand Reinhold, 1985.

[3] J.D. Foley and A. van Dam. *Fundamentals of Interactive Computer Graphics.* Addison-Wesley, 1982.

[4] B.W. Kernighan and D.M. Ritchie. *The C Programming Language.* Prentice-Hall, 1978.

[5] W.M. Newman and R.F. Sproull. *Principles of Interactive Computer Graphics.* McGraw-Hill, 1979.

[6] V.R. Pratt. *Standards and Performance Issues in the Workstation Market.* IEEE Computer Graphics and Applications, April 1984.

[7] *SunView 1 Programmer's Guide.* Sun Microsystems.

[8] *SunView 1 System Programmer's Guide.* Sun Microsystems.

[9] *Pixrect Reference Manual.* Sun Microsystems.

[10] *SunCore Reference Manual.* Sun Microsystems.

[11] *FORTRAN Programmer's Guide for the Sun Workstation.* Sun Microsystems.

2

Initializing and Terminating SunCGI

2

Initializing and Terminating SunCGI

The current CGI standard does not provide functions for initializing and terminating devices. ANSI CGI is intended to provide an interface for a single view surface (one per CGI instance). *SunCGI* extends CGI into the window environment by allowing a single CGI process to control multiple view surfaces. Six nonstandard functions, `open_cgi()`, `close_cgi()`, `open_vws()`, `close_vws()`, `activate_vws()`, and `deactivate_vws()`, are included in *SunCGI*. `open_cgi()` and `close_cgi()` initialize and terminate the operation of the *SunCGI* package. `open_vws()` and `close_vws()` initialize and terminate a view surface. `activate_vws()` activates the view surface. `deactivate_vws()` restricts output primitives from a view surface.

SunCGI is capable of handling up to five view surfaces at once.

2.1. View Surface Initialization and Selection

A view surface is automatically activated when it is opened. However, a view surface can be deactivated (with the `deactivate_vws()` function) when the output stream is not intended to appear on all view surfaces. Subsequent calls to *SunCGI* output functions will not apply to deactivated view surfaces. until `activate_vws()` is called again (see the following example). However, inputs can be received on deactivated view surfaces.

```
#include <cgidefs.h>

main()
{
    Ccoor   ll,         /* coord of lower-left corner of rectangle   */
            ur,         /* coord of upper-right corner of rectangle  */
            center;     /* coord of center of circle                 */
    Cint    name1,      /* name of first CGI view surface            */
            name2,      /* name of second CGI view surface           */
            radius;     /* radius of circle                          */
    Cvwsurf device1,    /* 1st CGI device struct (see NORMAL_VWSURF) */
            device2;    /* 2nd CGI device struct (see NORMAL_VWSURF) */
    static  Cchar   *scrn_name = "/dev/fb";
    char    *toolposition = "0,0,250,250,0,0,250,250,0";

    ll.x = ll.y = 5000;                 /* set rectangle coordinates */
    ur.x = ur.y = 15000;
```

```
    center.x = center.y = 10000;        /* set circle coordinates */
    radius = 5000;

    NORMAL_VWSURF(device1, PIXWINDD);   /* set up a default window        */
    NORMAL_VWSURF(device2, PIXWINDD);   /* set up a 2nd default window    */
    device2.flags = VWSURF_NEWFLG;      /* don't take over current window */
    device2.ptr = &toolposition;        /* set position and size of 2nd   */

    open_cgi();                         /* open CGI and view surfaces */
    open_vws(&name1, &device1);
    open_vws(&name2, &device2);

    rectangle(&ll, &ur);          /* rectangle draws on both devices */
    deactivate_vws(name2);        /* only display one is acive now */
    circle(&center, radius);      /* draw circle on device one only */
    activate_vws(name2);          /* both displays active again */
    circle(&center, 2*radius);    /* circle draws on both devices */

    sleep(20);

    close_vws(name1);             /* close view surfaces and CGI */
    close_vws(name2);
    close_cgi();
}
```

Open CGI (SunCGI Extension)

`Cerror open_cgi()`

`open_cgi()` initializes the state of *SunCGI* to CGOP (CGi OPen). `open_cgi()` does not initialize input devices but does initialize the *event queue*. No other CGI functions can be used without generating an error if `open_cgi()` has not been called. *SunCGI* traps various signals as described in Section 2.3.

`ENOTCGCL` [1] CGI not in proper state: CGI shall be in state CGCL.

Table 2-1 *SunCGI Default States*

State	*Value*
Range of VDC space	0-32767 in both *x* and *y* directions
Clip Indicator	CLIP
Clip Rectangle	Range of VDC space
Error Warning Mask	INTERRUPT
Input Devices	Uninitialized
Input Queue	EMPTY
Trigger Associations	Defaults specific values listed in Table 5-2
Echo Modes	Device specific values listed in Table 5-3

You may be unfamiliar with some of the entries discussed in Table 2-1. However, these concepts are explained in the course of this chapter. Further, each of these concepts are referenced in the index.

Open View Surface (SunCGI Extension)

```
Cerror open_vws(name, devdd)
Cint *name;      /* name assigned to cgi view surface */
Cvwsurf *devdd; /* view surface descriptor */
```

`open_vws()` initializes a view surface. The list of available view surfaces is described in Table 2-2. `open_vws()` initializes the attributes to their default values (listed in Table 2-3). The returned argument *name* is the identifier which is used to refer to this view surface in other *SunCGI* functions. To reinitialize the state of the view surface without reopening it, use the `hard_reset()` function.

A maximum of five view surfaces may be open at one time. Output primitives are displayed on all *active* view surfaces (view surfaces must be opened before they are activated). However, input is only echoed on the view surface pointed to by the mouse. Most of the `Cvwsurf` fields should be zeroed, as by the `NORMAL_VWSURF` macro. Set the view surface type by assigning the *dd* (device driver) element of the *devdd* argument to the name of the appropriate device driver as in this example:[1]

```
Cvwsurf device;
NORMAL_VWSURF(device, BW2DD);
open_vws(&name, &device);
```

NOTE *The* `NORMAL_VWSURF` *macro initializes the dd element of the* `Cvwsurf` *structure and guarantees that the view surface will be opened in the normal fashion. However, to open a window with some nonstandard parameters, or to open a second window from a graphics tool, read the following paragraphs. To use an existing Pixwin, skip the following paragraphs and read Appendix E instead.*

If the view surface of the specified type has been previously initialized and the type of view surface is a window (`PIXWINDD` or `CGPIXWINDD`), a CGI tool (a window with the name CGI Tool) is opened. Other characteristics of the view surface can be defined by setting the other elements of the *devdd* argument (which is of type `Cvwsurf`).

[1] Notice that when *SunCGI* specifies a pointer it usually requires that the argument is prefaced by an & character when the argument is actually used.

```
typedef struct {
    char screenname[DEVNAMESIZE]; /* physical screen */
    char windowname[DEVNAMESIZE]; /* window */
    int windowfd;                 /* window file descriptor */
    int retained;                 /* retained flag */
    int dd;                       /* device */
    int cmapsize;                 /* colormap size */
    char cmapname[DEVNAMESIZE];   /* colormap name */
    int flags;                    /* new flag */
    char **ptr;                   /* CGI tool descriptor */
} Cvwsurf;
```

The elements *screenname* and *windowname* specify alternate screens (for example, */dev/cgone0*) or alternate windows (for example, */dev/win10*). If these elements are left blank, the current screen and the current window are used, unless the *dd* field implicitly specifies a device (for example, *CG1DD*). The element *windowfd* is the window file descriptor for the current device. The current implementation of *SunCGI* ignores this element.

If the element *retained* is nonzero, then the view surface created by `open_vws()` has a retained window associated with it (that is, if the window is covered up by another window and then revealed, the picture present before the window was covered-up will be redisplayed. By default the window created by `open_vws()` is non-retained. That is, if the window is covered-up and then revealed, the covered-portion will be redisplayed as white. However, drawing in non-retained windows is twice as fast as drawing in retained windows, so the choice of which type of view surface to open should be carefully considered.

The *dd* element specifies the view surface type. The *cmapsize* and the *cmapname* elements determine the size and the name of the colormap. *No colormap is enabled for monochrome devices.* The colormap determines the mapping between color indices and red, green, and blue values. If the colormap specified by the *cmapname* element of the *devdd* argument is the same as a colormap segment which already exists, then the colormap segment is shared. *cmapsize* should be a power of two, less than or equal to 256. The *cmapsize* and the *cmapname* fields provided in the `Cvwsurf` structure that is passed to `open_vws()` must be initialized to modify the colormap.

See Chapter 4, section 4.9, for a description on using colormaps in *SunCGI*. For more information about colormaps in CGIPW, refer to the *SunView 1 Programmer's Guide.*

SunCGI must define its own colormap by creating a new colormap or using a shared colormap whether the *SunCGI* application is running inside or outside the window system.

The *SunCGI* color intensity scheme ranges from 0 to 255.

In *SunCGI*, first set the *dd* element of the view surface structure to be the frame buffer type {`CG1DD`, `CG2DD`, `CG4DD`, `GP1DD`, or `CGPIXWINDD`}. In the window environment, the graphics processor is accessed through `CGPIXWINDD`. If the graphics processor is available, the `CGPIXWINDD` uses the device for transformation calculations. Within the view surface structure, set the *cmapsize*

element to the colormap size, and the *cmapname* element to the string that names the colormap. When the view surface is opened, and the red, green, and blue color arrays are initialized, the colormap array of type `Ccentry` points to the red, green, and blue color arrays.

When the *flags* element is nonzero, no attempt is made to take over the current graphics subwindow (if one exists). If this flag is set or the graphics subwindow has already been taken over by *SunCGI*, then a CGI Tool (a window with the name *View Surface Tool*) is created. The *ptr* element specifies the size and placement of the CGI Tool. *ptr* is a pointer to an array of strings, only the first of which is currently used. This string should consist of nine decimal numbers separated by commas. The array takes the following form:

```
"nl,nt,nw,nh,il,it,iw,ih,I"
```

Each element of the array should be filled with an integer. The first two elements specify the *x* and *y* coordinates of the upper left-hand corner of the CGI Tool in screen, or *Pixwin* coordinates. This coordinate system specifies the **upper left-hand corner** as the origin, so be sure that the *y* value for the upper corner given is **less than** the value for the lower corner. The third and fourth elements specify the width and height of the CGI Tool. The fifth through eighth elements specify the position and size of the iconic form of the CGI Tool. If the ninth element is nonzero, the tool is displayed in its iconic form.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`ENOWSTYP` [11]	Specified view surface type does not exist.
`EMAXVSOP` [12]	Maximum number of view surfaces already open.
`EMEMSPAC` [110]	Space allocation has failed.
`ENOTCCPW` [112]	Function or argument not compatible with CGIPW mode.

SunCGI distinguishes between the inside and the outside of the window system. While running under `suntools`, *SunCGI* uses different window devices as the view surface.

The color view surfaces for the window system are the 'color graphics pixwins,' called `cgpixwindds`. *SunCGI*, while running inside the window system, uses `cgpixwindds` or `gppixwindds`. While running outside the window system, *SunCGI* uses the raw frame buffer. These devices are described in the following table.

Table 2-2 *Available SunCGI View Surfaces*

dd Element of View Surface	*Name*	*Description*
1	BW1DD	The Sun 1 monochrome frame buffer device; and for Sun 2 multibus systems when running outside `suntools`, in console mode.
2	BW2DD	The Sun 2 VME and Sun 3 monochrome frame buffer device when running outside `suntools`, in console mode.
3	CG1DD	The Sun 1 color frame buffer device; and for Sun 2 multibus systems when running outside `suntools`, in console mode.
4	BWPIXWINDD	A monochrome window, when running the application in a `suntools` window, or in a SunView canvas subwindow, as in the case for CGIPW.
5	CGPIXWINDD	A color window, when running the application in a `suntools` window; or in a *SunView* canvas subwindow, as is the case for CGIPW.
6	GP1DD	The graphics processer† when running the application outside `suntools`, in console mode.
7	CG2DD	The Sun 2 and Sun 3 color frame device when running outside `suntools`, in console mode.
8	CG4DD	The Sun 3/110 color frame buffer device when running outside `suntools`, in console mode.
9	PIXWINDD	A monochrome or color window, when running the application in a `suntools` window, or in a *SunView* canvas subwindow as in the case of CGIPW. Use this device when you are not sure whether you will have a monochrome or color monitor.

† The graphics processor is Sun's hardware graphics accelerator. This is a single board option. An additional graphics buffer board option may also be added at a later time.

Table 2-3 *View Surface Default States*

State	*Value*
View Surface	Cleared
Device Viewport	View Surface

NOTE *Most failures during the opening of a view surface result in error* `ENOWSTYP [11]`. *The most common reason is missetting (or failing to set) the dd element of the* `Cvwsurf` *structure. For example, opening a device surface type* `PIXWINDD` *instead of* `CGPIXWINDD` *on a color pixwin, or using* `CG2DD` *when a /dev/cgtwo surface is being used by* `suntools`. *The* `NORMAL_VWSURF` *macro should be used to initialize this structure.*

Activate View Surface (SunCGI Extension)

```
Cerror activate_vws(name)
Cint name; /* view surface name */
```

`activate_vws()` activates the view surface specified by name. Subsequent *SunCGI* calls affect this view surface. Nothing is displayed on a view surface unless that view surface is active. Since a view surface is active as soon as it is opened, `activate_vws()` is only needed to reactivate a deactivated view surface. Note that activating a view surface may reset the state of *SunCGI*.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`EVSIDINV` [10]	Specified view surface name is invalid.
`EVSNOTOP` [13]	Specified view surface not open.
`EVSISACT` [14]	Specified view surface is active.

Deactivate View Surface (SunCGI Extension)

```
Cerror deactivate_vws(name)
Cint name; /* view surface name */
```

`deactivate_vws()` prevents calls to *SunCGI* functions from having an effect on this view surface. The view surface may be reactivated by `activate_vws()` at a later time without having to be reopened. Note that deactivating a view surface may reset the state of *SunCGI*.

`ENOTVSAC` [4]	CGI not in proper state: CGI shall be in state VSAC.
`EVSIDINV` [10]	Specified view surface name is invalid.
`EVSNOTOP` [13]	Specified view surface not open.
`EVSNTACT` [15]	Specified view surface is not active.

Close View Surface (SunCGI Extension)

```
Cerror close_vws(name)
Cint name; /* view surface name */
```

`close_vws()` terminates a view surface. Future *SunCGI* calls have no effect on this view surface. The view surface cannot be reactivated without being reopened.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EVSIDINV [10]	Specified view surface name is invalid.
EVSNOTOP [13]	Specified view surface not open.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

Close CGI (SunCGI Extension)

```
Cerror close_cgi()
```

`close_cgi()` terminates all open view surfaces and restores the state of the *SunView* to the state that it was in before *SunCGI* was opened. Future *SunCGI* calls will have no effect and will generate errors.

A call to `close_cgi()` should be included in the exit routines of an application program to guarantee leaving the *SunView* and *SunCGI* in a stable state.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

2.2. View Surface Control

The functions described in this section perform the following:

- define the range of world and device coordinates
- control clipping
- reset selected aspects of the view surface and the internal state of *SunCGI*.

Most functions in *SunCGI* express coordinates in VDC space (Virtual Device Coordinate space). In conventional computer graphics terms, VDC space corresponds to world coordinate space. The mapping between VDC space and screen space is determined by the physical size of the screen in pixels. Screen space is set by default to the entire size of the screen or the graphics window depending on the device type. The mapping from VDC space to screen space is always isotropic (the shape of the rectangle defining screen space is the same shape as VDC space). Therefore, VDC space defines the shape of the active view surface. The portion of screen space which does not correspond to VDC space is ignored. The aspect ratio (the ratio between the height and width) is therefore, defined by VDC space and not screen space.

VDC Extent

```
Cerror vdc_extent(c1, c2)
Ccoor *c1, *c2; /* bottom left-hand and */
                /* top right-hand corner of VDC space */
```

`vdc_extent()` defines the limits of VDC space. The range of the coordinates must be between -32767 and 32767 (or an error is generated). VDC space can be set by the application program, but it ranges from 0 to 32767 in both the *x* and the *y* directions by default. Resetting VDC space impacts the display of output primitives on all view surfaces.

Resetting the limits of VDC space *automatically* redefines the clipping rectangle to the new limits of VDC space, regardless of the value of the *clip indicator*.

Changing the mapping from screen space to VDC space allows for translation (move) or scaling (zoom in/zoom out) of output primitives. However, no rotation functions are provided by *SunCGI*, and therefore, must be supplied in the application program. The code fragment below translates and zooms in on a rectangle.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADRCTD [20]	Rectangle definition is invalid.
EVDCSDIL [24]	VDC space definition is illegal.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

```
#include <cgidefs.h>

main()
{
    Cvwsurf device;
    Cint name;
    Ccoor dv1, dv2, lower, upper;

    NORMAL_VWSURF(device, PIXWINDD);

    open_cgi();
    open_vws(&name, &device);
    dv1.x = dv1.y = 0;
    dv2.x = dv2.y = 200;          /* coord. space (0<x|y<200) */
    vdc_extent(&dv1, &dv2);

    lower.x = lower.y = 30;       /* rectangle coordinates */
    upper.x = upper.y = 70;
    rectangle(&upper, &lower);    /* draw initial rectangle */
    sleep(4);

    dv1.x = dv1.y = 0;
    dv2.x = dv2.y = 100;          /* coord. space (0<x|y<100) */
    vdc_extent(&dv1, &dv2);       /* center rectangle */
    rectangle(&upper, &lower);
    sleep(4);

    dv1.x = dv1.y = 20;
    dv2.x = dv2.y = 80;           /* coord. space (20<x|y<80) */
    vdc_extent(&dv1, &dv2);       /* enlarge rectangle */
    rectangle(&upper, &lower);
    sleep(20);

    close_vws(name);
    close_cgi();
}
```

Device Viewport

```
Cerror device_viewport(name, c1, c2)
Cint name;       /* name assigned to cgi view surface */
Ccoor *c1, *c2; /* bottom left-hand and top right-hand */
                 /* corner of view surface to map */
                 /* device (expressed in pixels) */
```

`device_viewport()` redefines the limits of screen space. The coordinate values specified are in pixels and are in the screen's coordinate system, which has its origin in the **upper left-hand** corner of the screen. If the new limits are not less than or equal to the size of the current screen or window size, an error is returned. Although `device_viewport()` does not redefine the aspect ratio, it may redefine which areas of the screen are unused.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EVSIDINV [10]	Specified view surface name is invalid.
EVSNOTOP [13]	Specified view surface not open.
EBADRCTD [20]	Rectangle definition is invalid.
EBDVIEWP [21]	Viewport is not within Device Coordinates.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

Clip Indicator

```
Cerror clip_indicator(cflag)
Cclip cflag; /* CLIP, NOCLIP or CLIP_RECTANGLE */
```

The value of the argument *cflag* determines whether output primitives are clipped within the viewport before they are displayed. The default state is CLIP. The advantage of turning clipping off is that it improves the speed of drawing primitives. However, if clipping is set to NOCLIP, *SunCGI* may draw output primitives outside of the window or within the bounds of an overlapping window. The application is responsible for placing the object within the limits of the display rectangle. Drawing outside the display rectangle can result in unpredictable results, including system errors.

If clipping is not NOCLIP, output primitives are clipped to either the clip rectangle (if *cflag* equals CLIP_RECTANGLE), or the full extent of VDC space (if *cflag* equals CLIP). The extent of VDC may be set with the `vdc_extent()` function.

```
typedef enum {
    NOCLIP,
    CLIP,
    CLIP_RECTANGLE
} Cclip;
```

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

Clip Rectangle

```
Cerror clip_rectangle(xmin, xmax, ymin, ymax)
Cint xmin, xmax, ymin, ymax; /* bottom left-hand and top */
                             /* right-hand corner of clipping *
                             /* rectangle */
```

`clip_rectangle()` defines the clipping rectangle in VDC space, to be used when the *clip indicator* is set to CLIP_RECTANGLE. By default, the clipping rectangle is set to the borders of VDC space. The clipping rectangle is automatically reset by `vdc_extent()`.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADRCTD [20]	Rectangle definition is invalid.
ECLIPTOL [22]	Clipping rectangle is too large.
ECLIPTOS [23]	Clipping rectangle is too small.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

Hard Reset

```
Cerror hard_reset()
```

Device control functions restore the view surface and the internal state of *SunCGI* to a known state. The individual aspects of the device which can be reset are the output attributes, the view surface (screen), and the error reporting.

`hard_reset()` returns the output attributes to their default values: it terminates all input devices, empties the *event queue*, and clears all view surfaces. VDC space is reset to its default values and the *clip indicator* is set to CLIP. This function should be used sparingly because most control, attribute, and input functions called before this function will not have any effect on functions called after `hard_reset()` is called.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Reset to Defaults

```
Cerror reset_to_defaults()
```

`reset_to_defaults()` returns output attributes to defaults (see Table 4-1). `reset_to_defaults()` does *not* clear the screen, reset the input devices, or reset the *character set index*.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EVSIDINV [10]	Specified view surface name is invalid.

Clear View Surface

```
Cerror clear_view_surface(name, defflag, index)
Cint name;      /* name assigned to cgi view surface */
Cflag defflag;  /* default color flag */
Cint index;     /* color of cleared screen */
```

`clear_view_surface()` changes all pixels in the relevant area of the view surface specified by *name* to the color specified by the *index* argument, unless the

defflag argument is set to OFF. If *defflag* is equal to OFF, the view surface is cleared to color zero. The area of the view surface which is actually cleared is determined by the `clear_control()` function.
`clear_view_surface()` also resets the internal state of *SunCGI* according to previous calls to the `clear_control()` function.
`clear_view_surface()` resets the current *background color* to the color of the cleared view surface.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVSIDINV [10]	Specified view surface name is invalid.
EVSNOTOP [13]	Specified view surface not open.
EVSNTACT [15]	Specified view surface is not active.
ECINDXLZ [35]	Color index is less than zero.
EBADCOLX [36]	Color index is invalid.

Clear Control

```
Cerror clear_control(soft, hard, intern, extent)
Cacttype soft, hard; /* soft and hard copy actions */
Cacttype intern;     /* internal action */
Cexttype extent;     /* clear extent */
```

`clear_control()` determines the action taken when `clear_view_surface()` is called. The argument *soft* can be set to either NO_OP or CLEAR. The argument *hard*, which regulates clearing rules for plotters, is ignored (because *SunCGI* does not currently support hard-copy devices) and is included only for ANSI CGI compatibility. The argument *intern* is set to either RETAIN or CLEAR. This parameter was included to support segmentation storage, which is not currently a part of ANSI CGI. Therefore, the *intern* argument is ignored. The argument *extent* determines what area of the screen is cleared. It is set to one of the values in the `Cexttype` enumerated type:

```
typedef enum {
    CLIP_RECT,
    VIEWPORT,
    VIEWSURFACE
} Cexttype;
```

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
ENOTCCPW [112]	Function or argument not compatible with CGIPW mode.

Set Error Warning Mask

```
Cerror set_error_warning_mask(action)
Cerrtype action; /* action on receipt of an error */
```

`set_error_warning_mask()`[2] determines the action taken by *SunCGI* when an error occurs. Three types of action are possible: NO_ACTION, POLL,

[2] The syntax of `set_error_warning_mask()` in *SunCGI* is slightly different from the proposed ANSI standard in that the ANSI definition allows different actions for different classes of errors.

INTERRUPT. If the *action* argument is set to NO_ACTION, errors are detected internally, but not reported. The error number is returned to the caller of a CGI routine. The user is advised *not* to set the *action* argument to NO_ACTION.

POLL and INTERRUPT actions print an error message on the terminal, and also return the error number (see Appendix C) so the program can perform exception handling. The default `set_error_warning_mask()` is INTERRUPT.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Table 2-4 *Error Warning Masks*

Error Warning Mask	*Message Printed*	*Program Aborted*	*Error Number Returned*
`NO_ACTION`	No	No	Yes
`POLL`	Yes	No	Yes
`INTERRUPT`	Yes	FATAL errors†	Non-FATAL errors

† *SunCGI* defines no errors as FATAL. All errors are non-fatal so the application has complete control to abort or perform other processing as desired. Therefore, POLL and INTERRUPT are the same in *SunCGI*.

2.3. Running SunCGI with SunView

SunCGI always traps five signals: SIGINT, SIGCHLD, SIGIO, SIGHUP and SIGWINCH. The first four of these cause *SunCGI* cleanup and program termination. When using a Graphics Processor option, *SunCGI* also traps SIGXCPU. All registered signal handlers are called when its respective signal occurs. Be careful that the actions performed by one signal handler do not interfere with the actions performed by another signal handler, including *SunCGI*'s. The Notifier is an example of a signal handler that must be coordinated in this way.

Unless a *SunCGI* application program has opened a *retained* view surface, overlapping another window onto a graphics subwindow will destroy the picture below. *SunCGI* programs can regenerate a display surface by trapping the SIGWINCH (SIGnal WINdow CHange) signal.

It is possible (though unsupported) to install a signal handler for signals after calling `open_pw_cgi()` (see Appendix E). Since these signal handlers replace *SunCGI*'s handler, the application should save *SunCGI*'s signal handler (returned by signal), and call the saved handler when the signal occurs (amid the user's own processing). Because the response of the program to the signal then depends on the place in the user's own signal handling that *SunCGI*'s handler is called, results are unpredictable, and may change with a new version of *SunCGI*.

Note that it is not necessary for an application to catch a SIGWINCH signal, since *SunCGI*'s `set_up_sigwinch()` routine offers an easier interface. A user's `sig_function()` has a different calling semantics from a SIGWINCH in that `pw_damaged()` and `pw_donedamaged()` have already been invoked.

When a window's contents needs regeneration during execution time, the process associated with a window receives a SIGWINCH signal. The application can use this signal to determine when a view surface needs to be regenerated.

NOTE *Under no circumstances will the user be able to access the SIGWINCH signals generated when a view surface is initialized.*

When a window obstructs a *SunCGI* view surface, output to that view surface is normally clipped to the exposed portion only (unless the clip indicator is NOCLIP). When the obstruction is removed, unless the window is RETAINED, the picture must be regenerated by re-running the output generation of the applications, for that view surface at least. An application's SIGWINCH handling function is called for this purpose.

When a *SunCGI* window's size changes during execution, the picture must be regenerated. But first, *SunCGI* updates the transformation used to map VDC space into screen space. Then, if the affected view surface is RETAINED, the retained copy is rewritten onto the view surface. (Because of the size change, this may not repair the damage satisfactorily.) Lastly, the application's SIGWINCH function is called.

Set Up SIGWINCH (SunCGI Extension)

```
Cerror set_up_sigwinch(name, sig_function)
Cint name;
Cint (*sig_function)(); /* signal handling function */
```

`set_up_sigwinch()` allows the application program to trap SIGWINCH signals for view surface *name*. `sig_function()` is a pointer to a function returning an integer. If `sig_function()` is nonzero, all SIGWINCH signals that are not trapped by the internals of *SunCGI* (from view surface initialization) are passed to the function specified by `sig_function()`.

The `sig_function()` is called when the SIGWINCH signal is received. It is the programmer's responsibility to use a flag to determine if it is safe to process the signal at this time, or to set a flag indicating that signal processing has been put off until later. See the *SunView 1 Programmer's Guide* for information on SIGWINCH handling.

The `sig_function()` argument is called with a single argument: the name of the view surface with which it is associated by the call to `set_up_sigwinch()`. This allows more than one view surface to share the same `sig_function()`, and differentiate which view surface needs redisplay.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Following is an example of a program that uses `set_up_sigwinch()`.

```
#include <cgidefs.h>

Ccoor box[5] = { 10000,10000 ,
                 10000,20000 ,
                 20000,20000 ,
                 20000,10000 ,
                 10000,10000 };
Cint name;
extern Cint redraw();
Cvwsurf device;

main()
{
    Ccoorlist boxlist;

    boxlist.n = 5;
    boxlist.ptlist = box;
    NORMAL_VWSURF(device, PIXWINDD);

    open_cgi();
    open_vws(&name, &device);
    set_up_sigwinch(name, redraw);

    polyline(&boxlist);
    sleep(10);

    close_vws(name);
    close_cgi();
}

Cint redraw()
{
    clear_view_surface(name, ON, 0);
}
```

2.4. Interface Negotiation

CGI is intended to support a 'negotiated device interface', allowing hardware-specific programs written to run on other machines. *SunCGI* only allows inquiry of most of the settable modes.[3] You may want to find out which types of input devices are supported. However, functions for setting color precision, coordinate type, specification mode, and color specification are *not* provided because *SunCGI* only supports one type of color precision (8-bit), coordinate type (integers), and color specification (indexed). The width and size specification modes are settable; the functions that set them are described in Chapter 4. The inquiry negotiation functions are supported so that an application program written for a CGI on another manufacturers' workstation can find out whether the *SunCGI* is capable of running that application.

[3] The functions not supported by *SunCGI* are classified as non-required by the March 1984 ANSI CGI standard. See Appendix A.

Inquire Device Identification

```
Cerror inquire_device_identification(name, devid)
Cint name;                    /* device name */
Cchar devid[DEVNAMESIZE];     /* workstation type */
```

`inquire_device_identification()` reports which type of Sun Workstation view surface *name* is associated with. The argument *devid* may be set to one of the Sun Workstation types described in Table 2-2. The inclusion of the *name* argument deviates from the ANSI standard, but is necessary so that the characteristics of individual view surfaces may be inquired.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`EVSIDINV` [10]	Specified view surface name is invalid.
`EVSNOTOP` [13]	Specified view surface not open.

Inquire Device Class

```
Cerror inquire_device_class(output, input)
Cint *output, *input; /* output and input abilities */
```

`inquire_device_class()` describes the capabilities of Sun Workstations in terms of the CGI functions they support.[4] Each of the two returned values reports the number of functions of each of the two classes that are supported in *SunCGI*. These numbers (the values of *input* and *output*) are used to make more detailed inquiries by using functions `inquire_input_capabilities()` and `inquire_output_capabilities()`.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Physical Coordinate System

```
Cerror inquire_physical_coordinate_system(name, xbase,
    ybase, xext, yext, xunits, yunits)
Cint name;                  /* name assigned to cgi view surface
Cint *xbase, *ybase;        /* base coordinates */
Cint *xext, *yext;          /* pixels in x and y directions */
Cfloat *xunits, *yunits; /* number of pixels per mm. */
```

`inquire_physical_coordinate_system()` reports the physical dimensions of the coordinate system of view surface *name* in pixels and millimeters. `inquire_physical_coordinate_system()` is provided to permit the drawing of objects of a known physical size. `inquire_physical_coordinate_system()` is also provided to assist in the computation of parameters for the `device_viewport()` function.

xbase and *ybase* are expressed in the screen coordinate system and are therefore given in pixels, meaning they have the **upper left-hand corner** of the screen as their origin. *xext* and *yext* describe the maximum extent of the window in which the application program is run. (The window may or may not cover the entire screen.) The number of pixels per millimeter is always set to 0 because the actual screen size of device varies between individual monitors. The actual size

[4] The *output* argument does not include the non-standard CGI functions.

of the screen may be obtained from the number of pixels in the *x* and *y* directions from the monitor specifications and perform the division in an application program.

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

EVSIDINV [10] Specified view surface name is invalid.

EVSNOTOP [13] Specified view surface not open.

Inquire Output Function Set

```
Cerror inquire_output_function_set(level, support)
Cint level;         /* level of output */
Csuptype *support; /* amount of support */
```

`inquire_output_function_set()` reports the extent to which each level of the output portion of the ANSI CGI standard is supported.

```
typedef enum {
    NONE,
    REQUIRED_FUNCTIONS_ONLY,
    SOME_NON_REQUIRED_FUNCTIONS,
    ALL_NON_REQUIRED_FUNCTIONS
} Csuptype;
```

The standard requires that the *level* argument be an enumerated type; however, for reasons of simplicity only the level number is used by *SunCGI*. Levels 1-6 are supported completely (that is, both required and non-required functions are implemented). Level 7 is not supported at all. Refer to the ANSI standard for the precise definition of each level.

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire VDC Type

```
Cerror inquire_vdc_type(type)
Cvdctype *type; /* type of VDC space */
```

`inquire_vdc_type()` reports the type of coordinates used by *SunCGI* in the returned argument *type*.

```
typedef enum {
    INTEGER,
    REAL,
    BOTH
} Cvdctype;
```

type is always set to INTEGER (32-bit). *SunCore* is a higher-level graphics system with coordinate space expressed in real numbers.

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Output Capabilities

```
Cerror inquire_output_capabilities(first, num, list)
Cint first;      /* first element */
Cint num;        /* number of elements in list to be returned
Cchar *list[];   /* returned list */
```

`inquire_output_capabilities()` lists the output functions in the returned argument *list*. The range of the *first* and *num* arguments is determined by the returned argument *output* from the `inquire_device_class()` function.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`EINQLTL` [16]	Inquiry arguments are longer than list.

2.5. Input Capability Inquiries

Input devices have a separate class of negotiation functions. Input capability inquiries report qualitative abilities as well as quantitative abilities of input devices. The `inquire_input_capabilities()` function reports which devices and overall features are supported by *SunCGI*. The remaining functions report the capabilities of individual devices or features. Input devices are virtual devices which must be *associated* with physical *triggers* (such as mouse buttons). Initializing an input device defines the measure used by a device, for example initializing a LOCATOR device defines the measure as *x-y* coordinates. In addition to being associated with a trigger, each device has selectable screen echoing capabilities. Association and echoing capabilities for each input device are reported by the functions described in this section.

Inquire Input Capabilities

```
Cerror inquire_input_capabilities(valid, table)
Clogical *valid;     /* device state */
Ccgidesctab *table; /* CGI input description table */
```

`inquire_input_capabilities()` reports the total number of input devices of each class that is supported. The argument *valid* returns the value L_TRUE if *SunCGI* is initialized, and L_FALSE otherwise. If *valid* is set to L_TRUE, the elements of *table* are set to the quantity and quality of inputs supported. All Sun Workstations support input at the same level.

```
typedef struct {
    Cint numloc;
    Cint numval;
    Cint numstrk;
    Cint numchoice;
    Cint numstr;
    Cint numtrig;
    Csuptype event_queue;
    Csuptype asynch;
    Csuptype coord_map;
    Csuptype echo;
    Csuptype tracking;
    Csuptype prompt;
    Csuptype acknowledgement;
    Csuptype trigger_manipulation;
} Ccgidesctab;
```

Elements of type `Cint` report how many of each type device is supported, as well as how many types of triggers are supported. Elements of type `Csuptype` report how many of the functions of each class are supported. All functions except the tracking functions are fully supported.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire LID Capabilities

```
Cerror inquire_lid_capabilities(devclass, devnum,
    valid, table)
Cdevoff devclass;
Cint devnum;          /* device number */
Clogical *valid;      /* device supported at all */
Cliddescript *table; /* table of descriptors */
```

`inquire_lid_capabilities()` describes the capabilities of a specific input device (hereafter, specified device). The input arguments *devclass* and *devnum* refer to a specific device type and number. The argument *valid* reports whether CGI is initialized.

```
typedef struct {
    Clogical    sample;
    Cchangetype change;
    Cint    numassoc;
    Cint    *trigassoc;
    Cinputability prompt;
    Cinputability acknowledgement;
    Cechotypelst *echo;
    Cchar   *classdep;
    Cstatelist  state;
} Cliddescript;
```

`Cliddescript` indicates whether an ability is present in the specified logical input device. The *change* element reports whether associations are changeable at all (all input devices except string are changeable). The *numassoc* and *trigassoc* elements of *table* report how many and which triggers may be associated with the

specified logical input device. *SunCGI* does not support either *prompt* or *acknowledgement* for any input device. The *echo* argument describes which echo types are supported (see Chapter 5 for a list of echo types).[5] The *classdep* argument provides class dependent information in character form (the type of information is given in Table 2-5). If more than one piece of class dependent information is returned, then the pieces of information are separated by commas. The *state* argument reports the initial state of the specified device. See the `inquire_lid_state_list()` function.

Table 2-5 *Class Dependent Information*

Device Class	*Information*	*Possible Values*
IC_LOCATOR	Coordinate Mapping	Yes, No, Partial
	Native Range	xmin, xmax, ymin, ymax
IC_VALUATOR	Set Valuator Range	yes/no
IC_STROKE	Time Increment Settable	yes/no
	Minimum Distance	yes/no
IC_CHOICE	Range	min/max
IC_STRING	None	None

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Trigger Capabilities

```
Cerror inquire_trigger_capabilities(trigger, valid, tdis)
Cint trigger;     /* trigger number */
Clogical *valid; /* trigger supported at all */
Ctrigdis *tdis;  /* trigger description table */
```

`inquire_trigger_capabilities()` describes how a particular *trigger* can be associated. The argument *valid* reports whether the device supports input at all.

```
typedef struct {
    Cchangetype change;
    Cassoclid *numassoc;
    Cint maxassoc;
    Cpromstate prompt;
    Cackstate acknowledgement;
    Cchar *name;
    Cchar *description;
} Ctrigdis;
```

The *change* element of *tdis* reports whether the specified trigger can be associated with a logical input device. The *numassoc* element of *tdis* gives supported LID associations for this trigger. This consists of *n*, the number of LID classes which can be associated with the trigger, a pointer to an array of *n* entries telling which *n* device classes can be associated with the trigger, and how many of each

[5] Note that `inquire_lid_capabilities()` returns an enumerated type whereas `track_on()` accepts integers. Therefore these values may be different.

device class is defined. The *maxassoc* field gives the number of LIDs which can be concurrently associated with this trigger. *SunCGI* does not support either *prompt* or *acknowledgement* for any input device. The *name* element is simply a character form of the trigger name (for example, LEFT MOUSE BUTTON). The *description* element is never filled and is included for standards compatibility.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EINTRNEX [86]	Trigger does not exist.

3

Output

3

Output

SunCGI supports two classes of output primitives: geometrical output primitives and raster primitives.

Geometrical Output Primitives
include arcs, circles, polylines, polygons, and markers. The position of geometrical output primitives are always specified in absolute VDC coordinates.[6]

Raster Primitives
draw text and scaled and unscaled 2D arrays. The coordinate system for raster primitives depends on the type of primitive. The drawing mode determines how output primitives are drawn on top of other output primitives or the background.

3.1. Geometrical Output Primitives

Geometrical primitives (except `polymarker()`) are considered either closed or not closed. Polymarker uses its own attributes (see Section 4.3). Non-closed figures (polylines, circular arcs, or elliptical arcs) are drawn with a style, width and color determined from line attributes (see Section 4.2). Closed figures (polygons, rectangles, circles, ellipses, and circular and elliptical closed arcs) use the solid object attributes (see Section 4.4). The geometrical information specifies the boundary of a closed figure. The interior of this boundary is filled using fill area attributes. The boundary may be surrounded with a line, drawn with perimeter attributes, not the line attributes. For example, a circle of radius 1000 and a perimeter width of 100 VDC units has its perimeter between the circle of radius 1000 and a concentric circle of radius 1100 (not from 950 through 1050).

[6] *SunCGI* (unlike *SunCore*) maintains no concept of current position.

Most polygonal primitives (`polyline()`, `polymarker()`, `polygon()`, and `partial_polygon()`) take one argument of type `Ccoorlist`:

```
typedef struct {
    Cint x;
    Cint y;
} Ccoor;

typedef struct {
    Ccoor *ptlist;
    Cint n;
} Ccoorlist;
```

The element *ptlist* is really a pointer to an array of type `Ccoor`, which contains the *n* coordinates of the points defining the primitive. The style, color, and other features of lines, markers, and fill patterns used by geometrical output primitives are set by the attribute functions described in Chapter 4.

The polygons generated by *SunCGI* may or may not be closed. *SunCGI* automatically assumes the polygon is closed for the purpose of filling. However, a polygon must be explicitly closed in order to get all of its edges drawn, so take care to generate explicitly closed polygons. The `rectangle()` function implicitly generates closed objects.[7]

SunCGI has two classes of conical primitives: *circular* and *elliptical*. Each class has functions for drawing solid objects, arcs, and closed arcs. Drawing of conical primitives is regulated by the same attributes that regulate the drawing of polygons and polylines.

Polyline

```
Cerror polyline(polycoors)
Ccoorlist *polycoors; /* list of points */
```

`polyline()` draws lines between the points specified by the *ptlist* element of *polycoors*. `polyline()` does *not* draw a line between the first and last element of the point list. To generate a closed polyline, the last point on the list must have the same coordinates as the first point on the list. The style, color, and width of the lines are set by the `polyline_bundle_index()`, `line_type()`, `line_color()`, `line_width()` and `line_width_specification_mode()` functions. If a line segment of a polyline has a length of zero, the line is not drawn. To draw a point, use the `circle()` function. If you specify a polyline that has less than two points, an error is generated. Similarly, if the number of points specified is greater than the maximum number of points (MAXPTS), an error is generated.

`ENOTVSAC` [4]	CGI not in proper state: CGI shall be in state VSAC.
`ENMPTSTL` [60]	Number of points is too large.
`EPLMTWPT` [61]	Polylines must have at least two points.

[7] A closed portion of a closed figure boundary will not be drawn if it exceeds a clipping boundary.

Disjoint Polyline

```
Cerror disjoint_polyline(polycoors)
Ccoorlist *polycoors; /* list of points */
```

`disjoint_polyline()` draws lines between pairs of elements in *ptlist*. The line attributes described in Section 4.2 determine the appearance of the `disjoint_polyline()` function. If *polycoors* contains an odd number of points, the last point is ignored. As with `polyline()`, if the number of points is less than two or greater than MAXPTS, an error is generated.

`disjoint_polyline()` is typically used to implement scan-line polygon filling algorithms.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
ENMPTSTL [60]	Number of points is too large.
EPLMTWPT [61]	Polylines must have at least two points.

Polymarker

```
Cerror polymarker(polycoors)
Ccoorlist *polycoors; /* list of points */
```

`polymarker()` draws a marker at each point. The type, color, and size of marker are set by the `polymarker_bundle_index()`, `marker_type()`, `marker_color()`, `marker_size()`, and `marker_size_specification_mode()` functions. If the number of points specified is greater than the maximum number of points, an error is generated. `polymarker()` is useful for making graphs such as scatter plots.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
ENMPTSTL [60]	Number of points is too large.

Polygon

```
Cerror polygon(polycoors)
Ccoorlist *polycoors; /* list of points */
```

`polygon()` displays the polygon described by the points in *polycoors*. Any points added to the *global polygon list* by the `partial_polygon()` function are also displayed. The polygon is filled between edges. Polygons are allowed to be self-intersecting. The visibility of individual edges can only be set by the `partial_polygon()` function. The style and color used to fill the polygon are set by the solid object attribute functions described in Chapter 4. The characteristics of the edges are controlled by the perimeter attribute functions. The number of points in the polygon used to determine the error condition of too few[8] or too many points is the total number of points on the *global polygon list*, not the number of points specified in *polycoors*. After the polygon is drawn, the *global polygon list* is emptied.

[8] The CGI standard specifies that `polygon()` may be called with fewer than three points without generating an error. Zero points should be a no-op, one should be a point, and two should be a line segment. *SunCGI* does not support these degenerate polygons.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
ENMPTSTL [60]	Number of points is too large.
EPGMTHPT [62]	Polygons must have at least three points.
EGPLISFL [63]	Global polygon list is full.

Partial Polygon

```
Cerror partial_polygon(polycoors, cflag)
Ccoorlist *polycoors; /* list of points */
Ccflag cflag;         /* CLOSE previous polygon? */
```

`partial_polygon()` adds elements to the *global polygon list* without displaying the polygon. The `partial_polygon()` function provides the capability of drawing multiple-boundary polygons, including polygons with holes. The drawing is actually performed when `polygon()` is called. `polygon()` will close the last boundary on the *global polygon list* and add the coordinate list it is passed as the final polygon boundary before drawing.

cflag controls whether the last polygon in the *global polygon list* is open or closed. If *cflag* is set to CLOSE, the last polygon on the *global polygon list* will be closed by drawing a *visible* perimeter edge between the last and the first points of the last polygon on the *global polygon list.* If the *cflag* is set to OPEN, the points in *polycoors* are appended to the last polygon on the *global polygon list,* but an *invisible* perimeter edge will be drawn between the last point currently on the *global polygon list* and the first point in the `Ccoorlist`. The visibility of polygon edges can be individually controlled by calling `partial_polygon()` with *cflag* set to OPEN for each invisible edge and with *cflag* set to CLOSE for each new boundary. The interpretation of *cflag* is slightly different than the pseudocode given in the CGI standard. Future versions of CGI may use a different syntax to offer the capabilities of multiple-boundary polygons and invisible edges.

The CGI standard specifies that `circle()`, `rectangle()` and `ellipse()` are primitives that may use the *global polygon list* for filling. *SunCGI* does not use the *global polygon list* in these functions, and therefore leaves it untouched. These *SunCGI* routines *do not* empty the *global polygon list.*

An error is detected if the number of points on the *global polygon list* exceeds MAXPTS. In this case, the polygon on the *global polygon list* is drawn, and the new information is not added. The same error handling applies to `polygon()`.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
ENMPTSTL [60]	Number of points is too large.
EPGMTHPT [62]	Polygons must have at least three points.
EGPLISFL [63]	Global polygon list is full.

```
#include <cgidefs.h>

#define NPTS    4

main()
{
    Cint        name;
    Cvwsurf     device;
    Ccoor       list[NPTS];             /* list of coords. */
    Ccoorlist   points;                 /* structure for list of coords. */

    NORMAL_VWSURF(device, PIXWINDD);

    open_cgi();
    open_vws(&name, &device);

    interior_style(SOLIDI, ON);         /* solid fill with edge */
    list[0].x = list[0].y = 10000;
    list[1].x = 10000;
    list[1].y = 20000;
    list[2].x = list[2].y = 20000;
    list[3].x = 20000;
    list[3].y = 10000;
    points.ptlist = list;
    points.n = NPTS;
    partial_polygon(&points, CLOSE);    /* draw closed polygon */

    list[0].x = list[0].y = 12500;
    list[1].x = 12500;
    list[1].y = 17500;
    list[2].x = list[2].y = 17500;
    list[3].x = 17500;
    list[3].y = 12500;
    points.ptlist = list;               /*[Redundant, but good practice]*/
    points.n = NPTS;
    polygon(&points);                   /* cut a hole in it */

    sleep(10);

    close_vws(name);
    close_cgi();
}
```

Rectangle

```
Cerror rectangle(rbc, ltc)
Ccoor *rbc, *ltc; /* corners defining rectangle */
```

`rectangle()` displays a box with its lower right-hand corner at point *rbc* and its upper left-hand corner at point *ltc*. Calls to `rectangle()` do not affect the *global polygon list*. The interior of the rectangle (the filled portion) is defined by *rbc* and *ltc*. The perimeter is drawn outside of this region. The appearance of the rectangle is determined by the fill area and perimeter attributes. A rectangle with one side coincident with a clipping boundary specifies an interior extending to the boundary. Hence, a portion of the perimeter is outside the clipping boundary and is not drawn.

If the arguments to `rectangle()` would result in a point or a line, the point or line is drawn. However, if the arguments to rectangle determine a point, the point is drawn with width zero, regardless of the current value of *perimeter width*. If the values of *rbc* and *ltc* are reversed, the points are automatically reversed and the rectangle is drawn normally.

`ENOTVSAC [4]` CGI not in proper state: CGI shall be in state VSAC.

Circle

```
Cerror circle(c1, rad)
Ccoor *c1; /* center */
Cint rad;  /* radius */
```

`circle()` draws a circle of radius *rad* centered at *c1*. The argument *rad* is expressed in terms of VDC space. The color, form, and visibility of the interior and perimeter are controlled by the same solid object attributes which control the drawing of polygons and rectangles.

The argument *rad* determines the size of the *interior* of the circle. Therefore, a circle with a thick perimeter may be larger than expected. If the radius is zero, a point is drawn, and no textured perimeter is drawn, even if the perimeter width is large. If the radius is negative, the absolute value of the radius is used.

Textured circles may possibly contain an incorrect element at one point because the digital circumference may not be exactly divisible by the length of the texture element.

`ENOTVSAC [4]` CGI not in proper state: CGI shall be in state VSAC.

Circular Arc Center

```
Cerror circular_arc_center(c1, c2x, c2y, c3x, c3y, rad)
Ccoor *c1;                /* center */
Cint c2x, c2y, c3x, c3y; /* endpoints */
Cint rad;                 /* radius */
```

`circular_arc_center()` draws a circular arc between points *c2x, c2y* and *c3x, c3y* with circle of radius *rad* at center *c1*. Point *c2x, c2y* is the starting point and point *c3x, c3y* is the ending point. Circular arcs are drawn in a *counterclockwise* manner.

If *rad* is negative, the points 180 degrees opposite from *c2x, c2y* and *c3x, c3y* are used as the endpoints of the arc. If the *rad* is zero, a point is drawn at *c1*. If either *c2x, c2y* or *c3x, c3y* are not on the circumference of the circle determined by *c1* and *rad*, an error is generated, and the arc is not drawn. The attributes

which determine the style, width, and color of the arc are the same functions which regulate the drawing of *polylines*.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

EARCPNCI [64] Arc points do not lie on circle.

Circular Arc Center Close

```
Cerror circular_arc_center_close(c1, c2x,
    c2y, c3x, c3y, rad, close)
Ccoor *c1;                /* center */
Cint c2x, c2y, c3x, c3y; /* endpoints */
Cint rad;                 /* radius */
Cclosetype close;         /* PIE or CHORD */
```

`circular_arc_center_close()` draws a closed arc centered at *c1* with radius *rad* and endpoints *c2x*, *c2y* and *c3x*, *c3y*. Arcs are closed with either the PIE or CHORD algorithm. The PIE algorithm draws a line from each of the endpoints of the arc to the center point of the circle. *SunCGI* then fills this region as it would any other solid object. The CHORD algorithm draws a line connecting the endpoints of the arc and then fills this region using solid object attributes. `circular_arc_center_close()` is useful for drawing pie charts (see the following example program).

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

EARCPNCI [64] Arc points do not lie on circle.

```
#include <cgidefs.h>

/* Indices of colors to be used.  Using the defaults. */
#define RED     1
#define YELLOW  2
#define GREEN   3
#define CYAN    4

/* definitions for circle coord's and values */
#define MID     16000
#define RAD     (MID / 2)
#define MIN     (MID - RAD)
#define MAX     (MID + RAD)

main()          /* draws four quadrants in different colors and fills */
{
    Ccoor       c1;     /* coord of center           */
    Cint        name;   /* CGI name for view surface */
    Cvwsurf     device; /* view surface device struct */

    c1.x = c1.y = MID;  /* center */

    NORMAL_VWSURF( device, CGPIXWINDD);

    open_cgi();
    open_vws( &name, &device);
```

```
    perimeter_width( 1.0);              /* perimeter width 1% of VDC */

    interior_style( SOLIDI, OFF);
    fill_color( RED);                   /* color of quadrant 1  */
    circular_arc_center_close( &c1, MAX, MID, MID, MAX, RAD, PIE);

    interior_style( HOLLOW, OFF);
    fill_color( YELLOW);                /* color of quadrant 2  */
    circular_arc_center_close( &c1, MID, MAX, MIN, MID, RAD, PIE);

    interior_style( SOLIDI, ON);
    fill_color( GREEN);                 /* color of quadrant 3  */
    circular_arc_center_close( &c1, MIN, MID, MID, MIN, RAD, PIE);

    interior_style( HOLLOW, ON);
    fill_color( CYAN);                  /* color of quadrant 4  */
    circular_arc_center_close( &c1, MID, MIN, MAX, MID, RAD, PIE);

    sleep(10);
    close_vws(name);                    /* close view surface and CGI */
    close_cgi();
}
```

Circular Arc 3pt

```
Cerror circular_arc_3pt(c1, c2, c3)
Ccoor *c1, *c2, *c3; /* starting, intermediate
                        and ending points */
```

`circular_arc_3pt()` draws a circular arc starting at point *c1* and ending at point *c3* which is *guaranteed* to pass through point *c2*. The line attributes functions described in Section 4.2 determine the appearance of the `circular_arc_3pt()` function. If the circular arc is textured (for example, dotted) then the intermediate point may not be displayed. However, if the arc is solid, the intermediate point is always drawn. If the three points are colinear, a line is drawn. If two of the three points are coincident, a line is drawn between the two distinct points. Finally, if all three points are coincident, a point is drawn. `circular_arc_3pt()` is considerably slower than `circular_arc_center()`; therefore, you are advised to use `circular_arc_center()` if both functions can meet your needs.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

Circular Arc 3pt Close

```
Cerror circular_arc_3pt_close(c1, c2, c3, close)
Ccoor *c1, *c2, *c3; /* starting, intermediate
                        and ending points */
Cclosetype close;    /* PIE or CHORD */
```

`circular_arc_3pt_close()` draws a circular arc starting at point *c1* and ending at point *c3* which is guaranteed to pass through point *c2*. The solid object attributes described in Section 4.4 determine the appearance of the `circular_arc_3pt_close()` function. `circular_arc_3pt_close()` is considerably slower than

`circular_arc_center_close()`; therefore, you are advised to use `circular_arc_center_close()` if both functions meet your needs.

If the three points are colinear, a line is drawn. If two of the three points are coincident, a line is drawn between the two distinct points. Finally, if all three points are coincident, a point is drawn. In none of these cases will any region be filled.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

Ellipse

```
Cerror ellipse(c1, majx, miny)
Ccoor *c1;        /* center */
Cint majx, miny; /* length of x and y axes */
```

ellipse draws an ellipse centered at point *c1* with major (*x*) and minor (*y*) axes of length *majx* and *miny*.[9] If either *majx* or *miny* are zero, a line is drawn. If both *majx* and *miny* are zero, a point is drawn. The attributes which control the drawing of ellipses are the solid object attributes described in Section 4.4.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

Elliptical Arc

```
Cerror elliptical_arc(c1, sx, sy, ex, ey, majx, miny)
Ccoor *c1;        /* center */
Cint sx, sy;      /* starting point of arc */
Cint ex, ey;      /* ending point of arc */
Cint majx, miny; /* endpoints of major and minor axes */
```

`elliptical_arc()` draws an elliptical arc centered at *c1* with major (*x*) and minor (*y*) axes of length *majx* and *miny*. *sx*, *sy* and *ex*, *ey* are the starting and ending points of the arc. An error is generated (and the ellipse is not drawn) if the points (*sx*, *sy*, and *ex*, *ey*) are not on the perimeter of the ellipse. Elliptical arcs are drawn in a *counterclockwise* manner. Switching the values of *sx*, *sy* and *ex*, *ey* will produce complementary arcs.

If either *majx* or *miny* are zero, a line is drawn. If both *majx* and *miny* are zero, a point is drawn. Polyline attributes are used to determine the appearance of elliptical arcs.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

EARCPNEL [65] Arc points do not lie on ellipse.

Elliptical Arc Close

```
Cerror elliptical_arc_close(c1, sx, sy, ex,
    ey, majx, miny, close)
Ccoor *c1;         /* center */
Cint sx, sy;       /* starting point of arc */
Cint ex, ey;       /* ending point of arc */
Cint majx, miny;  /* endpoints of major and minor axes */
Cclosetype close; /* PIE or CHORD */
```

[9] Although the axes are called the major and minor axes by the standard they are really the *x* and *y* axes. In fact, the *x* axis can either be the major or minor axis, depending on the relative length of the *y* axis.

`elliptical_arc_close()` draws an elliptical arc specified by *sx*, *sy*, *ex*, *ey* and *majx*, *miny*. The arc is closed with either the PIE or CHORD algorithm. The same restrictions on *sx*, *sy*, *ex*, and *ey* are applied to `elliptical_arc_close()` as to `elliptical_arc()`. However, `elliptical_arc_close()` uses the fill area and perimeter attributes, whereas `elliptical_arc()` uses the line attributes.

If either *majx* or *miny* are zero, a line is drawn. If both *majx* and *miny* are zero, a point is drawn. In neither of these cases will any region be filled.

`ENOTVSAC` [4] CGI not in proper state: CGI shall be in state VSAC.

`EARCPNEL` [65] Arc points do not lie on ellipse.

3.2. Raster Primitives

Raster primitives include text, cell arrays, pixel arrays, and bitblts (bit block transfer). Bitblts are pixel arrays (bitmaps) which can be drawn using the various drawing modes. The current *drawing mode* determines how bitblt primitives are affected by information which is already on the screen. Raster primitives differ from geometrical primitives because their dimensions are not necessarily expressed in VDC space. Therefore, you must be careful to consider whether position arguments are expressed in VDC space or screen coordinates.

Text

```
Cerror text(c1, tstring)
Ccoor *c1;      /* starting point of text (in VDC space) */
Cchar *tstring; /* text */
```

`text()` displays the text contained in *tstring* at point *c1* (expressed in VDC space). The appearance of text is controlled by the text attributes described in Section 4.8. Control characters are displayed as blanks, except in the SYMBOL font where they may be drawn as pictures of bugs.

`ENOTVSAC` [4] CGI not in proper state: CGI shall be in state VSAC.

VDM Text

```
Cerror vdm_text(c1, flag, tstring)
Ccoor *c1;       /* starting point of text (in VDC space) */
Ctextfinal flag; /* final text for alignment */
Cchar *tstring;  /* text */
```

`vdm_text()` displays the text contained in *tstring* at point *c1* (expressed in VDC space). The intended difference between `text()` and `vdm_text()` is that `vdm_text()` allows control characters; however, *SunCGI* does not handle control characters so text drawn with `vdm_text()` will appear identical to text drawn with the `text()` function. If the *flag* argument is equal to FINAL, the previous text and the appended text are aligned separately. However, if the *flag* argument is equal to NOT_FINAL, the appended and previous text are aligned together.

`ENOTVSAC` [4] CGI not in proper state: CGI shall be in state VSAC.

Append Text

```
Cerror append_text(flag, tstring)
Ctextfinal flag; /* final text for alignment */
Cchar *tstring;  /* text */
```

`append_text()` displays the text contained in *tstring* after the end of the most recently written text. The type of text written depends on the same attributes which control the display of text. The *flag* argument determines whether the appended text is aligned with the previous text if the alignment is continuous. If the *flag* argument is equal to FINAL, then the previous text and the appended text are aligned separately. However, if the *flag* argument is equal to NOT_FINAL, the appended and previous text are aligned together.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

Inquire Text Extent

```
Cerror inquire_text_extent(tstring, nextchar, concat,
    lleft, uleft, uright)
Cchar *tstring; /* text */
Cchar nextchar; /* next character (for kerning) */
Ccoor *concat;  /* concatenation point */
Ccoor *lleft, *uleft, *uright;
                /* coordinates of text bounding box */
```

`inquire_text_extent()` determines how large text *tstring* would be and where it would be placed if it were drawn using the current text attributes. The *nextchar* parameter is used to determine the point where text would start if more text (starting with *nextchar*) were appended to the text specified by *tstring*.[10] If *nextchar* equals '*single space*', the last point of the current character is used. The argument *concat* returns the coordinates of the point where appended text would start. The arguments *lleft*, *uleft*, and *uright* return three of the four corners of the bounding box of text contained in *tstring*.

The bounding box is a parallelogram (a rectangle if the character up vector and the character base vector are orthogonal). The names of the parallelogram corners are correct if no rotation is applied to the text. For some character orientations, the implied relationships do not hold. For example, *lleft* may not be the lowest. The fourth corner may be easily calculated from the three returned:

```
uright->x + lleft->x - uleft->x
uright->y + lleft->y - uleft->y
```

The concatenation point and text alignment parallelogram are returned in VDC space, but assume a text position of (0, 0). If the text is to be drawn at a position (x, y) then (x, y) must be added to each point to yield the true locations.

The values of *lleft*, *uleft*, and *uright* are defined by the bounding box of the character and therefore may not be at the exact pixel where the character ends or begins.

ENOTVSAC [4] CGI not in proper state: CGI shall be in state VSAC.

[10] This is a method for accounting for proportional spacing.

Cell Array

```
Cerror cell_array(p, q, r, dx, dy, colorind)
Ccoor *p, *q, *r;
                    /* corners of parallelogram (in VDC space) *
Cint dx, dy;        /* dimensions of color array */
Cint *colorind; /* array of color values */
```

`cell_array()` draws a scaled and skewed pixel array on the view surface(s). Points *p*, *q* and *r* (expressed in VDC space) define a parallelogram. Line *p-q* is a diagonal. *p* is the corner where the first color is deposited, going in the direction of *r* and continuing filling lines until *q*. *r* is one of the remaining two corners. *dx* and *dy* define the width and the height of the array *colorind*, which is mapped onto the parallelogram defined by *p*, *q*, and *r*.

`cell_array()` is one of the few primitives which depends on the actual size of the view surface. Cell arrays are not drawn if the elements of the array would be smaller than one pixel. However, because different view surfaces may have different dimensions, a cell array might be drawn on one view surface, but not on another smaller view surface. Finally, all cells composing the cell array are the same size; therefore, the upper left hand corner of the cell array might be down and to the right of point *q* because of the accumulated error of making all of the cells slightly smaller than their floating point size. For example if each cell of a 3×3 cell array is supposed to be 3.333 pixels wide, the actual cell array will be nine pixels wide instead of ten.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
ECELLATS [66]	Distance between p and q too small for given dx, dy.
ECELLPOS [67]	Cell array dimensions must be positive.

Pixel Array

```
Cerror pixel_array(pcell, m, n, colorind)
Ccoor *pcell;   /* base of array in VDC space */
Cint m, n;      /* dimensions of color array in screen space
Cint *colorind; /* array of color values */
```

`pixel_array()` draws the array of colors *colorind* starting at point *pcell* (expressed in VDC space). *m* and *n* (expressed in screen space) define the *x* and *y* dimensions of the array. Therefore, *pixel arrays* always have a constant physical size, independent of the dimensions of VDC space. The *pixel array* is drawn *down* and to the *right* from point *pcell*. If either *m* or *n* are not positive, the absolute value of *m* and the absolute value of *n* are used. `pixel_array()` is *not* affected by the current *drawing mode*.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVALOVWS [69]	Value outside of view surface.

Bitblt Source Array

```
Cerror bitblt_source_array(pixsource, xo, yo, xe, ye,
    pixtarget, xt, yt, name)
Cpixrect *pixsource, *pixtarget;
    /* source and target pixel arrays */
Cint xo, yo;
    /* coordinates of source array (in VDC space) */
Cint xe, ye;
    /* dimensions of source array (in screen space) */
Cint xt, yt;
    /* coordinates of target pixel array (in VDC space) */
Cint name; /* view surface name */
```

`bitblt_source_array()` moves a pixel array from point (*xo, yo*) to point (*xt, yt*) using the current *drawing mode*. Both of these points are expressed in VDC space. The size of the pixel array is determined by the *xe* and *ye* arguments, which are expressed in screen space. *pixsource* and *pixtarget* are pointers to pixrects, which must already be created by `mem_create()`.[11] These pixrects must be the same depth as the view surface: 1-bit deep on a monochrome device, 8-bits on a color device.

The source area of the view surface associated with name is saved into *pixsource* (at 0,0). The target area, after *pixsource* is applied to it, is read into *pixtarget* pixrect (at 0,0).

An error is detected if either *xe* or *ye* are not positive. If the replicated pattern array overlaps with the source array on the screen, the visual result depends on the current *drawing mode*. *pixsource* and *pixtarget* may have different contents, depending on the screen drawing mode (see the `set_drawing_mode()` function).

Multiple view surfaces and bitblts are incompatible, so a *name* argument must be specified.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVALOVWS [69]	Value outside of view surface.

Bitblt Pattern Array

```
Cerror bitblt_pattern_array(pixpat, px, py, pixtarget,
    rx, ry, ox, oy, dx, dy, name)
Cpixrect *pixpat;     /* pattern source array */
Cint px, py;          /* pattern extent */
Cpixrect *pixtarget; /* destination pattern array */
Cint rx, ry;          /* pattern reference point */
Cint ox, oy;          /* destination origin */
Cint dx, dy;          /* destination extent */
Cint name;            /* view surface name */
```

`bitblt_pattern_array()` replicates the pattern (using the current *drawing mode*) stored in *pixpat* to fill the area of the view surface, which is determined by *ox, oy* and *dx, dy*. The pattern reference point determines the offset of

[11] Refer to the *Pixrect Reference Manual* for more information about pixrects.

the pattern array from the point zero. The resultant pattern array is displayed at *ox, oy*. The visual result depends on the current drawing mode.

pixpat is a pointer to a pixrect which must be created and initialized with the pattern by the application program. *pixtarget* is a pointer to a pixrect (with same depth as the device) which must already be created by the user, using `mem_create()`. The target area, after *pixpat* is applied to it, is read into the *pixtarget* pixrect (at 0,0).

Multiple view surfaces and bitblts are incompatible, so a *name* argument must be specified.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVALOVWS [69]	Value outside of view surface.
EPXNOTCR [70]	Pixrect not created.

Bitblt Patterned Source Array

```
Cerror bitblt_patterned_source_array(pixpat, px, py,
    pixsource, sx, sy, pixtarget, rx, ry, ox, oy,
    dx, dy, name)
Cpixrect *pixpat;     /* pattern source array */
Cint px, py;          /* pattern extent */
Cpixrect *pixsource;  /* source array */
Cint sx, sy;          /* source origin */
Cpixrect *pixtarget;  /* destination pattern array */
Cint rx, ry;          /* pattern reference point */
Cint ox, oy;          /* destination origin */
Cint dx, dy;          /* destination extent */
Cint name;            /* view surface name */
```

`bitblt_patterned_source_array()` replicates (using the current drawing mode) the pattern stored in *pixpat* to fill the area of the view surface determined by *ox, oy* and *dx, dy*. The source area of the view surface is read into the pixrect pointed to by *pixsource* (which must already be created by the user with same depth as the device) at 0,0. The source area is stenciled through the replicated pattern onto the view surface at *ox, oy*, using the current drawing mode. The target area, after the copy, is read into the *pixtarget* pixrect. If the replicated pattern array overlaps with the source array on the screen, the visual result depends on the current drawing mode.

Multiple view surfaces and bitblts are incompatible, so a *name* argument must be specified.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVALOVWS [69]	Value outside of view surface.
EPXNOTCR [70]	Pixrect not created.

Inquire Cell Array

```
Cerror inquire_cell_array(name, p, q, r, dx, dy, colorind)
Cint name;      /* view surface name */
Ccoor *p, *q, *r;
    /* corners of parallelogram (in VDC space) */
Cint dx, dy;    /* dimensions of color array */
Cint *colorind; /* array of color values */
```

Points *p*, *q* and *r* (in VDC space) define a parallelogram with line *p*-*q* as the diagonal, where *p* is the lower left-hand corner. *r* is one of the remaining two corners. *dx* and *dy* define the width and the height of the array *colorind* which contains the colors of the pixels on the screen which lie within the parallelogram defined by *p*, *q*, and *r*. Notice that a view surface identifier, *name*, must be specified because the result of this function is highly dependent on the dimensions and contents of the view surface.

The area of the screen corresponding to the parallelogram is assumed to contain a regular grid of points. However, if each element of the grid is larger than one pixel, the color of the pixel at the lower left-hand corner of each element of the grid is defined to be the color of the grid element. Therefore, the values contained in *colorind* are highly dependent on the size of the view surface. An error is produced if the elements of the grid are smaller than one pixel.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVSIDINV [10]	Specified view surface name is invalid.
EVSNOTOP [13]	Specified view surface not open.
EVSNTACT [15]	Specified view surface is not active.
ECELLATS [66]	Distance between p and q too small for given dx, dy.
ECELLPOS [67]	Cell array dimensions must be positive.

Inquire Pixel Array

```
Cerror inquire_pixel_array(p, m, n, colorind, name)
Ccoor *p;       /* base of array in VDC space */
Cint m, n;      /* dimensions of color array in screen space */
Cint *colorind; /* array of color values */
Cint name;      /* view surface name */
```

`inquire_pixel_array()` fills array *colorind* with the values of pixels in the area of the screen defined by point *p* (expressed in VDC space) and points *m* and *n* (expressed in screen space). The array is filled *down* and to the *right* from point *p*. If either *m* or *n* are not positive, the absolute value of these arguments is used.

Multiple view surfaces and bitblts are incompatible, so a *name* argument must be specified.

ENOTVSAC [4]	CGI not in proper state: CGI shall be in state VSAC.
EVALOVWS [69]	Value outside of view surface.
EPXNOTCR [70]	Pixrect not created.

Inquire Device Bitmap

```
Cpixrect *inquire_device_bitmap(name)
Cint name; /* name assigned to cgi view surface */
```

`inquire_device_bitmap()` returns the pixrect that corresponds to the view surface. The pixrect describes the entire device, even if the view surface is a smaller pixwin. If you want to use subareas of this pixrect or manipulate it any other way, refer to the *Pixrect Reference Manual.*

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Bitblt Alignments

```
Cerror inquire_bitblt_alignments(base, width, px, py,
    maxpx, maxpy, name)
Cint *base;           /* bitmap base alignment */
Cint *width;          /* width alignment */
Cint *px, *py;        /* pattern extent alignment */
Cint *maxpx, *maxpy; /* maximum pattern size */
Cint name;            /* name assigned to cgi view surface */
```

`inquire_bitblt_alignments()` reports the alignment criteria necessary for some implementations. These factors are not critical for *SunCGI.* However, you should keep in mind the appropriate depth for the pixrect when talking to a specific device. Therefore the arguments *base*, *width*, *px*, and *py* are always set to zero. The arguments *maxpx* and *maxpy* are device dependent and determine the maximum size of a pattern for `bitblt_pattern_array()` and `bitblt_patterned_source_array()`.

Multiple view surfaces and bitblts are incompatible, so a *name* argument must be specified.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EVSIDINV [10]	Specified view surface name is invalid.
EVSNOTOP [13]	Specified view surface not open.
EVSNTACT [15]	Specified view surface is not active.

3.3. Drawing Modes

Drawing modes determine the result of drawing any output primitive on the clear screen (background) or on top of a previously drawn object. Drawing modes only affect the drawing of *bitblt* primitives. However, a non-standard `set_global_drawing_mode()` function is provided, which affects all output primitives *except* bitblts. Resetting the drawing mode in the middle of an application program only affects those output primitives drawn after the mode is reset. The novice user is advised *not* to reset the drawing mode until the user has written at least one application program using *SunCGI.*

Set Drawing Mode

```
Cerror set_drawing_mode(visibility, source,
    destination, combination)
Cbmode visibility;        /* transparent or opaque */
Cbitmaptype source;       /* NOT source bits */
Cbitmaptype destination;  /* NOT destination bits */
Ccombtype combination;    /* combination rules */
```

`set_drawing_mode()` determines the current *drawing mode* which in turn determines how bitblt primitives are displayed. The *visibility* argument determines how pixels with index zero are treated.

```
typedef enum {
    TRANSPARENT,
    OPAQUE
} Cbmode;

typedef enum {
    BITTRUE,
    BITNOT
} Cbitmaptype;

typedef enum {
    REPLACE,
    AND,
    OR,
    NOT,
    XOR
} Ccombtype;
```

If *visibility* is set to TRANSPARENT, all source pixels with index zero leave the destination pixel unchanged, regardless of the operation, whereas if *visibility* is set to OPAQUE, all pixels are treated normally. The arguments *source* and *destination* determine whether the contents of the source and destination pixrects are NOT-ted before the *bitblt* operation is performed.

The *combination* argument determines how the source and destination pixrects are combined. If *combination* is equal to REPLACE, the source pixrect (after optionally being NOT-ted) replaces the destination pixrect. If *combination* is equal to AND, OR, or XOR, the source pixrect and the destination pixrect are combined in the indicated Boolean fashion. If *combination* is equal to NOT, then the destination is set to a bitwise NOT operation of the source pixrect.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Set Global Drawing Mode (SunCGI Extension)

```
Cerror set_global_drawing_mode(combination)
Ccombtype combination; /* combination rules */
```

`set_global_drawing_mode()` determines the current *global drawing mode* which in turn determines how *all output primitives except bitblts* are displayed. The *combination* argument determines how the source and destination pixrects are combined. If *combination* is equal to REPLACE (the default value), the output primitive replaces the destination background. If *combination*

is equal to AND, OR, or XOR, the output primitive and the information on the screen are combined in the indicated Boolean fashion. If *combination* is equal to NOT, then the destination is set to a bitwise NOT operation of the source pixrect.

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Drawing Mode

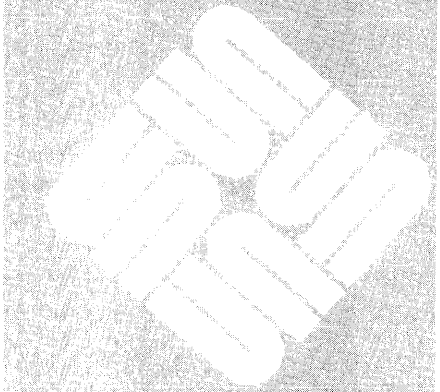
```
Cerror inquire_drawing_mode(visibility, source,
    destination, combination)
Cbmode *visibility;       /* transparent or opaque */
Cbitmaptype *source;      /* NOT source bits */
Cbitmaptype *destination; /* NOT destination bits */
Ccombtype *combination;   /* combination rules */
```

`inquire_drawing_mode()` returns the values of the four components of the current *drawing mode.*

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

4

Attributes



4

Attributes

The current attributes determine how output primitives are displayed. Attributes are *not* specific to any view surface, but affect all view surfaces. The default attributes are defined in Table 4-1.

The attributes associated with an output primitive may be set either individually or in bundles. The method for setting the current attribute depends on the state of the *aspect source flag* (ASF) of each attribute. The ASF works as follows:

- If the ASF for an attribute is INDIVIDUAL, then the value used is the current value set for that individual attribute. For example, a line is drawn in the current line color as set by the last call to the `line_color()` function.
- If the ASF is BUNDLED, then the value for that attribute is obtained from the entry in the *bundle table*, as set by the `define_bundle_index()` function. The bundle table is a collection of attributes for a particular type of primitive. A bundle table may describe the appearance of lines, markers, fill areas, edges, and text.

  Each attribute in the bundle table is pointed to by a *bundle index*. The value of a BUNDLED attribute is determined by this index and the contents of the specified bundle when the primitive is generated. The default bundle index is 1 (which initially contains the default values for the attribute). The maximum value for a bundle index is 10.

  By using a bundle table you can set multiple attributes for an output primitive with a single function call. For example, a bundle table may be defined and then referenced that will set the line type, line width, and line color for subsequent `polyline()` calls.

The majority of this chapter is devoted to individual attribute functions. Individual attribute functions are grouped according to the output primitives they effect: polylines, polymarkers, filled objects, and text. The `color_table()` function (which redefines color lookup table entries) is also included in this chapter. Finally, functions for obtaining the values of the current attributes are discussed.

Table 4-1 *Default Attributes*

Attribute	*Value*
Bundle Attributes:	
All ASFs	INDIVIDUAL
All Bundle Indices	1
Line Attributes:	
Line Color	1
Line Endstyle	BEST_FIT
Line Type	SOLID
Line Width	0.0
Line Width Specification Mode	SCALED
Marker Attributes:	
Marker Color	1
Marker Size	4.0
Marker Size Specification Mode	SCALED
Marker Type	DOT
Fill Attributes:	
Fill Color	1
Fill Hatch Index	0
Fill Pattern Index	1
Interior Style	HOLLOW
Number of Pattern Table Entries	2
Pattern Size	300,300
Pattern Reference Point	0,0
Pattern with Fill Color	OFF
Perimeter Color	1
Perimeter Type	SOLID
Perimeter Visibility	ON
Perimeter Width	0.0
Perimeter Width Specification Mode	SCALED
Text Attributes:	
Character Base.*x*	1.0
Character Base.*y*	0.0
Character Expansion Factor	1.0
Character Height	1000
Character Path	RIGHT
Character Spacing	0.1
Character Up.*x*	0.0
Character Up.*y*	1.0
Fixed Font	0
Fontset	1
Horizontal Text Alignment	NRMAL
Text Color	1
Text Continuous Alignment.*x*	1.0

Table 4-1 *Default Attributes— Continued*

Attribute	*Value*
Text Continuous Alignment.y	1.0
Text Font	STICK
Text Precision	STRING
Vertical Text Alignment	NORMAL

4.1. Bundled Attribute Functions

The attribute selector functions determine whether the current attributes are defined individually or by using a bundle table. The CGI standard specifies the bundle table as read-only but *SunCGI* allows user-definition of entries in the bundle table.

The following example program illustrates how to change the appearance of primitives with bundled attributes. The program draws a polyline using different line style and line width attributes. The bundled define also shows possible non-default attributes for other output primitives.

```
#include <cgidefs.h>

#define BOXPTS          5
#define NUMATTRS        18
#define BUNDLE_INDEX    2

Ccoor box[BOXPTS] = {   10000,10000 ,
                        10000,20000 ,
                        20000,20000 ,
                        20000,10000 ,
                        10000,10000 };

Cbunatt bundle = {      DASHED_DOTTED, 1., 4, X, 6., 4,
                        PATTERN, 1, 1, 2, DOTTED, 1.5, 1,
                        STICK, CHARACTER, 1.3, 0.05, 1 };

main()
{
    Cint        i,                      /* counter variable     */
                name;
    Cvwsurf     device;
    Ccoorlist   boxlist;                /* structure of coords. */
    Cflaglist   flags;                  /* structure of ASF's   */

    boxlist.n = BOXPTS;
    boxlist.ptlist = box;

    NORMAL_VWSURF(device, PIXWINDD);

    open_cgi();
    open_vws(&name, &device);

    /* allocate room for array of ASF's (one for each attribute)        */
```

```
    flags.value = (Casptype *) malloc( NUMATTRS*sizeof(Casptype) );
    flags.num = (Cint *) malloc( NUMATTRS*sizeof(Cint) );

    /* set all the ASF's to "BUNDLED", and set the appropriate flag #'s */
    for (i = 0; i < NUMATTRS; i++) {
        flags.value[i] = BUNDLED;
        flags.num[i] = i;
    }
    flags.n = NUMATTRS;

    /* define our bundle which contains a setting for every attribute   */
    define_bundle_index( BUNDLE_INDEX, &bundle);
    set_aspect_source_flags( &flags);
    polyline_bundle_index( BUNDLE_INDEX); /* select our polyline bundle */

    polyline( &boxlist);
    sleep(10);

    close_vws(name);                    /* close view surface and CGI   */
    close_cgi();
}
```

Set Aspect Source Flags

```
Cerror set_aspect_source_flags(flags)
Cflaglist *flags; /* list of ASFs */
```

`set_aspect_source_flags()` determines whether individual attributes are set individually or from bundle table entries.

```
typedef struct {
    Cint n;
    Cint num[];
    Casptype value[];
} Cflaglist;
```

The *n* element of the *flags* argument determines how many flags are to be set. The *num* array of the *flags* argument determines which flags are to be set. Flag numbers are provided in Table 4-2. Finally, the *value* array of the *flags* argument determines the values of the flags specified in *num*. If a value is assigned to INDIVIDUAL, the individual attribute functions affect the current attribute. If the value of index is BUNDLED, calls to individual attribute functions have *no effect.*[12] The default value of all *aspect source flags* is INDIVIDUAL.

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

[12] In fact, *SunCGI* currently produces error 30 when these individual attribute function is called while the corresponding ASF is BUNDLED.

Table 4-2 *Attribute Source Flag Numbers*

Flag	*Attribute*	*Flag*	*Attribute*
0	line type	9	fill color
1	line width	10	perimeter type
2	line color	11	perimeter width
3	marker type	12	perimeter color
4	marker width	13	text font index
5	marker color	14	text precision
6	interior style	15	character expansion factor
7	hatch index	16	character spacing
8	pattern index	17	text color

Define Bundle Index (SunCGI Extension)

```
Cerror define_bundle_index(index, entry)
Cint index;     /* entry in attribute bundle table */
Cbunatt *entry; /* new attribute values */
```

`define_bundle_index()` defines an entry in the *bundle table*. The type `Cbunatt` is a structure that contains elements corresponding to all the attributes. *index* is an entry into a list of available attribute bundles. The default *bundle index* is set to 1 (which initially contains the default value for the attributes specified in Table 4-1). The maximum value for a bundle table index is 10, and the minimum value is 1. If the contents of a *bundle table* entry are changed, all subsequently drawn primitives use the information in the new entry, depending on the relevant aspect source flags. You should keep this fact in mind if you are designing display list traversal algorithms using *SunCGI*.

```
typedef struct {
    Clintype line_type;
    Cfloat line_width;
    Cint line_color;
    Cmartype marker_type;
    Cfloat marker_size;
    Cint marker_color;
    Cintertype interior_style;
    Cint hatch_index;
    Cint pattern_index;
    Cint fill_color;
    Clintype perimeter_type;
    Cfloat perimeter_width;
    Cint perimeter_color;
    Cint text_font;
    Cprectype text_precision;
    Cfloat character_expansion;
    Cfloat character_spacing;
    Cint text_color;
} Cbunatt;
```

In addition to the errors listed below, other errors can be detected if any of the attribute values are invalid, as specified in later sections. Results are undefined if an error occurs.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBBDTBDI [31]	Bundle table index out of range.

4.2. Line Attributes

SunCGI provides for specifying the style, width and color of lines which constitute polylines, circular arcs, and elliptical arcs. The functions do *not* affect the drawing of the perimeter of solid objects, which are set by the perimeter functions.

Polyline Bundle Index

```
Cerror polyline_bundle_index(index)
Cint index; /* polyline bundle index */
```

`polyline_bundle_index()` sets the current polyline bundle index to the value of *index*. The contents of the *polyline bundle index* are *line type*, *line width* and *line color*. The *line width specification mode* and the *line endstyle* attributes are not included in the polyline bundle. If *index* is not defined, an error is generated, and the *polyline bundle index* does not change. If the ASFs for any of these attributes is set to BUNDLED, the current values of these attributes are set to the contents of the bundle.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADLINX [33]	Polyline index is invalid.

Line Type

```
Cerror line_type(type)
Clintype type; /* style of line */
```

`line_type()` defines the line type for polylines. The enumerated type `Clintype` contains values that correspond to valid line types.

```
typedef enum {
    SOLID,
    DOTTED,
    DASHED,
    DASHED_DOTTED,
    DASH_DOT_DOTTED,
    LONG_DASHED
} Clintype;
```

The default line style is SOLID. The actual representation of a line on the screen is affected by the *line endstyle*. DASH_DOT_DOTTED actually has three dots between dashes.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.

Line Endstyle (SunCGI Extension)

```
Cerror line_endstyle(type)
Cendstyle type; /* style of line */
```

`line_endstyle()` determines how a textured (non-SOLID) line terminates. The enumerated type `Cendstyle` contains values that correspond to valid line end styles.

```
typedef enum {
    NATURAL,
    POINT,
    BEST_FIT
} Cendstyle;
```

If the endstyle selected is NATURAL, the last component of the line texture (for example, a dash or a dot) which can be completely drawn is drawn. A blank space at the end of the line may cause the line to not appear as long as specified by the starting and ending coordinates. If the endstyle selected is POINT, the last point of the line is drawn whether it is appropriate or not. In this case, the end-points of the line always appear on the screen. If the endstyle selected is BEST_FIT, the last point is always drawn but is extended as far back as the last space if appropriate. However, the BEST_FIT endstyle may shorten the space between the last element of the line and the element preceding the last element by one in order to guarantee that the line ends on a drawn point. The default endstyle is BEST_FIT.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Line Width Specification Mode

```
Cerror line_width_specification_mode(mode)
Cspecmode mode; /* pixels or percent */
```

`line_width_specification_mode()` allows the *line width* to be specified in pixels or as a percentage of VDC space according to the value of mode. The enumerated type `Cspecmode` contains values that correspond to line width specification modes.

```
typedef enum {
    ABSOLUTE,
    SCALED
} Cspecmode;
```

If the *line width specification mode* is changed from ABSOLUTE to SCALED, the change in the line width will probably be dramatic. The default *line width specification mode* is SCALED.

If multiple view surfaces are active, the line width is scaled separately for each view surface.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Line Width

```
Cerror line_width(index)
Cfloat index; /* line width */
```

`line_width()` determines the width of the lines composing polylines, circular arcs, and so on. If the *line width specification mode* is SCALED, *index* is expressed in percent of VDC space, and if the *x* and *y* dimensions are different, the width is calculated on the basis of the range of the *x* coordinate of VDC space. If the parameter setting would result in a line less than one pixel wide, the line width is displayed as one pixel wide. The default *line width* is 0.0 (SCALED).

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
EBDWIDTH [34]	Width must be nonnegative.

Line Color

```
Cerror line_color(index)
Cint index; /* line color */
```

`line_color()` determines the color of the lines. *index* selects an entry in the color lookup table. The default value of *index* is 1. An error is detected if *index* is not between 0 and 255.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ECINDXLZ [35]	Color index is less than zero.
EBADCOLX [36]	Color index is invalid.

4.3. Polymarker Attributes

The type, size and color of markers (the components of polymarkers) are controlled by the following functions.

Polymarker Bundle Index

```
Cerror polymarker_bundle_index(index)
Cint index; /* polymarker bundle index */
```

`polymarker_bundle_index()` sets the current polymarker bundle index to the value of *index*. The contents of a *polymarker bundle* are *marker type*, *marker size* and *marker color*. The *marker size specification mode* function is not included in the polymarker bundle. If *index* is not defined, an error is generated, and the *polymarker bundle index* does not change. If the ASFs for any of these attributes is set to BUNDLED, the current values of these attributes are set to the values of the corresponding attribute in the bundle.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADMRKX [37]	Polymarker index is invalid.

Marker Type

```
Cerror marker_type(type)
Cmartype type; /* style of marker */
```

`marker_type()` sets the marker type. The enumerated type `Cmartype` contains values that correspond to valid marker types.

```
typedef enum {
    DOT,
    PLUS,
    ASTERISK,
    CIRCLE,
    X
} Cmartype;
```

Note that all marker types appear as a point when the marker size is very small. The default *marker type* is DOT.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

`EBTBUNDL` [30] ASF is BUNDLED.

Marker Size Specification Mode

```
Cerror marker_size_specification_mode(mode)
Cspecmode mode; /* pixels or percent */
```

`marker_size_specification_mode()` allows the *marker size* to be specified in pixels or as a percentage of VDC space according to the value of *mode*. The enumerated type `Cspecmode` contains values that correspond to valid marker size specifications.

```
typedef enum {
    ABSOLUTE,
    SCALED
} Cspecmode;
```

The default *marker size specification mode* is SCALED.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Marker Size

```
Cerror marker_size(index)
Cfloat index; /* marker size */
```

`marker_size()` sets the size of the *marker height* and *marker width*. *index* is expressed in percent of VDC space. The default marker size is 4.0 percent of VDC space. If the marker size becomes very small, markers of all types are displayed as points. An error is detected if *index* is negative.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

`EBADSIZE` [38] Size must be nonnegative.

Marker Color

```
Cerror marker_color(index)
Cint index; /* marker color */
```

`marker_color()` determines the color of the markers. *index* selects an entry in the color lookup table. An error is detected if *index* is not between 0 and 255. The default *marker color* is 1.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ECINDXLZ [35]	Color index is less than zero.
EBADCOLX [36]	Color index is invalid.

4.4. Solid Object Attributes

The solid object attribute functions describe how all solid object primitives are filled (colored-in). There are three sets of solid object attribute functions:

fill area attributes
determine the general method for filling solid geometrical objects.

hatch and pattern attributes
determine a pixel array for filling a polygon if the *fill style* is set to PATTERN.

perimeter attributes
determine how the boundary of a geometrical object is displayed if the *perimeter visibility* is ON.

Fill Area Bundle Index

```
Cerror fill_area_bundle_index(index)
Cint index; /* fill area bundle index */
```

`fill_area_bundle_index()` sets the current *fill area bundle index* to the value of *index*. The contents of the *fill area bundle* are *interior style*, *fill color*, *hatch index*, *pattern index*, *perimeter type*, *perimeter width*, and *perimeter color*. The *perimeter width specification mode* and the pattern attributes are not included in the definition of the fill area bundle. If *index* is not defined, an error is generated, and the fill area bundle index does not change. If the ASFs for any of these attributes is set to BUNDLED, the current value of the attribute is set to the value of the corresponding attribute in the bundle.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADFABX [39]	Fill area index is invalid.

Interior Style

```
Cerror interior_style(istyle, perimvis)
Cintertype istyle; /* fill style */
Cflag perimvis;    /* perimeter visibility */
```

`interior_style()` sets the *fill style* for solid objects. The enumerated type `Cintertype` contains values that correspond to valid line types.

```
typedef enum {
    HOLLOW,
    SOLIDI,
    PATTERN,
    HATCH
} Cintertype;
```

If the *fill style* is set to SOLIDI, the solid object is filled with the current *fill color*. If *istyle* is set to PATTERN or HATCH, the solid object is filled with the current PATTERN or HATCH style. The PATTERN and HATCH styles are explained in the pattern attributes section. The default *fill style* is HOLLOW.

`interior_style()` also determines whether the perimeter of the solid object is visible according to the value of *perimvis* (which must be ON or OFF). If *perimvis* is OFF, the perimeter attributes have no effect. The default value of *perimeter visibility* is ON.

Be careful when using the *interior style* function to explicitly specify the *perimvis* argument. If you do not specify it, or set it to OFF, the geometrical output primitive may not be displayed because the *interior style* is HOLLOW.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

4.5. Solid Interior Fill Attribute

The following section contains the description of a function that determines the color of an interior region if the *fill style* is not HOLLOW.

Fill Color

```
Cerror fill_color(color)
Cint color; /* color for solid object fill */
```

`fill_color()` determines the color for filling solid objects, if the *fill style* is not set to HOLLOW.

The default *fill style* is HOLLOW, so changing the *fill color* will not have an effect without changing the *interior style* first. The default *fill color* is 1. An error is detected if *fill color* is not between 0 and 255.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`ECINDXLZ` [35]	Color index is less than zero.
`EBADCOLX` [36]	Color index is invalid.

4.6. Hatch and Pattern Attributes

Geometrical primitives can be filled with 2D arrays of color values called patterns. *SunCGI* supports pre-defined as well as user-defined patterns. Pattern 0 is initially defined to be a 3×3 matrix which is set to zero at the corners and one elsewhere. Pattern 0 produces simple cross-hatching. Pattern 1 (which produces a polka-dot pattern) is initially defined to be a 3×3 matrix which is set to 1 at the center and 0 elsewhere.

The definition of patterns is stored in the *pattern table*. Each entry in the pattern table consists of a 2D array of color values and the *x* and *y* dimensions of the array. The starting position (upper left-hand corner) of the pattern is determined by the *pattern reference point*.

Two types of patterns are available: PATTERNs and HATCHes; PATTERNs can be scaled and translated. HATCHes can't and simply fill the geometrical output primitives with pixel arrays.

The following example program illustrates how to change the appearance with the individual attribute functions. The program draws a polygon and fills it with a pattern.

```
#include <cgidefs.h>

#define BOXPTS          5
#define PAT_ROWS        4
#define PAT_COLS        4
#define PAT_SIZE        (PAT_ROWS * PAT_COLS)
#define PAT_INDEX       2

#define PAT_DX          250
#define PAT_DY          250

Ccoor box[BOXPTS] = {   10000,10000 ,
                        10000,20000 ,
                        20000,20000 ,
                        20000,10000 ,
                        10000,10000 };

/*Cint pattern[PAT_SIZE] = {  50,  75, 100, 125,
                            150,   0,   0, 175,
                            200,   0,   0, 225,
                            250, 275, 300, 325 };*/
Cint pattern[PAT_SIZE] = { 6, 1, 1, 2,
                           7, 0, 0, 3,
                           7, 0, 0, 3,
                           6, 5, 5, 4 };

main()
{
    Cint        name;
    Cvwsurf     device;
    Ccoorlist   boxlist;

    boxlist.n = BOXPTS;
    boxlist.ptlist = box;
    NORMAL_VWSURF( device, PIXWINDD);

    open_cgi();
    open_vws( &name, &device);
```

```
    interior_style( PATTERN, ON);
    pattern_table( PAT_INDEX, PAT_ROWS, PAT_COLS, pattern);
    pattern_index( PAT_INDEX);
    pattern_size( PAT_DX, PAT_DY);
    polygon( &boxlist);

    sleep(10);

    close_vws( name);
    close_cgi();
}
```

Hatch Index

```
Cerror hatch_index(index)
Cint index; /* HATCH index in the pattern table */
```

`hatch_index()` determines which entry in the pattern table is used to fill solid objects when the *fill style* is set to HATCH. The default *hatch index* is 0. An error is generated if *index* points to an undefined entry in the pattern table.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ESTYLLEZ [42]	Style (pattern or hatch) index is less than zero.
ENOPATNX [43]	Pattern table index not defined.

Pattern Index

```
Cerror pattern_index(index)
Cint index; /* PATTERN index in the pattern table */
```

`pattern_index()` determines which index in the pattern table is used to fill solid objects when the *fill style* is set to PATTERN. The default *pattern index* is 1. An error is generated if *index* points to an undefined entry in the pattern table.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ESTYLLEZ [42]	Style (pattern or hatch) index is less than zero.
ENOPATNX [43]	Pattern table index not defined.

Pattern Table

```
Cerror pattern_table(index, m, n, colorind)
Cint index;     /* entry in table */
Cint m, n;      /* number of rows and columns */
Cint *colorind; /* array containing pattern */
```

`pattern_table()` defines an entry in the pattern table. *index* defines the entry in the table (which must be less than 50). An error is generated if *index* is outside the bounds of the pattern table. *m* and *n* define the height and width of the pattern (in pixels). The array pointed to by the argument *colorind* contains the actual pattern row-wise from the upper left. For monochrome view surfaces,

all nonzero entries in *colorind* are treated as 1. The maximum number of elements in a pattern ($m \times n$) is MAXPATSIZE.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EPATARTL [40]	Pattern array too large.
EPATSZTS [41]	Pattern size too small.
ESTYLLEZ [42]	Style (pattern or hatch) index is less than zero.
EPATITOL [44]	Pattern table index too large.

Pattern Reference Point

```
Cerror pattern_reference_point(begin)
Ccoor *begin;
```

`pattern_reference_point()` defines the point in VDC space where the *pattern box* begins. The pattern is then replicated over all VDC space. The upper left-hand corner of the *pattern box* is determined by *begin*. The default *pattern reference point* is (0, 0). `pattern_reference_point()` has no effect if the *interior style* is not set to PATTERN.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Pattern Size

```
Cerror pattern_size(dx, dy)
Cint dx, dy; /* size of pattern in VDC space */
```

`pattern_size()` defines the size of the pattern array in VDC coordinates. *dx* and *dy* determine the size of an element of the pattern in VDC space. `pattern_size()` therefore allows you to 'stretch' the pattern to a certain size. If *dx* or *dy* would result in pattern elements less than one pixel wide, 1 is used. If the *pattern size* is larger than the bounds of screen space, the effective *pattern size* is the size of VDC space. The default *pattern size* is (300, 300).

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Pattern with Fill Color (SunCGI Extension)

```
Cerror pattern_with_fill_color(flag)
Cflag flag; /* ON to use nonzero pattern
               elements as fill color */
```

Binary patterns allow the same pattern to be applied in different colors, without redefining the pattern array. `pattern_with_fill_color()` sets a non-standard CGI state *pattern with fill color*. The default *pattern with fill color* is OFF, and each color value in a pattern table entry is used verbatim, as in standard CGI. When a pattern is used while *pattern with fill color* is ON, the pattern is considered to be a 2D array of flags; when the pattern element is nonzero, the current fill color is used, instead of the actual value of the pattern element. (When the pattern element is zero, a zero color index is used, just as when the flag is OFF.)

4.7. Perimeter Attributes

The following sections contain descriptions of functions that determine the perimeter attributes *perimeter type*, *perimeter width*, *perimeter width specification mode*, and *perimeter color*.

Perimeter Type

```
Cerror perimeter_type(type)
Clintype type; /* style of perimeter */
```

`perimeter_type()` defines the perimeter type for solid objects. The enumerated type `Clintype` contains values that correspond to valid perimeter types.

```
typedef enum {
    SOLID,
    DOTTED,
    DASHED,
    DASHED_DOTTED,
    DASH_DOT_DOTTED,
    LONG_DASHED
} Clintype;
```

The default perimeter style is SOLID. Notice that there is no ending style for perimeter. The endstyle is controlled by the `line_endstyle()` function.

As mentioned previously, control of the drawing of the borders of solid objects is under the control of the perimeter attribute functions, not the line attribute functions. However, the two sets of functions take the same values. The perimeter attributes are essentially the same as the line attributes except that they affect the borders of solid attributes. The appearance of a perimeter can be similar to a line especially if *interior style* is set to HOLLOW. Perimeter attribute functions have no effect if the *perimeter visibility* is set to OFF.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.

Perimeter Width

```
Cerror perimeter_width(width)
Cfloat width; /* perimeter width */
```

`perimeter_width()` determines the width of the perimeters of solid objects. *index* can be expressed in percent of VDC space or pixels. If the *perimeter width specification mode* is set to SCALED and the *x* and *y* dimensions are different, the *perimeter width* is calculated on the basis of the range of the *x* coordinate of VDC space. If the parameter setting would result in a perimeter less than one pixel wide, the perimeter width is displayed as one pixel wide. The default *perimeter width* is 0.0 (SCALED).

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
EBDWIDTH [34]	Width must be nonnegative.

Perimeter Width Specification Mode

```
Cerror perimeter_width_specification_mode(mode)
Cspecmode mode; /* pixels or percent */
```

`perimeter_width_specification_mode()` allows the `perimeter_width()` to be specified in pixels or as a percentage of VDC space according to the value of mode (which can either be ABSOLUTE or SCALED). If the *perimeter width specification mode* is changed from ABSOLUTE to SCALED, the change in the line width will probably be dramatic. The default *perimeter width specification mode* is SCALED.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Perimeter Color

```
Cerror perimeter_color(index)
Cint index; /* perimeter color */
```

`perimeter_color()` determines the color of the perimeters. *index* selects an entry in the color lookup table. The default value of *index* is 1. An error is detected if *index* is not between 0 and 255.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ECINDXLZ [35]	Color index is less than zero.
EBADCOLX [36]	Color index is invalid.

4.8. Text Attributes

SunCGI provides a variety of functions for determining how text is written to the screen. The most important text attribute is *text precision.* If *text precision* is set to STRING, firmware characters are used. The fonts, size, spacing, and alignment of firmware are more limited than characters drawn with *text precision* set to a value other than STRING. Therefore, calls to text attribute functions regulating these aspects of text drawing have no effect when *text precision* is set to STRING.

Text Bundle Index

```
Cerror text_bundle_index(index)
Cint index; /* text bundle index */
```

`text_bundle_index()` sets the current *text bundle index* to the value of *index.* The contents of the *text bundle index* are *text font, text precision, character expansion factor, character spacing,* and *text color.* The *character height, character orientation, character path, text alignment,* and *fixed font* are *not* included in the definition of the text bundle. If *index* is not defined, an error is generated, and the *text bundle index* does not change. If the ASFs for any of these attributes are set to BUNDLED, the current values of these attributes are set to the contents of the bundle.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBADTXTX [45]	Text index is invalid.

Text Precision

```
Cerror text_precision(type)
Cprectype type; /* text type */
```

`text_precision()` controls the precision with which text is displayed. The enumerated type `Cprectype` contains values that correspond to valid text precisions.

```
typedef enum {
    STRING,
    CHARACTER,
    STROKE
} Cprectype;
```

If the *text precision* is set to STRING, the firmware character set is used. Firmware characters cannot be scaled or rotated.

Characters are clipped, but not in parts (that is, if any portion of the character exceeds the clipping boundary the whole character is clipped). If the *text precision* is set to CHARACTER, software generated characters are employed, and characters are clipped, but not in parts. All text attributes have a visible effect on software generated characters. If the *text precision* is set to STROKE, the CHARACTER precision capabilities are enabled, and characters are clipped in parts. The default *text precision* is STRING.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.

Character Set Index

```
Cerror character_set_index(index)
Cint index; /* font set */
```

`character_set_index()` selects a set of fonts. Although *SunCGI* supports this function, only set number 1 is defined. Calls to `character_set_index()` with *index* assigned to a value other than 1 are ignored.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Text Font Index

```
Cerror text_font_index(index)
Cint index; /* font */
```

`text_font_index()` determines the current font. A list of available fonts and their availability when *text precision* is set to STRING is given in Table 4-3. A warning about the SYMBOL font: undefined characters are displayed as bugs (the six-legged kind). The default font is STICK.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ETXTFLIN [47]	Text font is invalid.

Table 4-3 *Available Fonts*

Font	*String Precision*	*Font Number*
ROMAN	Yes	0
GREEK	Yes†	1
SCRIPT	Yes	2
OLDENGLISH	No	3
STICK	Yes	4
SYMBOLS	No	5

† displayed as STICK font.

Character Expansion Factor

```
Cerror character_expansion_factor(efac)
Cfloat efac; /* width factor */
```

`character_expansion_factor()` determines the width-to-height ratio of characters. If *efac* is greater than 1 the characters appear fatter. If *efac* is less than 1 the characters appear slimmer. The default *character expansion factor* is 1.0. An error is generated if *efac* is less than 0.01 or greater than 10.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

`EBTBUNDL` [30] ASF is BUNDLED.

`ECEXFOOR` [48] Expansion factor is out of range.

Character Spacing

```
Cerror character_spacing(spcratio)
Cfloat spcratio; /* spacing ratio */
```

`character_spacing()` sets the spacing between characters based on the height of the characters. The amount of space between characters is obtained by multiplying the character height by *spcratio*. The default *character spacing factor* is 0.1. An error is generated if *spcratio* is less than -10 or greater than 10.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

`EBTBUNDL` [30] ASF is BUNDLED.

`ECEXFOOR` [48] Expansion factor is out of range.

Character Height

```
Cerror character_height(height)
Cint height; /* height in VDC */
```

The `character_height()` function determines the height of text in VDC units. The height is defined as the distance from the top to the bottom of the character. Notice that changing the character height implicitly changes the *character spacing*.

The default character height is 1000. This may result in huge characters if VDC space is reset from its default range (0-32767).

If the *x* and *y* dimensions of VDC space are different, the height is calculated on the basis of the range of the *x* coordinate of VDC space.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ECHHTLEZ [49]	Character height is less than or equal to zero.

Fixed Font (SunCGI Extension)

```
Cerror fixed_font(flag)
Cint flag; /* fixed or variable width characters */
```

`fixed_font()` allows characters to be of fixed or variable size. If *flag* is nonzero, the characters are of uniform size, otherwise the characters are packed proportional to their actual sizes. If the *character precision* is STRING, this function has no effect. By default *SunCGI* supports variable width characters.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Text Color

```
Cerror text_color(index)
Cint index; /* color */
```

`text_color()` determines the color of the text. *index* selects an entry in the color lookup table. The default value of *index* is 1. An error is detected if *index* is not between 0 and 255.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EBTBUNDL [30]	ASF is BUNDLED.
ECINDXLZ [35]	Color index is less than zero.
EBADCOLX [36]	Color index is invalid.

Character Orientation

```
Cerror character_orientation(xbase, ybase, xup, yup)
Cfloat xbase, ybase, xup, yup;
    /* character base and up vectors */
```

`character_orientation()` specifies the skew and direction of text. The left side of the character box lies on an invisible line called the *character up vector*, whose slope is determined by *xup* and *yup*. The bottom of the character box lies on an invisible line called the *character base vector*, whose slope is determined by *xbase* and *ybase*.

If the *character up vector* and the *character base vector* are not orthogonal, the text is distorted. Calls to `character_orientation()` have no effect if *text precision* is set to STRING. The default values for the *character base vector* and the *character up vector* are *xbase* = 1.0, *ybase* = 0.0, *xup* = 0.0, and *yup* = 1.0.

The *character base vector* and the *character up vector* influence the *character path* and the *text alignment*. For example, if *xbase* = -1.0 and the *character path* is RIGHT, the text is written to the *left*.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
ECHRUPVZ [50]	Length of character up vector or character base vector is zero.

Character Path

```
Cerror character_path(path)
Cpathtype path; /* text direction */
```

`character_path()` specifies the direction in which text is written. The enumerated type `Cpathtype` contains values that correspond to valid character paths.

```
typedef enum {
    RIGHT,
    LEFT,
    UP,
    DOWN
} Cpathtype;
```

The actual effect of `character_path()` depends on the *character up vector* and the *character base vector*. RIGHT specifies that the text is written in the direction of the *character base vector*. For example, if the direction of the *character base vector* points left instead of right (*xup* = -1.0 instead of 1.0), the text will be written right-to-left instead of left-to-right, which is the usual interpretation of RIGHT. LEFT specifies that the text is written in the opposite direction of the *character base vector*. The *character up vector* and *character base vector* essentially change functions when the character direction is set to UP or DOWN. UP specifies that the text is written in the direction of the *character up vector*. DOWN specifies that the text is written in the opposite direction of the *character up vector*. The default *character path* is RIGHT.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Text Alignment

```
Cerror text_alignment(halign, valign, hcalind, vcalind)
Chaligntype halign; /* horizontal alignment type */
Cvaligntype valign; /* vertical alignment type */
Cfloat hcalind, vcalind;
                    /* continuous alignment indicators */
```

`text_alignment()` determines where the text is positioned relative to the starting point specified by the *c1* argument of the `text()` or `vdm_text()` function. *halign* determines where the character is placed in relation to the *x* component of the starting coordinate of the text position (specified by the *c1* argument of *text*). The enumerated type `Chaligntype` contains values that correspond to valid horizontal alignments.

```
typedef enum {
    LFT,
    CNTER,
    RGHT,
    NRMAL,
    CNT
} Chaligntype;
```

If the value of *halign* is LFT, the horizontal position of the text will begin at the left edge of the box enclosing the text. Similarly, if the value of *halign* is RGHT, the horizontal position of the text will begin at the right edge of the box enclosing the text. If the value of *halign* is CNTER the horizontal position of the text will begin equidistant from the right and the left edges of the text box. NRMAL assigns the alignment based on the value of the *character path* (see Table 4-4). If the value of *halign* is CNT (continuous) the horizontal position of the text is determined by the argument *hcalind.* In this case, the text will begin *hcalind* fraction of the width of the text box from the left edge of the character box. The default value of *halign* is NRMAL.

valign specifies where the character is placed in relation to the *y* component of the text position. The enumerated type `Cvaligntype` contains values that correspond to valid vertical alignments.

```
typedef enum {
    TOP,
    CAP,
    HALF,
    BASE,
    BOTTOM,
    NORMAL,
    CONT
} Cvaligntype;
```

If the value of *valign* is TOP, the vertical position of the text will begin at the top edge of the character box. If the value of *valign* is CAP, the vertical position of the text will begin at the *cap line* of the character.[13] Similarly, if the value of *valign* is BOTTOM, the vertical position of the text will begin at the bottom edge of the character box. If the value of *valign* is BASE, the vertical position of the text will begin at the *baseline* of the character.[14] If the value of *valign* is HALF the vertical position of the text will begin equidistant from the top and the bottom edges of the character box. NORMAL assigns the alignment based on the value of the *character path* (see Table 4-4). If the value of *valign* is assigned to CONT (continuous), the vertical position of the text is determined by the argument *vcalind* and will begin *vcalind* fraction of the height of the character box from the bottom edge of the character box. The default value of *valign* is NORMAL.

---

[13] The *cap line* is defined as the invisible line corresponding to the top of the average character within a font.

[14] The *baseline* is defined as the invisible line corresponding to the bottom of the average character within a font. The *baseline* does not necessarily correspond to the bottom of a character. For example, a the tail of a lower-case g extends below the baseline.

Table 4-4 *Normal Alignment Values*

Character Path	*Horizontal Normal*	*Vertical Normal*
RIGHT	LEFT	BASELINE
LEFT	RIGHT	BASELINE
UP	CENTER	BASELINE
DOWN	CENTER	TOP

ENOTOPOP [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

4.9. Color Attributes

SunCGI supports only one color specification mode — INDEXED. This color specification mode means that the red, green, and blue values (hereafter referred to as RGB values) are obtained from a table known as the *color lookup table.* The initial values of the *color lookup table* are provided in Table 4-5.

Table 4-5 *Default Color Lookup Table*

Index	*Color*	*RGB Intensities*
0	black	0, 0, 0
1	red	255, 0, 0
2	yellow	128, 128, 0
3	green	0, 255, 0
4	cyan	0, 128, 128
5	blue	0, 0, 255
6	magenta	128, 0, 128
7	white	255, 255, 255

Color Lookup Table

```
Cerror color_table(istart, clist)
Cint istart;    /* starting address */
Ccentry *clist; /* color triples and number of entries */
```

`color_table()` defines RGB entries into the *color lookup table* used by CGI. The color lookup table is initialized based on the depth of the display frame buffer, the *cmapsize* field provided in the `Cvwsurf` structure provided to `open_vws()`, and the colormap defined by the RGB arrays. Before you can modify the color lookup table, both the *cmapsize* and *cmapname* fields provided in the `Cvwsurf` structure must be initialized

A monochrome device has an unwritable colormap; non-zero color indices are displayed as black, zero is displayed as white. A color device gets a colormap segment with 8 entries if the *cmapsize* field is zero upon opening the view surface. Larger colormaps are also initialized to a power of 2, even if you are not going to initialize all entries in the colormap.

The structure `Ccentry` contains elements that describe a colormap entry.

```
typedef struct {
    unsigned char *ra;
    unsigned char *ga;
    unsigned char *ba;
    Cint n;
} Ccentry;
```

The minimum and maximum color lookup table entries are treated specially by *SunView* and hence by *SunCGI*. If they are set to be the same value, the user's values for these two entries are *both* ignored. They revert to the inverse of the normal values; entry 0 becomes white, the maximum entry becomes black.

The argument *istart* determines the first entry in the color lookup table to be modified. The argument *clist* contains the color information for entry *istart* in terms of triples of values of numbers ranging between 0 and 255. The last field of *clist* reports how many entries are to be modified. An error is generated if either the indices to the *color lookup table* are out of range.

The following steps describe how to set up a color lookup table in *SunCGI*.

1. Set up the RGB arrays of colors. The number of elements in each array must be a power of 2. Each array must have intensities that range from 0 to 255; 255 represents a strong intensity of that color, and 0 is no intensity.

   A color is defined by the RGB array elements for that index of the color. For example, color element 3 is the color defined by red(3), green(3), and blue(3).

2. Set the RGB arrays into the `Ccentry` structure.

3. Call the `color_table()` function to set the colors in the color lookup table.

To later change the color lookup table, update the RGB arrays and call `color_table()`. See Appendix E for an example program.

To set or change a color lookup table in CGIPW, use the `pw_putcolormap()` function. This function is described in detail in the *SunView 1 Programmer's Guide*.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
`ECINDXLZ` [35]	Color index is less than zero.
`EBADCOLX` [36]	Color index is invalid.

4.10. Inquiry Functions

The attribute inquiry functions permit examination of the current attributes. Attributes are reported in groups corresponding to the class of output primitive they modify. The argument to each inquiry function has its own structure type which has an element for each of the individual attributes (see Appendix B).

Inquire Line Attributes

```
Clinatt *inquire_line_attributes()
    /* returns a pointer to line attribute structure */
```

`inquire_line_attributes()` reports the current *line style*, *line width*, *line color*, and *polyline bundle index* in the appropriate elements of the returned value of the function.

```
typedef struct {
    Clintype style;
    Cfloat width;
    Cint color;
    Cint index;
} Clinatt;
```

`inquire_line_attributes()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Marker Attributes

```
Cmarkatt *inquire_marker_attributes()
    /* returns a pointer to marker attribute structure */
```

`inquire_marker_attributes()` reports the current *marker style*, *marker width*, *marker color*, and *polymarker bundle index* in the appropriate elements of the returned value of the function.

```
typedef struct {
    Cmartype type;
    Cfloat size;
    Cint color;
    Cint index;
} Cmarkatt;
```

`inquire_marker_attributes()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Fill Area Attributes

```
Cfillatt *inquire_fill_area_attributes()
```

The current *interior style*, *perimeter visibility*, *fill color*, *hatch index*, *pattern index*, *fill area bundle index*, *perimeter style*, *perimeter width*, and *perimeter color* can be obtained by using the `inquire_fill_area_attributes()` function.

```
typedef struct {
    Cintertype style;
    Cflagtype visible;
    Cint color;
    Cint hatch_index;
    Cint pattern_index;
    Cint index;
    Clintype pstyle;
    Cfloat pwidth;
    Cint pcolor;
} fillatt;
```

`inquire_fill_area_attributes()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Pattern Attributes

```
Cpatternatt *inquire_pattern_attributes()
    /* returns a pointer to pattern attribute structure */
```

`inquire_pattern_attributes()` reports the *current pattern index, row count, column count, color list, pattern reference point,* and *pattern size.*

```
typedef struct {
    Cint cur_index;
    Cint row;
    Cint column;
    Cint *colorlist;
    Ccoor *point;
    Cint dx;
    Cint dy;
} patternatt;
```

`inquire_pattern_attributes()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Text Attributes

```
Ctextatt *inquire_text_attributes()
    /* returns a pointer to text attribute structure */
```

`inquire_text_attributes()` reports the current *font set, text bundle index, font, text precision, character expansion factor, character spacing, text color, character height, character base vector, character up vector, character path,* and *text alignment.*

```
typedef struct {
    Cint fontset;
    Cint index;
    Cint current_font;
    Cprectype precision;
    Cfloat exp_factor;
    Cfloat space;
    Cint color;
    Cint height;
    Cfloat basex;
    Cfloat basey;
    Cfloat upx;
    Cfloat upy;
    Cpathtype path;
    Chaligntype halign;
    Cvaligntype valign;
    Cfloat hcalind;
    Cfloat vcalind;
} textatt;
```

`inquire_text_attributes()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Inquire Aspect Source Flags

```
Cflaglist *inquire_aspect_source_flags()
    /* returns a pointer to text attribute structure */
```

`inquire_aspect_source_flags()` reports whether attributes are set individually by returning all of the values of the ASFs. The element *n* of the flaglist struct is set to 18. The definitions of each flag are in Table 4-2.

```
typedef struct {
    Cint n;
    Cint *num;
    Casptype *value;
} Cflaglist;
```

`inquire_aspect_source_flags()` returns a NULL (not an error number) in case of errors. Errors are printed if the error warning mode is not set to NO_ACTION.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

5

Input

5

Input

CGI has a collection of functions for managing input devices. The design of these functions has two purposes: provide an interface close to the actual input device and maintain portability of applications. CGI accomplishes the first goal with different input device classes and methods of extracting input values. The second goal is achieved through CGI's model of logical input devices (LID), an abstraction whereby logical input devices required by the CGI standard are mapped onto the physical devices available to a CGI implementation. This chapter will introduce some of the terms used in describing the functionality of the CGI input primitives.

A CGI input device consists of a *measure* associated with a *trigger*. A *measure* is the current value of a logical input device. For example, the IC_LOCATOR device reports an *x-y* position. This device is useful for determining a position on the screen. A *trigger* is a physical device used by an operator to accept a *current value*. A *trigger fire* corresponds to an event on a physical input device. At the request of the application program, *SunCGI* associates a measure with a trigger. Table 5-1 has a list of the five logical input devices available to *SunCGI* application programs and the available triggers. For example, a mouse button on a Sun workstation is a trigger that can be associated with a IC_LOCATOR device. When the mouse button is pressed, the *x-y* position of the mouse is returned as the measure of the IC_LOCATOR input device.

An *input event* is the information saved when a trigger fires. This includes the measure of a logical input device associated with a trigger.

Table 5-1 *Input Devices Offered by SunCGI*

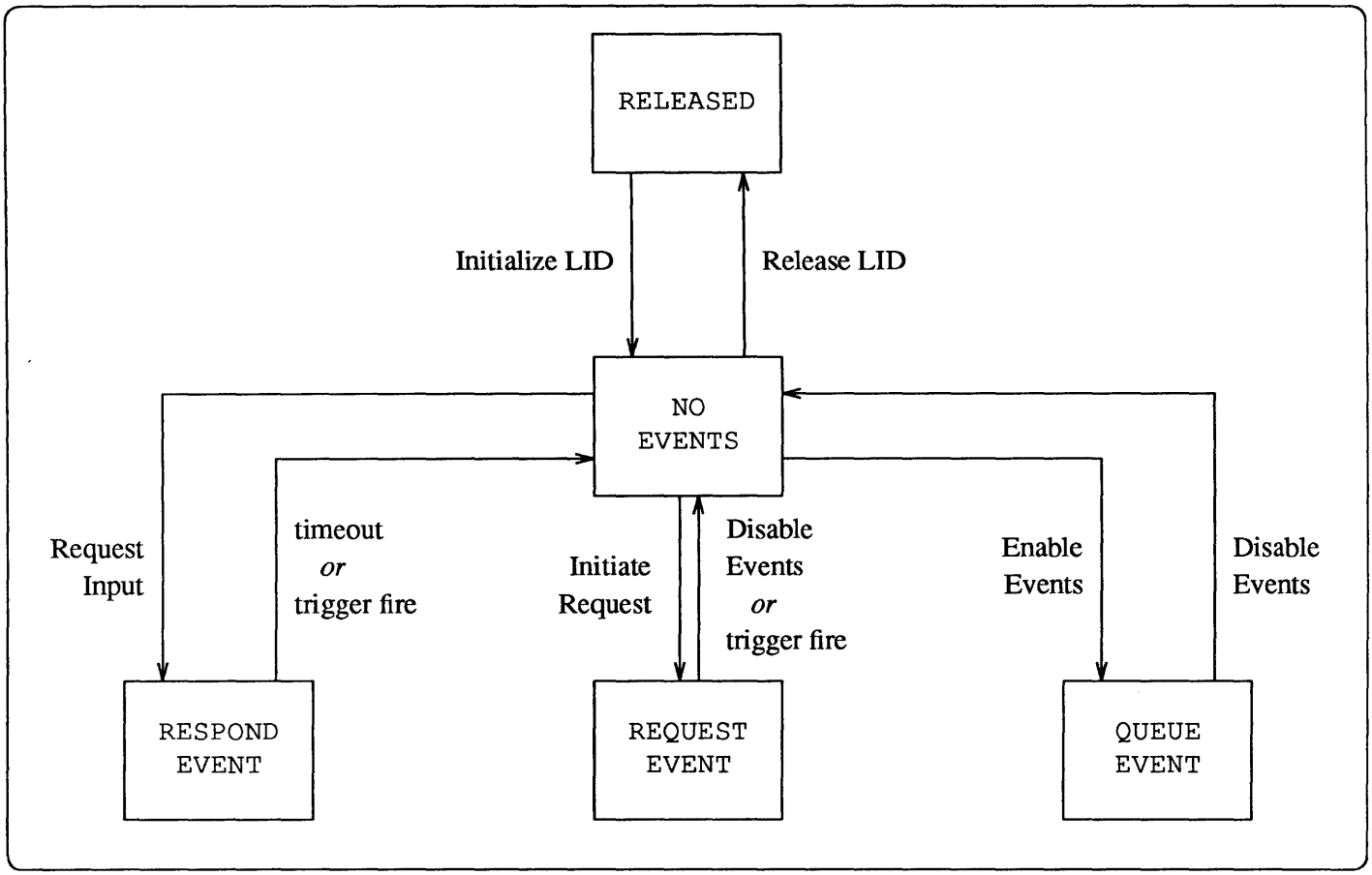
Device Class	*Measure*	*Trigger Number*	*Trigger*
IC_LOCATOR	*x-y* position in VDC space.	2	Left mouse button
		3	Middle mouse button
		4	Right mouse button
		5	Mouse movement†
		6	Mouse still‡
IC_STROKE	Array of *x-y* points in VDC space.	2	Left mouse button
		3	Middle mouse button
		4	Right mouse button
IC_VALUATOR	Normalized *x* position	2	Left mouse button
		3	Middle mouse button
		4	Right mouse button
		5	Mouse movement
		6	Mouse still
IC_CHOICE	A non-negative integer that identifies which mouse button was pressed. Zero represents "no choice".	2	Left mouse button
		3	Middle mouse button
		4	Right mouse button
IC_STRING	Character string.	1	Keyboard input terminated a carriage return.

† The *Mouse Movement* trigger fires when the mouse moves.
‡ The *Mouse Still* trigger fires when the mouse does not move for one fifth of a second or more.

The graphical method with which the measure of an input device is displayed is called *tracking*. *SunCGI* provides several methods of tracking for each input device. Table 5-3 has a list of track types available for each input device class. Tracking must be explicitly enabled for each device.

Each input device can be in one of the five states described pictorially in Figure 5-1. The state of an input device determines the manner in which the application program retrieves the measure of the input device. The input functions that allow a change of state are listed next to the arrows indicating the state change.

Figure 5-1 *CGI Input State Model*



RELEASED

Before an input device is initialized, it is in the RELEASED state. Any input function (except initialization) will generate an error in this state.

NO_EVENTS

After an input device has been initialized, it is in the NO_EVENTS state. An application program can extract an input value of an input device in NO_EVENTS state. This will result in either the value that the device was initialized with or the value the device had when it was in a state where it could process events. This is not necessarily the *current* measure of the device and does not change while the device is in this state.

RESPOND_EVENT

The RESPOND_EVENT state corresponds with synchronous communication between the process that controls the input device and the application program. When an application program requests the measure of an input device in RESPOND_EVENT state, *SunCGI* blocks program execution until it can fulfill the request. The `request_input()` function will return when the trigger fires and the input request is satisfied or after a timeout period. The input device then reverts to NO_EVENTS state.

The function that requests input and puts the input device in RESPOND_EVENT state is `request_input()`. When the trigger associated with an input device in RESPOND_EVENT state fires, the measure of that input device is then stored in the request register as well as returned by the `request_input()` function.

REQUEST_EVENT

The REQUEST_EVENT state corresponds with asynchronous communication between the process that controls the input device and the application program. When an application samples an input device, input handling and program execution continue in parallel. Either the requested trigger fires or an explicit request is made to disable event processing and return the device to NO_EVENTS state.

When the trigger associated with an input device in REQUEST_EVENT state fires, the measure of that input device is then stored in the *request register*, a buffer with one element per device. The request register can be then be read with `get_last_requested_input()`.

QUEUE_EVENT

When a device is in QUEUE_EVENT mode, events associated with the indicated device are appended to the *event queue*, a first-in, first-out (FIFO) buffer shared by *all* input devices. After calling `enable_events()`, the *SunCGI* application retains program control. While an input device is in QUEUE_EVENT mode, events are simultaneously added to the event queue when the program executes.

`await_event()` returns the event at the head of the event queue. If the queue is empty, `await_event()` will wait for the designated trigger to fire or a timeout. The application program must process this queue in a timely fashion or it will *overflow*. The event queue can be flushed completely or for a specific device. The application program must make an explicit request to disable event queue processing and return an input device to NO_EVENTS state.

5.1. Input Device Initialization

Before input can be processed, an input device must be initialized and associated with a trigger. Input device initialization requires at least one active view surface. Typically, the procedure for initializing an input device includes calls to the `initialize_lid()` and `associate()` functions, which turn on an input device and associate it with a specific trigger.

Initialize LID

```
Cerror initialize_lid(devclass, devnum, ival)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Cinrep *ival;     /* initial value of device measure */
```

`initialize_lid()` initializes an input device and changes its state from RELEASED to NO_EVENTS. This function must be called for an input device before it can be referenced by any other input function. The argument *devclass* specifies the desired type of input value. *devnum* indicates the number of the device within that class. The argument *ival* sets the initial measure of the device.

The `Cinrep` structure contains different elements for each type of measure. The appropriate element of `Cinrep` must be set or an error will be generated.

```
typedef struct {
    Ccoor *xypt;        /* LOCATOR */
    Ccoorlist *points;  /* STROKE devices */
    Cfloat val;         /* VALUATOR device */
    Cint choice;        /* CHOICE devices */
    Cchar *string;      /* STRING device */
    Cpick *pick;        /* PICK devices (unsupported) */
} Cinrep;
```

For example, in a LOCATOR device initialization, the *xypt* field of `Cinrep` must be set to the address of a `Ccoor` allocated by the application program before the *x* and *y* elements can be set.

Notice that whenever a device is initialized, no associations with triggers are made. This must be done by having the application program call the appropriate functions. An error is generated by `initialize_lid()` if the device does not exist, if it is already initialized, or if the initial value is out of range.

`ENOTVSAC` [4]	CGI not in proper state: CGI should be in state VSAC.
`EINDNOEX` [80]	Input device does not exist.
`EINDALIN` [82]	Input device already initialized.[15]
`EBADDATA` [95]	Contents of input data record are invalid.
`ESTRSIZE` [96]	Length of initial string is greater than the implementation defined maximum.

Release Input Device

```
Cerror release_input_device(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`release_input_device()` releases all associations between a device and its triggers, and removes all pending events for the device from the event queue. `release_input_device()` changes the state of the specified input device from NO_EVENTS to RELEASED. An error is produced if *devclass* and *devnum* do not refer to an existing and initialized device.

`ENOTVSAC` [4]	CGI not in proper state: CGI should be in state VSAC.
`EINDNOEX` [80]	Input device does not exist.
`EINDINIT` [81]	Input device not initialized.

[15] The ANSI standard allows initialized input devices to be re-initialized. *SunCGI* does not because it is felt that re-initialization is usually a mistake.

Associate

```
Cerror associate(trigger, devclass, devnum)
Cint trigger;     /* trigger number */
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`associate()` links a trigger with a specific device. The trigger numbers available for each device are listed in Table 5-1. Multiple associations are allowed; however, some associations are not allowed (for example, IC_LOCATOR may not be associated with the keyboard).

The interaction between an IC_STROKE device and the trigger requires some additional explanation. IC_STROKE can only be associated with the mouse buttons. The first coordinate in the IC_STROKE array is entered when the mouse button is initially pressed; the last coordinate is entered when the mouse button is released. For IC_LOCATOR and IC_VALUATOR devices, the measure is reported when the mouse button is pressed.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.
EINASAEX [83]	Association already exists.
EINAIIMP [84]	Association is impossible.
EINTRNEX [86]	Trigger does not exist.

Set Default Trigger Associations

```
Cerror set_default_trigger_associations(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`set_default_trigger_associations()` associates a device with a default trigger. The default associations are listed in Table 5-2. The rules for trigger association are the same as those for the `associate()` function.

Table 5-2 *Default Trigger Associations*

Device Class	*Trigger Number*	*Trigger*
IC_LOCATOR	5	Mouse position
IC_STROKE	4	Right mouse button
IC_VALUATOR	3	Middle mouse button
IC_CHOICE	2	Left mouse button
IC_STRING	1	Keyboard

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

EINASAEX [83] Association already exists.

EINTRNEX [86] Trigger does not exist.

Dissociate

```
Cerror dissociate(trigger, devclass, devnum)
Cint trigger;     /* trigger number */
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`dissociate()` removes the association between a trigger and a specified device. If `dissociate()` is called while there are events pending in the event queue for the dissociated device, the pending events are discarded.

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

EINDNOEX [80] Input device does not exist.

EINDINIT [81] Input device not initialized.

EINNTASD [85] Association does not exist.

EINTRNEX [86] Trigger does not exist.

Set Initial Value

```
Cerror set_initial_value(devclass, devnum, value)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Cinrep *value;    /* device value */
```

`set_initial_value()` sets the current measure of a specified device. This function resets the position of the track, if the track is appropriate and activated. `set_initial_value()` also resets the request register.

A pointer element of the `Cinrep` structure must be set to the address of an application program allocated area before the values can be set.

```
Cinrep ivalue;
point.x = 16384;
point.y = 16384;
ivalue.xypt = &point;
```

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

EINDNOEX [80] Input device does not exist.

EINDINIT [81] Input device not initialized.

EBADDATA [95] Contents of input data record are invalid.

ESTRSIZE [96] Length of initial string is greater than the implementation defined maximum.

Set VALUATOR Range

```
Cerror set_valuator_range(devnum, vmin, vmax)
Cint devnum;        /* device number */
Cfloat vmin, vmax; /* limits of VALUATOR */
```

`set_valuator_range()` specifies the limits of the IC_VALUATOR. Device coordinates are mapped into the IC_VALUATOR range. IC_VALUATOR events already on the event queue are not rescaled. These events must be dequeued with either the `selective_flush_of_event_queue()` function or `flush_event_queue()`.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

Track On

```
Cerror track_on(devclass, devnum, tracktype,
    trackregion, value)
Cdevoff devclass;        /* device type */
Cint devnum;             /* device number */
Cint tracktype;          /* track number */
Ccoorpair *trackregion; /* window for tracking */
Cinrep *value;           /* device value */
```

Tracking functions determine how the measure of an input device is displayed on the view surface. Each class of devices has its own set of possible tracks (given in Table 5-3). Although *SunCGI* allows certain classes of devices to track simultaneously, all types of input devices are not allowed to track at once. Tracking is not provided in the NO_EVENTS state unless the track type is PRINTERS_FIST.

`track_on()` initiates track (or echo) for a specific device. The *tracktype* argument specifies the type of track to be used. The *trackregion* argument is not used; the device tracks in all areas of the view surface. The argument *value* is used to initialize tracking. The track is initially displayed on the first view surface opened.

The *xypt* element of the `Cinrep` structure must be set to the address of an application allocated `Ccoor` and the `Ccoor`'s *x* and *y* fields are set to position the cursor. The reference point for IC_STROKE echos 2 through 5 is the first point in the STROKE array. The reference point for STRING_TRACK echo is the `append_text()` concatenation point, and can be changed by calling `text()` or `append_text()`.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINECHON [88]	Track already on.
EINETNSU [91]	Track type not supported.
EBADDATA [95]	Contents of input data record are invalid.
ESTRSIZE [96]	Length of initial string is greater than the implementation defined maximum.

Table 5-3 *Available Track Types*

Device Class	*Number*	*Track Type*†	*Description*
IC_LOCATOR(dd	≤0	NO_ECHO	Default cursor.
	1	PRINTERS_FIST	Designate the current position of the IC_LOCATOR device with a printer's fist cursor.
IC_STROKE‡	≤0	NO_ECHO	Default cursor.
	1	PRINTERS_FIST	Designate the current position of the IC_STROKE device with a printer's fist cursor.
	2	SOLID_LINE	Draw a line from the origin to the current position in the STROKE array.
	3	X_LINE	Draw a line from the *x*-axis to the current position in the STROKE array.
	4	Y_LINE	Draw a line from the *y*-axis to the current position in the STROKE array.
	5	RUBBER_BAND_BOX	Designate the current position of the IC_STROKE device with a rubber band line connecting the initial position and the current position in the STROKE array.
IC_VALUATOR‡	≤0	NO_ECHO	Default cursor.
	1	PRINTERS_FIST	Indicate the state of the IC_VALUATOR device with a printer's fist cursor.
	2	STRING_TRACK	Display a digital representation of the current IC_VALUATOR value.
IC_CHOICE‡	≤0	NO_ECHO	Default cursor.
	1	PRINTERS_FIST	Indicate the state of the IC_CHOICE device with a printer's fist cursor.
IC_STRING♦	≤0	NO_ECHO	Default cursor.
	1	PRINTERS_FIST	Indicate the state of the IC_STRING device with a printer's fist cursor.
	2	STRING_TRACK	Display the current STRING value.

† The values listed in the *Track Type* column are contained in the enumerated type `Cechotype` returned in the `Cstatelist` structure by `inquire_lid_state_list()`. They are *not* used by `track_on()` to define a track type.
‡ This is a mouse device.
♦ This is a keyboard device.

Track Off

```
Cerror track_off(devclass, devnum, tracktype, action)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Cint tracktype;
Cfreeze action;
```

`track_off()` terminates tracking for a specified input device. The *tracktype* and the *action* arguments are always ignored.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

5.2. Synchronous Input

The synchronous input function `request_input()` allows the application program to obtain the current measure an of input device. This function requires explicit identification of an input device (through the `associate()` function).

The following example program illustrates how to use the synchronous input functions to get information from an input device. First, an IC_LOCATOR device is initialized and associated with a trigger (the left mouse button). The tracking method for the IC_LOCATOR is defined to be a printer's fist. Then measure of the IC_LOCATOR is requested with a timeout period of ten seconds. If the trigger is activated during this period, `request_input()` returns a valid measure in *ivalue*. Finally, the IC_LOCATOR is dissociated from the mouse button and released. The program exits.

```
/*      NOTE: This example should be run from a grfxtool.                    */

#include <stdio.h>
#include <cgidefs.h>

#define TEN_SECS         (10 * 1000 * 1000)
#define LID_LOC          1
#define MOUSE_BUTTON_1   2
#define MOUSE_BUTTON_2   3
#define MOUSE_BUTTON_3   4
#define MOUSE_MOVE       5

main()
{
    static Ccoor  ipt = { 16384, 16384 };        /* initial pt */
    static Cinrep ivalue = { &ipt, NULL, 0., 0, ' ', NULL }; /* init LID */
    Cawresult     valid;
    Cint          name,
                  trigger;
    Cvwsurf       device;
    char          dummy, buf[80];

    fprintf(stderr,"Move cursor in graphics area & click mouse buttons.0);
    fprintf(stderr, "To exit, press mouse button three (right).0);

    NORMAL_VWSURF( device, PIXWINDD);

    open_cgi();
    open_vws( &name, &device);

    initialize_lid( IC_LOCATOR, LID_LOC, &ivalue);  /* create locator dev */
    associate(MOUSE_BUTTON_1, IC_LOCATOR, LID_LOC); /* trigger = button 1 */
    associate(MOUSE_BUTTON_2, IC_LOCATOR, LID_LOC); /* trigger = button 1 */
```

```
    associate(MOUSE_BUTTON_3, IC_LOCATOR, LID_LOC); /* trigger = button 1 */
    associate(MOUSE_MOVE, IC_LOCATOR, LID_LOC);     /* trigger = button 1 */

    do {        /* loop until get bad data or hit right mouse button  */
        request_input(IC_LOCATOR, LID_LOC, TEN_SECS,
                    &valid, &ivalue, &trigger);
        sprintf(buf, "X= %d  Y= %d  valid= %d trig= %d0,
                    ipt.x, ipt.y, valid, trigger);
        fprintf(stderr, "%s", buf);
    }   while (valid == VALID_DATA  && trigger != MOUSE_BUTTON_3);

    dissociate(MOUSE_BUTTON_1, IC_LOCATOR, LID_LOC);
    dissociate(MOUSE_BUTTON_2, IC_LOCATOR, LID_LOC);
    dissociate(MOUSE_BUTTON_3, IC_LOCATOR, LID_LOC);
    dissociate(MOUSE_MOVE, IC_LOCATOR, LID_LOC);
    release_input_device(IC_LOCATOR, LID_LOC);  /* shut down locator  */

    close_vws(name);
    close_cgi();
}
```

Request Input

```
Cerror request_input(devclass, devnum, timeout,
    valid, sample, trigger)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Cint timeout;     /* amount of time to wait for input */
Cawresult *valid; /* device status */
Cinrep *sample;   /* device value */
Cint *trigger;    /* trigger number */
```

`request_input()` waits *timeout* microseconds for activation of a trigger associated with a specific device. If *timeout* is negative, the request will wait forever. `request_input()` puts the input device in the RESPOND_EVENT state. If a trigger is activated within this period, the activating trigger and the device measure are returned in the *trigger* and *sample* arguments. If the trigger is not activated within this period, the current device measure is returned in the *sample* argument, and *trigger* is set to zero. Before returning, the input device is reset to NO_EVENTS state.

`request_input()` returns a device status in the argument *valid*. This argument uses the enumerated type `Cawresult` (AWait Result), which contains values describing the state of an input device.

```
typedef enum {
    VALID_DATA,
    TIMED_OUT,
    DISABLED,
    WRONG_STATE,
    NOT_SUPPORTED
} Cawresult;
```

VALID_DATA indicates that a trigger is activated within the specified timeout period. TIMED_OUT indicates that a trigger was not activated with a specified period. DISABLED indicates that a trigger is not activated. WRONG_STATE indicates *SunCGI* is not in state VSAC. NOT_SUPPORTED indicates the requested device is not a legal device.

If the appropriate field of the *sample* argument is a pointer, it must be set to an application program allocated area.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.
EINEVNEN [94]	Events not enabled.

5.3. Asynchronous Input

This section explains the asynchronous method of input device management where the application process and the input device process operate simultaneously. The designated input device is sampled with `initiate_request()` and the measure of the input device is read with `get_last_requested_input()`. Alternatively, the current measure of a device may be read with `sample_input()`.

Initiate Request

```
Cerror initiate_request(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`initiate_request()` sets up a device so that the measure resulting from the next trigger activation will be placed in the request register. `initiate_request()` puts the device in the REQUEST_EVENT state. It then returns to the calling function without waiting for a trigger activation. The value caused by the trigger activation can be obtained by the `get_last_requested_input()` function.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.
EINNTASD [85]	No triggers associated with device.

5.4. Event Queue Input

The event queue is a single FIFO buffer that holds events from input devices. Since the event queue has a fixed length, it must be processed in a timely fashion or it will overflow. Events can be removed from the event queue in three ways: the event at the head of the event queue can be processed with `await_event()`; the entire event queue can be emptied with `flush_event_queue()`; and the events from a particular device can be removed from the event queue with `selective_flush_of_event_queue()`.

The following example program illustrates how to use the event queue input functions to get information from an input device. First, an IC_STRING device is initialized and associated with a trigger (the keyboard). The tracking method for the IC_STRING is defined to be a string that echos the keyboard input on the bottom of the viewport. The IC_STRING is put into the QUEUE_EVENT state with `enable_events()`. After the trigger fires, the measure of the IC_STRING device is determined with `await_event()`. Finally, the IC_STRING is dissociated from the keyboard and released. The program then exits.

```
/*      NOTE: This example should be run from a grfxtool.                    */
#include <cgidefs.h>

#define TEN_SECONDS (10 * 1000 * 1000)

main()
{
    Cint        name;
    Cvwsurf     device;
    Cawresult   valid;
    Ccoor       point;
    Cdevoff     devclass = IC_STRING;
    Ceqflow     overflow;
    Cinrep      ivalue;
    Cint        devnum = 1,
                replost,
                time_stamp,
                timeout = TEN_SECONDS,
                tracktype = 2,
                trigger = 1;
    Cmesstype   message_link;
    Cqtype      qstat;

    NORMAL_VWSURF( device, PIXWINDD);
    point.x = point.y = 16384;
    ivalue.xypt = &point;
    ivalue.string = "Return from await_event";

    open_cgi();
    open_vws( &name, &device);

    initialize_lid( devclass, devnum, &ivalue);
    associate( trigger, devclass, devnum);
    track_on( devclass, devnum, tracktype, (Ccoorpair *)0, &ivalue);
    enable_events( devclass, devnum);

    await_event( timeout, &valid, &devclass, &devnum, &ivalue,
            &message_link, &replost, &time_stamp, &qstat, &overflow);
    printf( "%s0, ivalue.string);
    disable_events( IC_STRING, devnum);
    dissociate( trigger, IC_STRING, devnum);
    release_input_device( IC_STRING, devnum);
```

```
    close_vws( name);
    close_cgi();
}
```

Enable Events

```
Cerror enable_events(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`enable_events()` allows a device in NO_EVENTS state to put events on the event queue. `enable_events()` puts the input device in the QUEUE_EVENT state. An error is generated if the device specified by *devclass* or *devnum* does not exist or is not initialized.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.
EIAEVNEN [93]	Events already enabled.

Await Event

```
Cerror await_event(timeout, valid, devclass, devnum,
    measure, message_link, replost, time_stamp,
    qstat, overflow)
Cint timeout;              /* input timeout period */
Cawresult *valid;          /* status */
Cdevoff *devclass;         /* device type */
Cint *devnum;              /* device number */
Cinrep *measure;           /* device value */
Cmesstype *message_link;   /* type of message */
Cint *replost;             /* reports lost */
Cint *time_stamp;          /* time_stamp */
Cqtype *qstat;             /* queue status */
Ceqflow *overflow;         /* event queue status */
```

`await_event()` processes the event at the head of the event queue. *valid* is set to WRONG_STATE if *SunCGI* is not in state VSAC. If the event queue is EMPTY, then `await_event()` waits *timeout* microseconds for a trigger to be activated. If *timeout* is less than 0, *SunCGI* waits until a trigger is activated. *valid* is set to VALID_DATA if a trigger is activated within the specified timeout period and TIMED_OUT otherwise.

If either the event queue is not empty or a trigger is activated, the class, number and value of the device generating the event are reported in the returned arguments *devclass*, *devnum*, and *measure*. If the appropriate field of the *measure* argument is a pointer, it must be set to an application program allocated area.

If two events on the event queue have the same trigger but different values, the argument *message_link* is assigned to SIMULTANEOUS_EVENT_FOLLOWS; otherwise the argument *message_link* is set to SINGLE_EVENT. The enumerated type `Cmesstype` contains the following values.

```
typedef enum {
    SIMULTANEOUS_EVENT_FOLLOWS,
    SINGLE_EVENT
} Cmesstype;
```

The *replost* and *time_stamp* arguments should be ignored and are always zero. The returned argument *qstat* reports the queue status after an event is removed from the head of the event queue.

```
typedef enum {
    NOT_VALID,
    EMPTY,
    NON_EMPTY,
    ALMOST_FULL,
    FULL
} Cqtype;
```

qstat is set to EMPTY if the event queue has no pending events. *qstat* is set to NON_EMPTY if the event queue has events pending, but is not FULL or ALMOST_FULL. *qstat* is set to ALMOST_FULL if there is room for only one more event on the event queue. *qstat* is set to FULL if there is no room for more events on the event queue.

The argument *overflow* indicates whether the event queue has overflowed or not. The enumerated type `Ceqflow` contains the following values:

```
typedef enum {
    NO_OFLO,
    OFLO
} Ceqflow;
```

`ENOTVSAC` [4] CGI not in proper state: CGI should be in state VSAC.

`EINQOVFL` [97] Input queue has overflowed.

Flush Event Queue

```
Cerror flush_event_queue()
```

`flush_event_queue()` discards all events in the event queue. The purpose of `flush_event_queue()` is to return the event queue to a stable state (NO_OFLO). `flush_event_queue()` does not affect the state of input devices. This function should be used carefully to avoid throwing away mouse-ahead or type-ahead inputs.

`ENOTOPOP` [5] CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

Selective Flush of Event Queue

```
Cerror selective_flush_of_event_queue(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`selective_flush_of_event_queue()` discards all events in the event queue which were generated by a specified device. `selective_flush_of_event_queue()` does not affect the state of the specified input device. *devclass* and *devnum* must refer to an existing and

initialized device or an error is produced. However, no error is returned if no events from the specified device are pending.

ENOTOPOP [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

5.5. Miscellaneous Input Functions

The functions described in this section can be used with several of the input device management techniques described in the previous sections. For example, `sample_input()` can be used when a device is in either REQUEST_EVENT or QUEUE_EVENT state. Likewise, `disable_events()` can be used in either of these states.

Sample Input

```
Cerror sample_input(devclass, devnum, valid, sample)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Clogical *valid;  /* device status */
Cinrep *sample;   /* device value */
```

`sample_input()` reports the current measure of the specified input device in the returned argument *sample*. The returned argument *valid* reports whether the device is initialized and prepared to receive an input. The current measure of the device may be set by a queued event, a requested event, or a device initialization depending on the state of the input device and the most recent trigger activation(s). See the introduction of this chapter for an explanation of the relationship between the *measure* of an input device and the *state* of an input device. If the appropriate field of the *sample* argument is a pointer, it must be set to an application program allocated area.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

Get Last Requested Input

```
Cerror get_last_requested_input(devclass, devnum,
    valid, sample)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Clogical *valid;  /* device status */
Cinrep *sample;   /* device value */
```

`get_last_requested_input()` returns the contents of the request register. `get_last_requested_input()` is usually used with `initiate_request()`, but `request_input()` also changes the contents of the request register. The returned argument *valid* indicates whether the device exists and is initialized. The returned argument *sample* reports the event in the request register. If no event is in the request register, the initial device value is reported. If the appropriate field of the *sample* argument is a pointer, it must be set to an application program allocated area.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.

Disable Events

```
Cerror disable_events(devclass, devnum)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
```

`disable_events()` puts the input device in the NO_EVENTS state. If the device is in RESPOND_EVENT state, the specified device is returned to NO_EVENTS state; the measure of the device is not changed by `disable_events()`. If the device is in QUEUE_EVENT state, `disable_events()` stops the specified device from putting events on the event queue. However, existing entries on the event queue are not removed and existing associations remain. *devclass* and *devnum* must refer to an existing and initialized device or an error is produced.

ENOTVSAC [4]	CGI not in proper state: CGI should be in state VSAC.
EINDNOEX [80]	Input device does not exist.
EINDINIT [81]	Input device not initialized.
EINEVNEN [94]	Events not enabled.

5.6. Status Inquiries

The current state of the input devices, triggers, and the event queue can be obtained by using the functions discussed in this section.

Inquire LID State List

```
Cerror inquire_lid_state_list(devclass, devnum,
    valid, list)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Clogical *valid;  /* device supported at all */
Cstatelist *list; /* table of descriptors */
```

`inquire_lid_state_list()` reports the status of a specific input device specified by *devclass* and *devnum*. The argument *valid* reports whether the device is supported at all. The *list* argument reports the *track*, *associations*, *state*, and *measure* of the device in the appropriate elements of *list*. When checking the elements of *list*, first check the *state* element — if *state* is RELEASED, the other elements of *list* are undefined.

```
typedef struct {
    Clidstate state;
    Cpromstate prompt;
    Cackstate acknowledgement;
    Cinrep *current;
    Cint n;
    Cint *triggers;
    Cechotype echotyp;
    Cechostate echosta;
    Cint echodat;
} Cstatelist;
```

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

EINDNOEX [80] Input device does not exist.

Inquire LID State

```
Cerror inquire_lid_state(devclass, devnum, valid, state)
Cdevoff devclass; /* device type */
Cint devnum;      /* device number */
Clogical *valid;  /* device supported at all */
Clidstate *state; /* table of descriptors */
```

`inquire_lid_state()` reports the status of a specific input device specified by *devclass* and *devnum*. The argument *valid* reports whether the device is supported at all. The *state* argument (of type `Clidstate`) reports the current state of the specified input device.

```
typedef enum {
    RELEASE,
    NO_EVENTS,
    REQUEST_EVENT,
    RESPOND_EVENT,
    QUEUE_EVENT
} Clidstate;
```

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

EINDNOEX [80] Input device does not exist.

Inquire Trigger State

```
Cerror inquire_trigger_state(trigger, valid, list)
Cint trigger;     /* trigger number */
Clogical *valid;  /* trigger state */
Ctrigstate *list; /* trigger description table */
```

`inquire_trigger_state()` describes the binding between a trigger and an input device. If the *state* element of the returned argument *list* is INACTIVE, no associations have been made with the trigger. An error is generated if the trigger does not exist.

```
typedef struct {
    Cactstate state;  /* state */
    Cassoclid *assoc; /* list of associations */
} Ctrigstate;
```

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

EINTRNEX [86] Trigger does not exist.

Inquire Event Queue State

```
Cerror inquire_event_queue_state(qstat, qflow)
Cqtype * qstat;  /* queue state */
Ceqflow * qflow; /* overflow indicator */
```

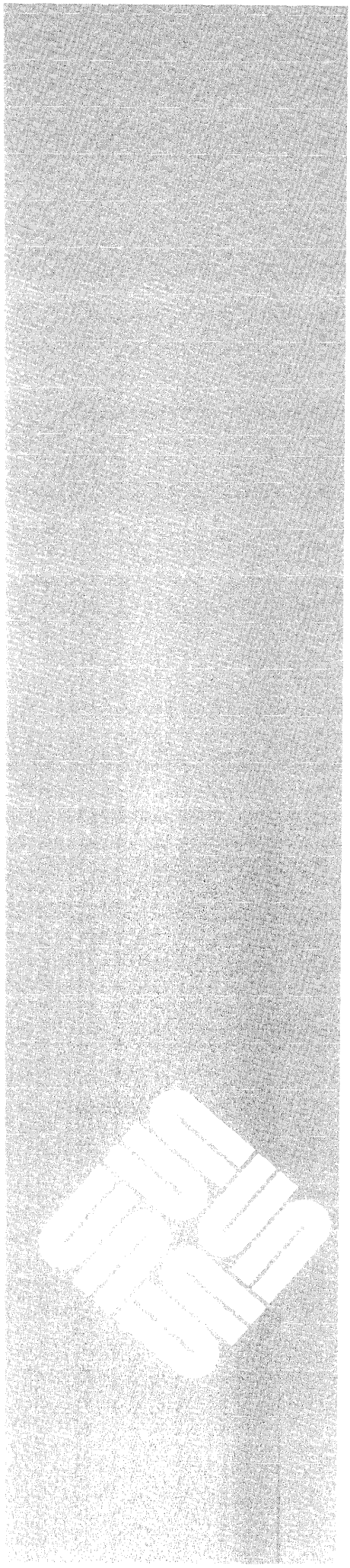
`inquire_event_queue_state()` reports the status of the event queue. *qstat* indicates whether any events are pending. The argument *qflow* reports if the event queue is overflowing.

```
typedef enum {
    NOT_VALID,
    EMPTY,
    NON_EMPTY,
    ALMOST_FULL,
    FULL
} Cqtype;

typedef enum {
    NO_OFLO,
    OFLO
} Ceqflow;
```

ENOTVSAC [4] CGI not in proper state: CGI should be in state VSAC.

A

Unsupported Aspects of CGI



A

Unsupported Aspects of CGI

SunCGI does not support certain optional aspects of the 1984 draft ANSI CGI standard. (This draft may greatly differ from other drafts of CGI.) Most notably *SunCGI* does not support the full constellation of negotiation functions or tracking. *SunCGI* does not allow the resetting of *coordinate type*, *coordinate precision* or *color specification mode* because to do so would greatly reduce the speed of application programs written in *SunCGI*. Furthermore, *SunCGI* does not support echoing functions for input, but provides the tracking functions instead.

Table A-1 *Unsupported Control Functions*

Function
`vdc_type()`
`vdc_precision_for_integer_points()`
`vdc_precision_for_real_points()`
`integer_precision()`
`real_precision()`
`index_precision()`
`color_selection_mode()`
`color_precision()`
`color_index_precision()`
`viewport_specification_mode()`
`make_picture_current()`

Table A-2 *Unsupported Input Functions*

Function
`set_prompt_state()`
`set_acknowledgement_state()`
`echo_on()`
`echo_off()`
`echo_update()`

The following *SunCGI* functions are nonstandard (that is, are not in the standards document) and are included to make CGI easier to use. In addition, *SunCGI* has non-standard view surface arguments for certain control functions.

Table A-3 *Nonstandard Control Functions*

Function
`open_cgi()`
`open_vws()`
`activate_vws()`
`deactivate_vws()`
`close_vws()`
`close_cgi()`

Table A-4 *Nonstandard Attribute Functions*

Function
`define_bundle_index()`
`line_endstyle()`
`set_global_drawing_mode()`
`pattern_with_fill_color()`
`fixed_font()`

The `Cinrep` structure contains a presently unsupported *pick* field, for compatibility with future segment manipulation capabilities.

B

Type and Structure Definitions

B

Type and Structure Definitions

This appendix provides a list of the structures and enumerated types used by *SunCGI* functions. In addition, a list of useful constants defined in `<cgiconstants.h>` is given.

```
/* devices */
#define BW1DD          1
#define BW2DD          2
#define CG1DD          3
#define BWPIXWINDD     4
#define CGPIXWINDD     5
#define GP1DD          6
#define CG2DD          7
#define CG4DD          8
#define PIXWINDD       9

#define VWSURF_NEWFLG  1
#define MAXVWS         5
#define MAXTRIG        6
#define MAXASSOC       5    /* maximum associations for a device */
#define MAXEVENTS      1024 /* maximum number of events the buffer holds */

/* limits */
#define MAXAESSIZE     10    /* maximum number of AES table entries */
#define MAXNUMPATS     50    /* maximum number of pattern table entries */
#define MAXPATSIZE    256    /* maximum pattern size */

#define MAXPTS       1024    /* maximum number of pts per polygon */
#define MAXCHAR       256    /* maximum number of chars in a string */

#define OUTFUNS        67    /* number of output functions */
#define INFUNS         22    /* number of input functions */

#define DEVNAMESIZE    20
```

The type and structure definitions that follow can be found in the header file <cgidefs.h>.

```
typedef enum {
    ACK_ON,
    ACK_OFF
} Cackstate;

typedef enum {
    ACTIVE,
    INACTIVE
} Cactstate;

typedef enum {
    CLEAR,
    NO_OP,
    RETAIN
} Cacttype;

typedef enum {
    INDIVIDUAL,
    BUNDLED
} Casptype;

typedef struct {
    Cint     n;
    Cdevoff  *class;
    Cint     *assoc;
} Cassoclid;

typedef enum {
    VALID_DATA,
    TIMED_OUT,
    DISABLED,
    WRONG_STATE,
    NOT_SUPPORTED
} Cawresult;

typedef enum {
    BITNOT,
    BITTRUE
} Cbitmaptype;

typedef enum {
    TRANSPARENT,
    OPAQUE
} Cbmode;
```

```
typedef struct {
    Clintype    line_type;
    Cfloat      line_width;
    Cint        line_color;
    Cmartype    marker_type;
    Cfloat      marker_size;
    Cint        marker_color;
    Cintertype  interior_style;
    Cint        hatch_index;
    Cint        pattern_index;
    Cint        fill_color;
    Clintype    perimeter_type;
    Cfloat      perimeter_width;
    Cint        perimeter_color;
    Cint        text_font;
    Cprectype   text_precision;
    Cfloat      character_expansion;
    Cfloat      character_spacing;
    Cint        text_color;
} Cbunatt;

typedef struct {
    unsigned char  *ra;
    unsigned char  *ga;
    unsigned char  *ba;
    Cint           n;
} Ccentry;

typedef enum {
    OPEN,
    CLOSE
} Ccflag;

typedef struct {
    Cint      numloc;
    Cint      numval;
    Cint      numstrk;
    Cint      numchoice;
    Cint      numstr;
    Cint      numtrig;
    Csuptype  event_queue;
    Csuptype  asynch;
    Csuptype  coord_map;
    Csuptype  echo;
    Csuptype  tracking;
    Csuptype  prompt;
    Csuptype  acknowledgement;
    Csuptype  trigger_manipulation;
} Ccgidesctab;
```

```
typedef enum {
    YES,
    NO
} Cchangetype;

typedef char Cchar;

typedef enum {
    NOCLIP,
    CLIP,
    CLIP_RECTANGLE
} Cclip;

typedef enum {
    CHORD,
    PIE
} Cclosetype;

typedef enum {
    REPLACE,
    AND,
    OR,
    NOT,
    XOR
} Ccombtype;

typedef struct {
    Cint  x;
    Cint  y;
} Ccoor;

typedef struct {
    Ccoor  *ptlist;
    Cint   n;
} Ccoorlist;

typedef struct {
    Ccoor  *upper;
    Ccoor  *lower;
} Ccoorpair;

typedef enum {
    IC_LOCATOR,
    IC_STROKE,
    IC_VALUATOR,
    IC_CHOICE,
    IC_STRING,
    IC_PICK
} Cdevoff;
```

```
typedef enum {
    E_TRACK,
    E_ECHO,
    E_TRACK_OR_ECHO,
    E_TRACK_AND_ECHO
} Cechoav;

typedef struct {
    Cinrep  *echos;
    Cint    n;
} Cechodatalst;

typedef enum {
    ECHO_OFF,
    ECHO_ON,
    TRACK_ON
} Cechostate;

typedef struct {
    Cechostate  *echos;
    Cint        n;
} Cechostatelst;

typedef enum {
    NO_ECHO,
    PRINTERS_FIST,
    HIGHLIGHT,
    RUBBER_BAND_BOX,
    DOTTED_LINE,
    SOLID_LINE,
    STRING_ECHO,
    XLINE,
    YLINE
} Cechotype;

typedef struct {
    Cint        n;
    Cechoav     *elements;
    Cechotype   *echos;
} Cechotypelst;

typedef enum {
    NATURAL,
    POINT,
    BEST_FIT
} Cendstyle;

typedef enum {
    NO_OFLO,
    OFLO
} Ceqflow;
```

```
typedef Cint Cerror;

typedef enum {
    INTERRUPT,
    NO_ACTION,
    POLL
} Cerrtype;

typedef enum {
    CLIP_RECT,
    VIEWPORT,
    VIEWSURFACE
} Cexttype;

typedef struct {
    Cintertype  style;
    Cflag       visible;
    Cint        color;
    Cint        hatch_index;
    Cint        pattern_index;
    Cint        index;
    Clintype    pstyle;
    Cfloat      pwidth;
    Cint        pcolor;
} Cfillatt;

typedef enum {
    OFF,
    ON
} Cflag;

typedef struct {
    Cint      n;
    Cint      *num;
    Casptype  *value;
} Cflaglist;

typedef float Cfloat;

typedef enum {
    FREEZE,
    REMOVE
} Cfreeze;

typedef enum {
    LFT,
    CNTER,
    RGHT,
    NRMAL,
    CNT
} Chalignype;
```

```
typedef enum {
    NO_INPUT,
    ALWAYS_ON,
    SETTABLE,
    DEPENDS_ON_LID
} Cinputability;

typedef struct {
    Ccoor      *xypt;
    Ccoorlist  *points;
    Cfloat     val;
    Cint       choice;
    Cchar      *string;
    Cpick      *pick;
} Cinrep;

typedef int Cint;

typedef enum {
    HOLLOW,
    SOLIDI,
    PATTERN,
    HATCH
} Cintertype;

typedef struct {
    Clogical       sample;
    Cchangetype    change;
    Cint           numassoc;
    Cint           *trigassoc;
    Cinputability  prompt;
    Cinputability  acknowledgement;
    Cechotypelst   *echo;
    Cchar          *classdep;
    Cstatelist     state;
} Cliddescript;

typedef enum {
    RELEASE,
    NO_EVENTS,
    REQUEST_EVENT,
    RESPOND_EVENT,
    QUEUE_EVENT
} Clidstate;

typedef struct {
    Clintype  style;
    Cfloat    width;
    Cint      color;
    Cint      index;
} Clinatt;
```

```
typedef enum {
    SOLID,
    DOTTED,
    DASHED,
    DASHED_DOTTED,
    DASH_DOT_DOTTED,
    LONG_DASHED
} Clintype;

typedef enum {
    L_FALSE,
    L_TRUE
} Clogical;

typedef struct {
    Cmartype  type;
    Cfloat    size;
    Cint      color;
    Cint      index;
} Cmarkatt;

typedef enum {
    DOT,
    PLUS,
    ASTERISK,
    CIRCLE,
    X
} Cmartype;

typedef enum {
    SIMULTANEOUS_EVENT_FOLLOWS,
    SINGLE_EVENT
} Cmesstype;

typedef enum {
    RIGHT,
    LEFT,
    UP,
    DOWN
} Cpathtype;

typedef struct {
    Cint   cur_index;
    Cint   row;
    Cint   column;
    Cint   *colorlist;
    Ccoor  *point;
    Cint   dx;
    Cint   dy;
} Cpatternatt;
```

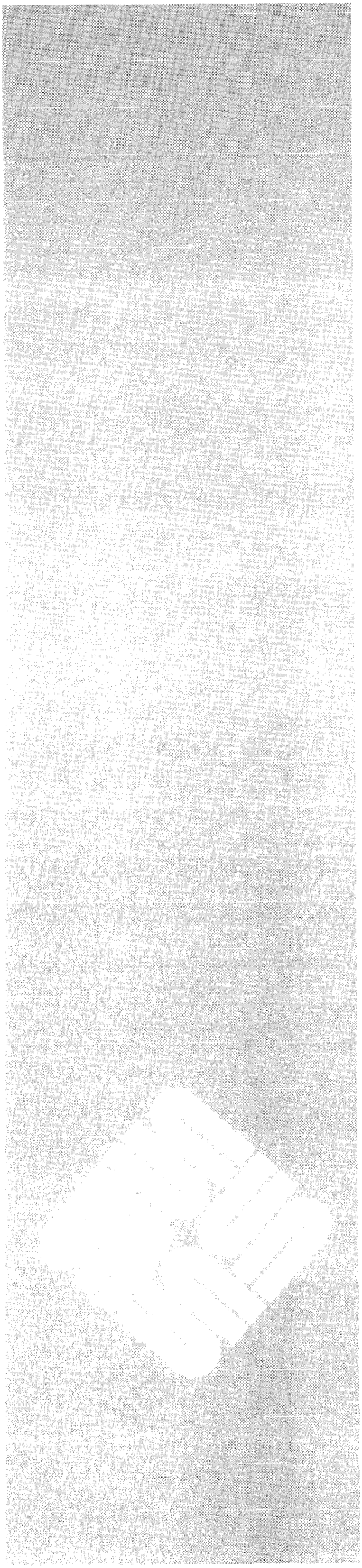
```
typedef struct {
    int  segid;
    int  pickid;
} Cpick;

typedef struct pixrect Cpixrect;

typedef enum {
    STRING,
    CHARACTER,
    STROKE
} Cprectype;

typedef enum {
    PROMPT_OFF,
    PROMPT_ON
} Cpromstate;

typedef enum {
    NOT_VALID,
    EMPTY,
    NON_EMPTY,
    ALMOST_FULL,
    FULL
} Cqtype;

typedef enum {
    ABSOLUTE,
    SCALED
} Cspecmode;

typedef struct {
    Clidstate   state;
    Cpromstate  prompt;
    Cackstate   acknowledgement;
    Cinrep      *current;
    Cint        n;
    Cint        *triggers;
    Cechotype   echotyp;
    Cechostate  echosta;
    Cint        echodat;
} Cstatelist;

typedef enum {
    NONE,
    REQUIRED_FUNCTIONS_ONLY,
    SOME_NON_REQUIRED_FUNCTIONS,
    ALL_NON_REQUIRED_FUNCTIONS
} Csuptype;
```

```
typedef struct {
    Cint          fontset;
    Cint          index;
    Cint          current_font;
    Cprectype     precision;
    Cfloat        exp_factor;
    Cfloat        space;
    Cint          color;
    Cint          height;
    Cfloat        basex;
    Cfloat        basey;
    Cfloat        upx;
    Cfloat        upy;
    Cpathtype     path;
    Chaligntype   halign;
    Cvaligntype   valign;
    Cfloat        hcalind;
    Cfloat        vcalind;
} Ctextatt;

typedef enum {
    NOT_FINAL,
    FINAL
} Ctextfinal;

typedef struct {
    Cchangetype   change;
    Cassoclid     *numassoc;
    Cint          maxassoc;
    Cpromstate    prompt;
    Cackstate     acknowledgement;
    Cchar         *name;
    Cchar         *description;
} Ctrigdis;

typedef struct {
    Cactstate   state;
    Cassoclid   *assoc;
} Ctrigstate;

typedef enum {
    TOP,
    CAP,
    HALF,
    BASE,
    BOTTOM,
    NORMAL,
    CONT
} Cvaligntype;
```

```
typedef enum {
    INTEGER,
    REAL,
    BOTH
} Cvdctype;

typedef struct {
    Cchar  screenname[DEVNAMESIZE];
    Cchar  windowname[DEVNAMESIZE];
    Cint   windowfd;
    Cint   retained;
    Cint   dd;
    Cint   cmapsize;
    Cchar  cmapname[DEVNAMESIZE];
    Cint   flags;
    Cchar  **ptr;
} Cvwsurf;
```

C

Error Messages



C

Error Messages

This appendix lists the error messages in numerical order. The probable cause of each error is given in the sentences following the error. In addition to explaining the error message, an initial suggestion for corrective action is given. In the title for each group of errors, the range of error numbers is given in parentheses after the title. If your application program is not behaving as you want it to, but does not generate error messages, then the tables at the end of this appendix, which lists commonly encountered problems and frequent causes, may be helpful.

C.1. Successful Return (0)

NO_ERROR [0] *No error.*

C.2. State Errors (1-5)

ENOTCGCL [1] *CGI not in proper state: CGI should be in state CGCL.* A call to `open_cgi()` was attempted when cgi was already open. Elimination of the error can be accomplished by removing the offending call to `open_cgi()`.

ENOTCGOP [2] *CGI not in proper state: CGI should be in state CGOP.* Every function except `open_cgi()` requires that CGI be open. If this error is received, make sure that your application program has called `open_cgi()`, or that it has not recently called `close_cgi()`.

ENOTVSOP [3] *CGI not in proper state: CGI should be in state VSOP.* The function which generated the error requires that at least one view surface be open. Corrective action would include either removing the most recent call to `close_vws()` or by including a call to `open_vws()`.

ENOTVSAC [4] *CGI not in proper state: CGI should be in state VSAC.* The function which generated the error requires that at least one view surface be active. Corrective action would include either removing the most recent call to `deactivate_vws()` or by including a call to `activate_vws()`.

	ENOTOPOP [5]	*CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.* The function which generated the error requires that *SunCGI* is at least initialized. If this error is received, make sure that your application program has called `open_cgi()`, or that it has not recently called `close_cgi()`.
C.3. Control Errors (10-16)	EVSIDINV [10]	*Specified view surface name is invalid.* The view surface name specified by the *name* argument has never been opened or if it has been opened, it has since been closed. Corrective action involves opening the view surface or changing the value of the *name* argument.
	ENOWSTYP [11]	*Specified view surface type does not exist.* The application program has specified a type of view surface which is not supported by *SunCGI*. Corrective action involves changing the type of view surface.
	EMAXVSOP [12]	*Maximum number of view surfaces already open.* An attempt was made to open a view surface when the maximum number of view surfaces is already open. Corrective action involves removing one call to `open_vws()`.
	EVSNOTOP [13]	*Specified view surface not open.* An attempt was made to close a view surface which is already closed. Corrective action involves removing one call to `close_vws()`.
	EVSISACT [14]	*Specified view surface is active.* An attempt was made to activate a view surface which is already activated. Corrective action involves removing one call to `activate_vws()`.
	EVSNTACT [15]	*Specified view surface is not active.* An attempt was made to deactivate a view surface which has already been deactivated. Corrective action involves removing one call to `deactivate_vws()`.
	EINQALTL [16]	*Inquiry arguments are longer than list.* A call to an inquiry negotiation function with indices greater than the number of supported functions was made. The returned list is always empty. Corrective action may be facilitated by obtaining the size of the list by using the `inquire_device_class()` function.
C.4. Coordinate Definition (20-24)	EBADRCTD [20]	*Rectangle definition is invalid.* The application program has made a call to `vdc_extent()` or `device_viewport()` with the coordinates of both corners equal in the *x* or *y* dimensions or both. Corrective action involves changing one of the arguments to the function which generated the error so that the values of the two arguments are different in both the *x* and *y* dimensions.

EBDVIEWP [21] *Viewport is not within Device Coordinates.* A call to `device_viewport()` has been made which specifies a viewport larger than the view surface. Corrective action involves making the arguments to `device_viewport()` less than the view surface size. The size of the view surface can be obtained by calling the `inquire_physical_coordinate_system()` function.

ECLIPTOL [22] *Clipping rectangle is too large.* The clipping rectangle would exceed the boundaries of VDC space. Corrective action involves resetting the clipping rectangle to be within the limits of VDC space.

ECLIPTOS [23] *Clipping rectangle is too small.* The clipping rectangle would define an area of screen space smaller than one pixel. The clipping rectangle remains unchanged. Since the occurrence of this error is partially a function of the size of the view surface, changing the size of the view surface may be a viable alternative to changing the size of the clipping rectangle.

EVDCSDIL [24] *VDC space definition is illegal.* One or more of the arguments to the `vdc_extent()` function exceeds the acceptable limits (-32767 to 32767) or the coordinates of the lower-left hand corner are greater than the coordinates of the upper-right hand corner. Corrective action involves changing the arguments to `vdc_extent()`.

C.5. Output Attributes (30-51)

EBTBUNDL [30] *ASF is BUNDLED.* Error 30 is generated when attempting to call an individual attribute function when the attributes are specified by entries in the *attribute table*. Calls to these functions have no effect on the current attributes. Corrective action includes resetting the *attribute selector* to BUNDLED by using the *attribute selector* functions.

EBBDTBDI [31] *Bundle table index out of range.* The entry in the *bundle table* exceeds the size of the table. The only corrective action is to change the value of the *index* argument.

EBTUNDEF [32] *Bundle table index is undefined.* The entry in the *attribute table* specified by the most recent call to an *attribute table* index setting function has not been defined by *SunCGI* or the application program.

EBADLINX [33] *Polyline index is invalid.* The polyline bundle is not defined. Corrective action involves changing the *index* argument to `polyline_bundle_index()`, or by defining the *polyline bundle index.*

EBDWIDTH [34] *Width must be nonnegative.* The width of a perimeter or line must be greater than or equal to zero. The current value of the *perimeter width* or *line width* remains unchanged. Changing the value of the width argument to a nonnegative value will correct this error.

ECINDXLZ [35] *Color index is less than zero.* The value of the *index* argument to one of the attribute functions or the color entry in one of the bundles is negative. Corrective action involves changing the value of the color.

EBADCOLX [36] *Color index is invalid.* The color index argument to one of the attribute functions or the color entry in one of the bundles is not defined in the colormap. Indices in the *color lookup table* must be between 0 and 255 for the Sun 8-bit per pixel frame buffer. Any color specification outside of this range is ignored. Corrective action involves changing the value of the color.

EBADMRKX [37] *Polymarker index is invalid.* The polymarker bundle is not defined. Corrective action involves changing the *index* argument to `polymarker_bundle_index()`, or by defining the *polymarker bundle index.*

EBADSIZE [38] *Size must be nonnegative.* The size of a marker or line must be greater than or equal to zero. The current value of the *marker size* remains unchanged. Changing the value of the size argument to a nonnegative value will correct this error.

EBADFABX [39] *Fill area index is invalid.* The fill area bundle is not defined. Corrective action involves changing the *index* argument to `fill_area_bundle_index()`, or by defining the *fill area bundle index.*

EPATARTL [40] *Pattern array too large.* The pattern array must contain less than 257 elements. The pattern is not entered into the pattern table. Corrective action involves designing a new pattern.

EPATSZTS [41] *Pattern size too small.* The pattern size must be at least two-by-two. The pattern is not entered into the pattern table. Corrective action could include designing a new pattern which includes several replications of the original pattern.

ESTYLLEZ [42] *Style (pattern or hatch) index is less than zero.* All indices in the pattern table must be positive. To fix this mistake, change the argument to the `pattern_index()` or the `hatch_index()` or the entries in the bundle table.

ENOPATNX [43] *Pattern table index not defined.* The argument to the `hatch_index()` or `pattern_index()` function or the entry bundle table should be reset to correspond to a defined value.

EPATITOL [44] *Pattern table index too large.* The *index* argument to `pattern_table()` exceeded the bounds of the pattern table. The pattern is not entered into the pattern table. Redefining the pattern index to be between one and ten will eliminate the error.

EBADTXTX [45] *Text index is invalid.* The text bundle is not defined. Corrective action involves changing the *index* argument to `text_bundle_index()`, or by defining the *text bundle index.*

EBDCHRIX [46] *Character index is undefined.* CGI ignores all character indices other than index 1. You are advised to ignore the `character_set_index()` function entirely.

ETXTFLIN [47] *Text font is invalid.* The text fonts range from 1 to 6. All other integers do not correspond to actual fonts. Corrective action involves changing the argument to the `text_font_index()` function or resetting the *font index* in the text bundle.

ECEXFOOR [48] *Expansion factor is out of range.* The *character expansion factor* or the *character space expansion factor* would result in a character or a space which would exceed the bounds of the screen or would result in a character smaller than the limitations of the character drawing software. To eliminate this error, reset the offending value to within an acceptable range (0.1-2.0 are reasonable guidelines).

ECHHTLEZ [49] *Character height is less than or equal to zero.* The *character height* must be positive. Corrective action involves changing the argument to the *character height* function or the element of the text bundle.

ECHRUPVZ [50] *Length of character up vector or character base vector is zero.* Both the *character up vector* and the *character base vector* must be nonzero. Corrective action involves changing the arguments to the `character_orientation()` function or the element of the text bundle.

ECOLRNGE [51] *RGB values must be between 0 and 255.* The red, green, and blue values are only defined between 0 and 255. The call to `color_table()` that produced the error is ignored. Corrective action requires respecifying the values of the arguments to `color_table()`.

C.6. Output Primitives (60-70)

ENMPTSTL [60] *Number of points is too large.* The number of points exceeds MAXPTS. Change the *n* element of the `Ccoor-list` structure to a value less than or equal to MAXPTS.

EPLMTWPT [61] *polylines must have at least two points.* Change the *n* element of the `Ccoorlist` structure to a value greater than or equal to 2 and add the corresponding points to the *ptlist* element.

EPGMTHPT [62] *Polygons must have at least three points.* Change the *n* element of the `Ccoorlist` structure to a value greater than or equal to 3 and add the corresponding points to the *ptlist* element.

EGPLISFL [63] *Global polygon list is full.* The number of points on the *global polygon list* exceeds MAXPTS. The points which exceed MAXPTS are ignored. This error can be corrected by inserting a call to `polygon()` (which clears the *global polygon list* by displaying its contents) before the call to `partial_polygon()` that caused the overflow.

EARCPNCI [64] *Arc points do not lie on circle.* The starting and ending points of either an open or close circular arc do not lie on the perimeter of the circle described by the arguments *c1* and *rad*. If this error occurs, the arc is not drawn. Corrective action may include determination of the endpoints with the application program (for example *c2.x = rad*cos(start_angle);*).

EARCPNEL [65] *Arc points do not lie on ellipse.* The starting and ending points of either an open or close elliptical arc do not lie on the perimeter of the ellipse described by the arguments *c1*, *c2*, and *c3*. If this error occurs, the arc is not drawn. Corrective action may include determination of the endpoints with the application program.

ECELLATS [66] *Distance between p and q too small for given dx, dy.* The dimensions of the cell array are too small for a cell array element to be mapped onto one pixel of the view surface. The cell array is not drawn. This error depends on the physical size of the view surface as well as the limits of VDC space. Therefore, corrective action might require changing the size of the view surface, VDC space, or both.

ECELLPOS [67] *Cell array dimensions must be positive.* Negative cell array dimensions are not permitted. Corrective action requires changing the parameters to the *cell array* function.

ECELLTLS [68] Is not used.

EVALOVWS [69] *Value outside of view surface.* A coordinate of a pixel array is outside the physical range of the view surface. The pixel array is not drawn. Change the arguments to the `pixel_array()` or `bitblt_source_array()`.

EPXNOTCR [70] *Pixrect not created.* One of the bitblt functions required a user-defined pixrect, and that pixrect had not been created. Corrective action involves creating a pixrect in your application program before calling the offending bitblt function.

C.7. Input (80-97)

EINDNOEX [80] *Input device does not exist.* The input device specification (specified by the *devclass* and *devnum* arguments of most input functions) does not exist. Corrective action involves resetting the device specification to a valid device.

EINDINIT [81] *Input device not initialized.* A call to an input device function specified a device that was not initialized. Calls which generate this error have no effect. A call to `initialize_lid()` should be inserted before the call generating the error.

EINDALIN [82] *Input device already initialized.* An attempt was made to initialize a device that has previously been initialized. The parameters to the offending call to `initialize_lid()` are ignored. Removing the offending call to `initialize_lid()` will correct this error.

EINASAEX [83] *Association already exists.* An attempt is being made to bind the input device to a trigger to which it has been previously bound. The status of the input device trigger are unchanged. This error is purely informational and no corrective action is required.

EINAIIMP [84] *Association is impossible.* An attempt is being made to bind the input device to a trigger to which it cannot be bound. For example, an IC_STRING device cannot be bound to a mouse button. To eliminate this error, change the arguments to the offending call of the `associate()` function.

EINNTASD [85] *Association does not exist.* An attempt to call an input function that specifies a device with no associated triggers was made. The offending call is ignored. Corrective action involves calling `associate()` before the offending call is issued.

EINTRNEX [86] *Trigger does not exist.* An attempt was made to associate or inquire about a trigger which has a number less than one or greater than five. The offending call is ignored. To eliminate the error, change the trigger number.

EINNECHO [87] *Input device does not echo.* CHOICE devices can only echo if one echos the LOCATOR device. Create and use the device as a CHOICE device, but for the `track_on()` function call, pass the device argument as a LOCATOR device, even though it is a CHOICE device.

EINECHON [88] *Echo already on.* A call to `track_on()` has been made to a device whose echoing ability has already been activated. To stop generation of the error either remove the offending call or change the arguments to specify a device whose echo is currently off.

EINEINCP [89] *Echo incompatible with existing echos.* Although *SunCGI* can support certain combinations of echos (such as IC_STRING and IC_LOCATOR), not all combinations are supported. The easiest remedy is to remove the offending call from the application program.

EINERVWS [90] *Echo region larger than view surface.* Error 90 is generated when the rectangle defined by the *echoregion* argument exceeds the limits of VDC space. To eliminate this error, change the values to the *echoregion* argument to be within the confines of VDC space.

EINETNSU [91] *Echo type not supported.* All devices except the IC_STROKE device only support one type of echo. Therefore, assigning a value to *echotype* other than zero or one will produce an error for any device except IC_STROKE. Corrective action involves changing the value of the *echotype* argument.

EINENOTO [92] *Echo not on.* The device echoing has not been turned on. Either remove the call to `track_off()`, turn the echo on, or change the device specification.

EIAEVNEN [93] *Events already enabled.* Events have already been enabled for the specified device. The solution is to remove the offending call to `enable_events()`.

EINEVNEN [94] *Events not enabled.* Events have not been enabled for the specified device. The solution is to include a call to `enable_events()` before a call to the `await_event()`, `sample_input()`, or `get_last_requested_input()` function is made with the specified device as input parameter.

EBADDATA [95] *Contents of input data record are invalid.* The *value* argument of `initialize_lid()` function is out of range or is the wrong type. The solution is to change the contents of the *value* argument.

`ESTRSIZE` [96] *Length of initial string is greater than the implementation defined maximum.* The initial string in the value argument is greater than 80 characters. Shorten the string.

`EINQOVFL` [97] *Input queue has overflowed.* The *event queue* can no longer record input events. Solutions include flushing the *event queue* or dequeueing events with the `await_event()`, `sample_input()`, or `get_last_requested_input()` function.

C.8. Implementation Dependent (110-112)

`EMEMSPAC` [110] *Space allocation has failed.* A function that was supposed to work has failed. The only action which you can take is to eliminate other processes which may be using memory. If you have eliminated all other processes, and this error is still generated, please contact Sun Microsystems.

`ENOTCSTD` [111] *Function or argument not compatible with standard CGI.* A function call is not supported by the CGI library.

`ENOTCCPW` [112] *Function or argument not compatible with CGIPW mode.* A function call is not supported by the CGIPW library.

C.9. Possible Causes of Visual Errors

Table C-1 *Attribute Errors*

Behavior	***Possible Cause***
Attribute setting has no effect	Attribute ASF is set to BUNDLED.
Text attributes have no effect	Text precision is set to CHARACTER. Attribute ASF is set to BUNDLED.
PATTERN fill is the same as HATCH	*pattern index* and *hatch index* are identical. *pattern size* is too small.
PATTERN fill is different on different view surfaces.	View surfaces are of different size.

Table C-2 *Input Errors*

Behavior	***Possible Cause***
Input device does not report	Device not initialized.
Input device does not echo	Echo not initialized.
Input device does not echo on whole view surface	Echo region not set to whole view surface.

Table C-3 *View Surface Errors*

Behavior	***Possible Cause***
Segmentation fault for `open_vws()`	*devdd* argument for `open_vws()` is declared as a pointer (the address of *devdd* should be passed).
No primitives displayed	View surface not initialized.
	View surface not active.
	VDC to device coordinate mapping makes objects too small.
	Clipping rectangle is too small and clipping is ON.
	Perimeter visibility is set to OFF and interior style is set to HOLLOW.
	line color or *fill color* is set to background color.
Primitives displayed on undesired view surfaces	Undesired view surfaces have not been deactivated.
Segmentation fault for inquiry functions	Passing variable instead of address (&) of variable.

Table C-4 *Primitive Errors*

Behavior	*Possible Cause*
Polylines or polymarkers aren't displayed.	Width or size is zero.
	Color is the same as background.
Polygon borders aren't displayed.	Width is zero.
	Color is the same as background.
	Perimeter visibility is set to OFF.
Circles aren't displayed.	Width or size is zero.
	Color is the same as background.
Ellipses aren't displayed.	Width or size is zero.
	Color is the same as background.
Text isn't displayed.	Width or size is zero.
	Color is the same as background.
	Character height is too small.
	Coordinates are outside the range of VDC space or the clipping rectangle.
Cell arrays aren't displayed.	*dx* or *dy* arguments are too small.
	Color is the same as background.
Cell arrays aren't displayed on all active view surfaces.	Mapping from cell size to view surface for smaller view surfaces is too small.
Pixel arrays aren't displayed.	Location is outside of view surface or clipping rectangle.
	Color is the same as background.
Bitblts aren't displayed.	Width or size is zero.
	Color is the same as background.

D

Sample Programs

D

Sample Programs

This chapter contains sample *SunCGI* programs written in C. Refer to Appendix E for sample programs that use CGIPW functions and Appendix F for sample *SunCGI* FORTRAN programs .

D.1. Martini Glass

The following program draws a martini glass. The program exits after 10 seconds.

```
#include <cgidefs.h>

Ccoorlist martinilist;
Ccoor glass_coords[10] = { 0,0,
                           -10,0,
                           -1,1,
                           -1,20,
                           -15,35,
                           15,35,
                           1,20,
                           1,1,
                           10,0,
                           0,0 };
Ccoor water_coords[2] = { -12,33,
                          12,33 };
Ccoor vpll = { -50,-10 };
Ccoor vpur = { 50,80 };

main()
{
    Cvwsurf device;
    Cint name;

    NORMAL_VWSURF(device, PIXWINDD);

    open_cgi();
    open_vws(&name, &device);
    vdc_extent(&vpll, &vpur);

    martinilist.ptlist = glass_coords;
    martinilist.n = 10;
    polyline(&martinilist);
```

```
    martinilist.ptlist = water_coords;
    martinilist.n = 2;
    polyline(&martinilist);

    sleep(10);
    close_vws(name);
    close_cgi();
}
```

D.2. Tracking Box

The following program demonstrates the use of the CGI input functions. A square is displayed on the screen and moved with the mouse. The program exits if the mouse is still for five seconds.

```
#include <cgidefs.h>
#define DEVNUM  1           /* device number */
#define MOUSE_POSITION  5   /* trigger number */
#define TIMEOUT (5 * 1000 * 1000)   /* timeout in microseconds */

Ccoor ulc = {1000, 2000};
Ccoor lrc = {2000, 1000};

main()
{
    Cint name;
    Cvwsurf device;
    Cawresult stat;
    Cinrep sample;  /* device measure value */
    Ccoor samp;     /* LOCATOR's x,y position */
    Cint trigger;   /* trigger number */

    NORMAL_VWSURF(device, PIXWINDD);
    sample.xypt = &samp;
    samp.x = 0;
    samp.y = 27000;

    open_cgi();
    open_vws(&name, &device);
    set_global_drawing_mode(XOR);
    initialize_lid(IC_LOCATOR, DEVNUM, &sample);
    associate(MOUSE_POSITION, IC_LOCATOR, DEVNUM);
    rectangle(&lrc, &ulc);  /* draw first rectangle */
        /* wait TIMEOUT micro-seconds for input and check the status */
    while (request_input(IC_LOCATOR, DEVNUM, TIMEOUT,
        &stat, &sample, &trigger), (stat == VALID_DATA)) {
        if ((sample.xypt->x != ulc.x) || (sample.xypt->y != lrc.y) ) {
            rectangle(&lrc, &ulc);
            lrc.y = sample.xypt->y; /* move to new location */
            lrc.x = (sample.xypt->x + 1000);
            ulc.x = sample.xypt->x;
            ulc.y = (sample.xypt->y + 1000);
```

```
            rectangle(&lrc, &ulc);
        }
    }
    dissociate(MOUSE_POSITION, IC_LOCATOR, DEVNUM);
    release_input_device(IC_LOCATOR, DEVNUM);
    close_vws(name);
    close_cgi();
}
```

D.3. Colored Lines

The following program draws colored lines.

```
#include <cgidefs.h>
#include <stdio.h>

#define NCOLORS 64
#define MIN     0
#define MAX     10000

typedef unsigned char   Color;

static  Ccoor   vpll    = { MIN, MIN }; /* lower left corner */
static  Ccoor   vpur    = { MAX, MAX }; /* upper right corner */

main()
{
        int     name;                   /* view surface name */
        Cvwsurf device;                 /* view surface device */
        Ccoorlist line;                 /* line coordinate list */
        Ccoor   points[2];              /* point list */
        int     i;                      /* position counter */
        Ccentry clist;                  /* color map list */
        Color   red[NCOLORS];           /* red color map */
        Color   green[NCOLORS];         /* green color map */
        Color   blue[NCOLORS];          /* blue color map */

        device.dd = PIXWINDD;           /* select output device */
        open_cgi();                     /* initilize cgi */
        open_vws(&name,&device);        /* open view surface */
        vdc_extent(&vpll,&vpur);        /* reset vdc space */

        line_width_specification_mode(ABSOLUTE);
                                        /* set the line attributes */
        line_width(1.0);

        for(i=0; i<NCOLORS; i++) {      /* set up the color map */
                red[i] = (i*3);
                green[i] = 64;
                blue[i] = 128;
        }
        clist.n = NCOLORS;
        clist.ra = red;
```

```
        clist.ga = green;
        clist.ba = blue;

    color_table(0,&clist);

    for( i=0; i<NCOLORS; i++) {
        line.n = 2;                         /* draw a line */
        line.ptlist = points;
        line_color(i);
        points[0].y = MIN;
        points[0].x = (i*1000);
        points[1].y = MAX;
        points[1].x = (i*1000);
        polyline(&line);
     }
        sleep(3);

        close_vws(name);
        close_cgi();
}
```

E

Using SunCGI and Pixwins

E

Using SunCGI and Pixwins

This appendix describes how to add the richness of CGI's primitives (such as circles and arcs) to the *Pixwins* application through CGIPW. To accomplish this, you must first write a standard *Pixwins* program, which brings up windows and controls the events delivered to them with the notifier. You may then add the CGIPW functions, thus enabling you to draw with both the CGI and *Pixwins* output primitives.[16]

With the CGIPW functions, you can also combine CGI with *Pixwins*' ability to manage multiple (potentially overlapping) windows. The CGI standard does not provide facilities for dealing with multiple overlapping windows.

The command line to compile a CGIPW program is as follows:

```
cc box.c -o box -lcgi -lsuntool -lsunwindow -lpixrect -lm
```

where `box.c` is the source program.

Many CGI calls have been replaced with CGIPW calls. For example, `cgipw_polyline()` replaces `polyline()`. The first argument of each CGIPW function is a pixwin descriptor of type `Ccgiwin`.

The file `<cgipw.h>` must be included in the CGIPW application program instead of `<cgidefs.h>`.

E.1. SunCGI – Pixwins Interface

The five functions `open_pw_cgi()`, `open_cgi_pw()`, `open_cgi_canvas()`, `close_cgi_pw()` and `close_pw_cgi()` are necessary for managing the *SunCGI – Pixwins* interface.

Open Pixwin CGI

```
Cerror open_pw_cgi()
```

`open_pw_cgi()` initializes CGI by setting the attributes to the default values and setting the VDC to device coordinates (i.e. *Pixwin* coordinates) mapping to 1:1. Therefore, all input and output primitives will use device coordinates.

NOTE *As in Pixwins coordinates, the origin of the device coordinates is in the upper left-hand corner instead of the lower left-hand corner.*

[16] This appendix assumes familiarity with both *SunCGI* and *Pixwins*. See the *SunView 1 Programmer's Guide* for designing the application's *Pixwins* windows, input, color usage, and output.

The entire window is used, not just a square region within it. No standard errors are specified for `open_pw_cgi()`. If `open_pw_cgi()` returns a nonzero result, then the initialization failed. `open_pw_cgi()` corresponds to `open_cgi()`.

Open a CGI Pixwin

```
Cerror open_cgi_pw(pw, desc, name)
struct pixwin *pw; /* pixwin */
Ccgiwin *desc;     /* CGI pixwin descriptor */
Cint *name;
```

`open_cgi_pw()` informs CGI of the pixwin pointed to by *pw*. Calls to CGI primitives may then reference this pixwin. However, CGI does not guarantee that a pixwin exists or is in any other way properly initialized. *desc* is a pointer to a CGI pixwin descriptor allocated by the application program and defined by `open_cgi_pw()`. It will be used as the first argument to CGIPW functions. Calls may also be made to any pixwin function. Multiple calls to `open_cgi_pw()` with pointers to different `Ccgiwin` structures will allow primitives to be displayed on multiple view surfaces by repeating calls to CGIPW functions with different `Ccgiwin` descriptors. Attributes are local to the pixwin associated with the CGI descriptor passed to the CGIPW attribute functions. `open_cgi_pw()` corresponds to `open_vws()`. `open_pw_cgi()` must be called prior to `open_cgi_pw()`; otherwise, error 111 is returned. Other errors (as with `open_vws()`) may also be detected.

`ENOTOPOP` [5]	CGI not in proper state: CGI shall be either in state CGOP, VSOP, or VSAC.
`ENOWSTYP` [11]	Specified view surface type does not exist.
`EMAXVSOP` [12]	Maximum number of view surfaces already open.
`EMEMSPAC` [110]	Space allocation has failed.
`ENOTCSTD` [111]	Function or argument not compatible with standard CGI.

Open a CGI Canvas

```
Cerror open_cgi_canvas(canvas, desc, name)
Canvas canvas;
Ccgiwin *desc;
Cint *name;
```

`open_cgi_canvas()` is a view surface initialization function for compatibility with *SunView* canvases. This must be used instead of `open_cgi_pw()`, so *SunCGI* knows to handle coordinate transformation and window repainting in a way that is compatible with the *Canvas* package.

`open_cgi_canvas()` is used in place of `open_cgi_pw()` to initialize *SunCGI* to use a canvas. This gives *SunCGI* the canvas handle, which is a higher-level object than a pixwin. After calling this initialization function, the resultant descriptor can be treated like that from `open_cgi_pw()` for calling any CGIPW function, including `close_cgi_pw()`. Note that a canvas is a pointer to the canvas handle of type *Canvas* returned by `window_create()`.

With the exception of input functions, CGIPW functions should work correctly with canvases. In particular, the new *SunCGI* extension

`cgipw_set_vdc_extent()` will correctly map the VDC extent to the underlying canvas. *SunCGI* input should not be used with canvases, since the *Canvas* package handles all input events on the canvas by calling a client handler function. *SunCGI* has no knowledge of this handler, and would consume input events the *Canvas* package expects, thus interfering with scrollbars and tool border functions such as menus.

Close a CGI Pixwin

```
Cerror close_cgi_pw(desc)
Ccgiwin *desc; /* CGI pixwin descriptor */
```

`close_cgi_pw()` takes the CGI pixwin descriptor *desc* as an argument and removes it from the list of pixwins to which CGI writes. The pixwin is *not* closed. `close_cgi_pw()` corresponds to `close_vws()`, and may return any of the errors `close_vws()` detects (except 112).

`ENOTOPOP` [5]	CGI not in proper state: CGI shall be either in state CGOP, VSOP, or VSAC.
`EVSIDINV` [10]	Specified view surface name is invalid.
`EVSNOTOP` [13]	Specified view surface not open.

Close Pixwin CGI

```
Cerror close_pw_cgi()
```

`close_pw_cgi()` takes care of leaving CGI in an orderly state. This function should be called before exiting the application program. `close_pw_cgi()` corresponds to `close_cgi()`.

`ENOTOPOP` [5]	CGI not in proper state: CGI should be in state CGOP, VSOP, or VSAC.

E.2. Using CGIPW

After calling the two initialization functions (`open_pw_cgi()` and `open_cgi_pw()`), the application program may call functions from both the *Pixwins* and CGIPW libraries.

Since CGIPW functions use a 1:1 mapping from VDC to device coordinates, attributes in VDC units (such as *pattern size* and *character height*) will be huge unless they are reset. And because the CGIPW origin is the device coordinate origin, the upper left-hand corner, attributes with direction or position (for example, *pattern reference point* and *character orientation*) have their meaning reversed in the *y* dimension.

Most CGIPW functions do not print error messages even if the error warning mask is INTERRUPT or POLL. They all return error codes which may be tested.

NOTE *The application program should not use both SunCGI and window system input functions, since both SunCGI and the window system share a common event queue. For example, events handled by a SunCGI function will not be handled by a window system call after the SunCGI call. However,* `pw_putcolormap()` *calls before, within, and after the call to open CGIPW will change the colormap.*

E.3. CGIPW Functions

Table E-1 contains a list of functions available in CGIPW. If a function is not included in this table, then use the normal *SunCGI* function except as described in Table E-2. *SunCGI* functions incompatible with CGIPW are given in Table E-2.

Most of the functions listed in Table E-1 are output and attribute functions; however, the tracking functions are listed so that you can control which surfaces input devices echo on. The arguments of the CGIPW functions are the same as those of the *SunCGI* functions except that the first argument is always a *desc* argument of type `Ccgiwin`. *desc* is a pointer to a pixwin descriptor filled in by the `open_cgi_pw()` function.

`partial_polygon()` may be used with `cgipw_polygon()`, but the *global polygon list* is freed after use by `cgipw_polygon()`, so calls to `partial_polygon()` must be repeated prior to use of `cgipw_polygon()` on another view surface.

Table E-1 *List of CGIPW Functions*

SunCGI Function Name	*CGIPW Function Name*
`append_text(flag, tstring)`	`cgipw_append_text(desc, flag, tstring)`
`cell_array(p, q, r, dx, dy, colorind)`	`cgipw_cell_array(desc, p, q, r, dx, dy, colorind)`
`character_expansion_factor(sfac)`	`cgipw_character_expansion_factor(desc, sfac)`
`character_height(height)`	`cgipw_character_height(desc, height)`
`character_orientation(xbase, ybase, xup, yup)`	`cgipw_character_orientation(desc, xbase, ybase, xup, yup)`
`character_path(path)`	`cgipw_character_path(desc, path)`
`character_set_index(index)`	`cgipw_character_set_index(desc, index)`
`character_spacing(spcratio)`	`cgipw_character_spacing(desc, spcratio)`
`circle(c1, rad)`	`cgipw_circle(desc, c1, rad)`
`circular_arc_3pt(c1, c2, c3)`	`cgipw_circular_arc_3pt(desc, c1, c2, c3)`
`circular_arc_3pt_close(c1, c2, c3, close)`	`cgipw_circular_arc_3pt_close(desc, c1, c2, c3, close)`
`circular_arc_center(c1, c2x, c2y, c3x, c3y, rad)`	`cgipw_circular_arc_center(desc, c1, c2x, c2y, c3x, c3y, rad)`
`circular_arc_center_close(c1, c2x, c2y, c3x, c3y, rad, close)`	`cgipw_circular_arc_center_close(desc, c1, c2x, c2y, c3x, c3y, rad, close)`
`color_table(istart, clist)`	`cgipw_color_table(desc, istart, clist)`
`define_bundle_index(index)`	`cgipw_define_bundle_index(desc, index)`
`disjoint_polyline(polycoors)`	`cgipw_disjoint_polyline(desc, polycoors)`
`ellipse(c1, majx, miny)`	`cgipw_ellipse(desc, c1, majx, miny)`
`elliptical_arc(c1, sx, sy, ex, ey, majx, miny)`	`cgipw_elliptical_arc(desc, c1, sx, sy, ex, ey, majx, miny)`
`elliptical_arc_close(c1, sx, sy, ex, ey, majx, miny, close)`	`cgipw_elliptical_arc_close(desc, c1, sx, sy, ex, ey, majx, miny, close)`
`fill_area_bundle_index(index)`	`cgipw_fill_area_bundle_index(desc, index)`
`fill_color(color)`	`cgipw_fill_color(desc, color)`
`fixed_font(index)`	`cgipw_fixed_font(desc, index)`
`hatch_index(index)`	`cgipw_hatch_index(desc, index);`
`inquire_aspect_source_flags()`	`cgipw_inquire_aspect_source_flags(desc);`
`inquire_fill_area_attributes()`	`cgipw_inquire_fill_area_attributes(desc);`

Table E-1 *List of CGIPW Functions— Continued*

SunCGI Function Name	*CGIPW Function Name*
inquire_line_attributes()	cgipw_inquire_line_attributes(desc);
inquire_marker_attributes()	cgipw_inquire_marker_attributes(desc);
inquire_text_attributes()	cgipw_inquire_text_attributes(desc);
inquire_text_extent(tstring, nextchar, concat, lleft, uleft, uright)	cgipw_inquire_text_extent(desc, tstring, nextchar, concat, lleft, uleft, uright)
interior_style(istyle, perimvis)	cgipw_interior_style(desc, istyle, perimvis)
line_color(index)	cgipw_line_color(desc, index)
line_endstyle(ttyp)	cgipw_line_endstyle(desc, ttyp)
line_type(ttyp)	cgipw_line_type(desc, ttyp)
line_width(index)	cgipw_line_width(desc, index)
line_width_specification_mode(mode)	cgipw_line_width_specification_mode(desc, mode)
marker_color(index)	cgipw_marker_color(desc, index)
marker_size(index)	cgipw_marker_size(desc, index)
marker_size_specification_mode(mode)	cgipw_marker_size_specification_mode(desc, mode)
marker_type(ttyp)	cgipw_marker_type(desc, ttyp)
pattern_index(index)	cgipw_pattern_index(desc, index);
pattern_reference_point(open)	cgipw_pattern_reference_point(desc, open)
pattern_size(dx, dy)	cgipw_pattern_size(desc, dx, dy)
perimeter_color(index)	cgipw_perimeter_color(desc, index)
perimeter_type(ttyp)	cgipw_perimeter_type(desc, ttyp)
perimeter_width(width)	cgipw_perimeter_width(desc, width)
perimeter_width_specification_mode(mode)	cgipw_perimeter_width_specification_mode(desc, mode)
pixel_array(pcell, m, n, colorind)	cgipw_pixel_array(desc, pcell, m, n, colorind)
polygon(polycoors)	cgipw_polygon(desc, polycoors)
polyline(polycoors)	cgipw_polyline(desc, polycoors)
polyline_bundle_index(index)	cgipw_polyline_bundle_index(desc, index)
polymarker(polycoors)	cgipw_polymarker(desc, polycoors)
polymarker_bundle_index(index)	cgipw_polymarker_bundle_index(desc, index)
rectangle(lrc, ulc)	cgipw_rectangle(desc, lrc, ulc)
set_aspect_source_flags(flags)	cgipw_set_aspect_source_flags(desc, flags)
text(c1, tstring)	cgipw_text(desc, c1, tstring)
text_alignment(halign, valign, hcalind, vcalind)	cgipw_text_alignment(desc, halign, valign, hcalind, vcalind)
text_bundle_index(index)	cgipw_text_bundle_index(desc, index)
text_color(index)	cgipw_text_color(desc, index)
text_font_index(index)	cgipw_text_font_index(desc, index)
text_precision(ttyp)	cgipw_text_precision(desc, ttyp)
vdc_extent)c1, c2)	cgipw_set_vdc_extent)desc, c1, c2)
vdm_text(c1, flag, tstring)	cgipw_vdm_text(desc, c1, flag, tstring)

Table E-2 *SunCGI Functions not Compatible with CGIPW Mode*

Function	*Discussion*
`clear_control()` †	All clear extents are identical
`clip_indicator()` †	when *cflag* is CLIP_RECTANGLE
`clip_rectangle()` †	Instead, use `pw_region()` prior to `open_cgi_pw()`
`close_cgi()` †	Use `close_pw_cgi()`
`close_vws()` †	Use `close_cgi_pw()`
`device_viewport()` †	use `pw_region()` prior to `open_cgi_pw()`
`open_cgi()`	Use `open_pw_cgi()`
`open_vws()` †	Use `open_cgi_pw()`
`partial_polygon()`	*global polygon list* is freed after `cgipw_polygon()`

† This function produces error `ENOTCCPW [112]`

E.4. Example Programs

The following example program creates a *SunView* canvas. When the user clicks the left mouse button, CGIPW draws a triangle inside a 10-by-10 rectangle.

```
#include <suntool/sunview.h>
#include <suntool/canvas.h>
#include <cgipw.h>

/*
 *      SunView window handles
 */
Frame   frame;
Canvas  canvas;

/*
 *      CGIPW canvas
 */
Ccgiwin vpw;

/*
 *      Canvas event handler
 */

canvas_event_proc( window, event)
Window  window;     /* unused */
Event   *event;
{
        if (event_is_down( event))
                return;

        switch (event_id( event)) {

        case MS_LEFT:
                draw_box_at( event_x( event), event_y( event));
                break;

        case MS_MIDDLE:
        printf("print_canvas_event: 0);
        printf("canvas x,y = (%d,%d)0,
                event_x(event), event_y(event));
        canvas_window_event( canvas, event);
        printf("pixwin region x,y = (%d,%d)0,
                event_x(event), event_y(event));
                break;

        case MS_RIGHT:
                window_done( frame);
        close_cgi_pw( &vpw);
        close_pw_cgi();
                exit(0);

        default:
                break;
        }
}
```

```
main()
{
    Cint     name;          /* goes unused in this example */

        frame = window_create( NULL, FRAME, 0);
        canvas = window_create( frame, CANVAS,
                CANVAS_AUTO_SHRINK,     FALSE,
                WIN_EVENT_PROC,         canvas_event_proc,
                CANVAS_WIDTH,           1000,
                CANVAS_HEIGHT,          1000,
                WIN_VERTICAL_SCROLLBAR, scrollbar_create(0),
                WIN_HORIZONTAL_SCROLLBAR,scrollbar_create(0),
                0);

        open_pw_cgi();
        open_cgi_canvas( canvas, &vpw, &name);
        window_main_loop( frame);
}


/*
 *      draw_box_at()
 *
 *      Draw a rectangular box using the passed x,y point as
 *      the upper left corner of the box.
 */
draw_box_at(x,y)
int     x,y;
{
        Ccoor   lr,ul;
        Ccoor   triangle[3];
        Ccoorlist coorlist;

        ul.x = x;
        ul.y = y;
        lr.x = x + 10;
        lr.y = y + 10;
        cgipw_rectangle( &vpw, &lr, &ul);
        triangle[0].x = x+2;
        triangle[0].y = y+7;
        triangle[1].x = x+8;
        triangle[1].y = y + 7;
        triangle[2].x = x + 5;
        triangle[2].y = y + 2;
        coorlist.n = 3;
        coorlist.ptlist = triangle;
        cgipw_polygon( &vpw, &coorlist);
}
```

The next example draws using *SunView* and CGIPW operations in a canvas. If *SunView* color is initialized, the *SunView* output primitives and the CGIPW output primitives both recognize the *SunView* colormap.

```
#include        <suntool/sunview.h>
#include        <suntool/panel.h>
#include        <suntool/canvas.h>
#include        <suntool/scrollbar.h>
#include        <sunwindow/notify.h>
#include        <cgipw.h>
#include        <math.h>

Frame           frame;
Panel           panel;
Panel_item      button;
int             button_notify();
Canvas          canvas;
Pixwin          *pw;
Ccgiwin         desc;
Cint            name;
u_char          red[8], green[8], blue[8];


main()
{
        initialize_sunview();
        set_up_sunview_colors();
        initialize_cgipw();
        window_main_loop( frame);
}

int
initialize_sunview()    /* initialize Sunview */
{
        frame = window_create( NULL, FRAME, 0);

        panel = window_create(frame, PANEL, 0);
        button= panel_create_item( panel, PANEL_BUTTON,
                  PANEL_LABEL_IMAGE,    panel_button_image(panel, "Draw",4,0),
                  PANEL_NOTIFY_PROC,    button_notify,
                  0);
        window_fit_height( panel);

        canvas= window_create(frame, CANVAS,
                        CANVAS_RETAINED,          TRUE,
                        CANVAS_WIDTH,             750,
                        CANVAS_HEIGHT,            750,
                        WIN_VERTICAL_SCROLLBAR,   scrollbar_create(0),
                        WIN_HORIZONTAL_SCROLLBAR,  scrollbar_create(0),
                        CANVAS_FIXED_IMAGE,         TRUE,
                        CANVAS_AUTO_EXPAND,         FALSE,
                        CANVAS_AUTO_SHRINK,         FALSE,
                        0);

        pw = canvas_pixwin( canvas);
}
```

```
int
initialize_cgipw()      /* initialize cgi, view surface */
{
        open_pw_cgi();
        open_cgi_canvas( canvas, &desc, &name);
}

button_notify()
{
        Ccoor           center;
        Cint            radius;

        printf("we are in the panel button notify proc0);
        pw_vector(pw, 000, 000, 100, 100, PIX_SRC| PIX_COLOR(1), 1);
        pw_vector(pw, 100, 100, 200, 200, PIX_SRC| PIX_COLOR(2), 1);
        pw_vector(pw, 200, 200, 300, 300, PIX_SRC| PIX_COLOR(3), 1);
        pw_vector(pw, 300, 300, 400, 400, PIX_SRC| PIX_COLOR(4), 1);
        pw_vector(pw, 400, 400, 500, 500, PIX_SRC| PIX_COLOR(5), 1);
        pw_vector(pw, 500, 500, 600, 600, PIX_SRC| PIX_COLOR(6), 1);
        pw_text( pw, 20, 20, PIX_SRC| PIX_COLOR(7), 0, "canvas text");

        interior_style( SOLIDI, ON);
        perimeter_color( 3);            /* set perimeter color */
        fill_color( 3);                         /* set fill color */
        center.x = 400;
        center.y = 400;
        radius   =  50;
        cgipw_circle( &desc, &center, radius);
}

set_up_sunview_colors()
{
    /* initialize Sunview colormap */
        red[0] = 255;   green[0] = 255;  blue[0] = 255;   /* white */
        red[1] = 000;   green[1] = 255;  blue[1] = 000;   /* green */
        red[2] = 000;   green[2] = 000;  blue[2] = 255;   /* blue */
        red[3] = 255;   green[3] = 255;  blue[3] = 000;   /* yellow */
        red[4] = 000;   green[4] = 255;  blue[4] = 255;   /* aqua */
        red[5] = 255;   green[5] = 000;  blue[5] = 255;   /* purple */
        red[6] = 255;   green[6] = 000;  blue[6] = 000;   /* red */
        red[7] = 000;   green[7] = 000;  blue[7] = 000;   /* black */

        pw_setcmsname( pw, "my_colors");
        pw_putcolormap(pw, 0, 8, red, green, blue);
}
```

F

Using SunCGI with FORTRAN Programs

F

Using SunCGI with FORTRAN Programs

All functions provided in *SunCGI* may be called from FORTRAN programs by linking them with the `libcgi77.a` library. This is done by using the *f77* compiler with a command line like:

```
% f77 -o box box.f -lcgi77 -lcgi -lsunwindow -lpixrect -lm
```

where `box.f` is the FORTRAN source program. Note that `libcgi.a` must be linked with the program (the `-lcgi` option), and `libcgi77.a` must precede it (the `-lcgi77` option).

Defined constants may be referenced in source programs by including `cgidefs77.h`. In a FORTRAN program, this must be done via a source statement like:

```
include 'cgidefs77.h'
```

This include statement must be in each FORTRAN program unit which uses the defined constants, not just once in each source program file.

In the Sun release of FORTRAN, names are restricted to sixteen characters in length and may not contain the underline character. For this reason, FORTRAN programs must use abbreviated names to call the corresponding *SunCGI* functions. The correspondence between the full *SunCGI* names and the FORTRAN names appears later in this appendix. In addition, FORTRAN declarations for all *SunCGI* functions appear at the end of this appendix.

F.1. Programming Tips

- The abbreviated names of the *SunCGI* functions are less readable than the full length names because the underline character cannot be used in the FORTRAN names. However, since FORTRAN doesn't distinguish between upper-case and lower-case letters in names, upper-case characters can be used to improve readability.
- Character strings passed from FORTRAN programs to *SunCGI* cannot be longer than 256 characters.
- Pointers returned by C functions are handled in FORTRAN as `integer*4` values, and exist solely to be passed to other Sun graphics functions.

- FORTRAN passes all arguments by reference. Although some *SunCGI* functions receive arguments by value, the FORTRAN programmer need not worry about this. The interface routines in `/usr/lib/libcgi77.a` handle this situation correctly. When in doubt, look at the FORTRAN declarations for *SunCGI* functions at the end of this appendix.
- Some *SunCGI* functions have structures as arguments or return values. These are handled in FORTRAN by unbundling the structures into separate arguments. In general, these will be in the same order, and have the same names, as the members of the C structures. One exception is the `Ccoorlist` structure, which is replaced in FORTRAN with an array of *x*'s, and one of *y*'s, rather than an array of *x*-*y* pairs. You may need to consult both the C and FORTRAN documentation to determine which FORTRAN arguments are input values, and which are output.
- Since FORTRAN does not distinguish between upper-case letters and lower-case letters in identifiers, any FORTRAN program unit which includes the `cgidefs77.h` header file cannot use the same spelling as any constant defined in that header file, regardless of case.
- The function `cfqoutcap` returns the FORTRAN binding names of the output capabilities, rather than the C bindings. This is an exception to the rule that the FORTRAN library provides a transparent interface to the C functions.

F.2. Example Programs

The following example is the FORTRAN equivalent of the very simple program for drawing a martini glass.

```
      include "/usr/include/f77/cgidefs77.h"
C
      parameter (ibignum=256)
C
      integer name
      character screenname*(ibignum)
      integer screenlen
      character windowname*(ibignum)
      integer windowlen
      integer windowfd
      integer retained
      integer dd
      integer cmapsize
      character cmapname*(ibignum)
      integer cmaplen
      integer flags
      character ptr*(ibignum)
      integer noargs
C
      integer xc(10), yc(10), n
      integer xc2(2), yc2(2)
      data xc /0, -10, -1, -1, -15, 15, 1, 1, 10, 0/
      data yc /0,   0,  1, 20,  35, 35, 20, 1, 0, 0/
      data xc2 /-12, 12/
      data yc2 /33,  33/
```

```
C
C       Initialize CGI and view surface
C
        call cfopencgi()
        dd = 4
        call cfopenvws(name, screenname,  windowname,
     .          windowfd, retained, dd ,cmapsize,
     .          cmapname,  flags, ptr, noargs)
        call cfvdcext( -50, -10, 50, 80)
C
C       Set clipping off
C
        call cfclipind(0)
C
C       Draw the martini glass
C
        n = 10
        call cfpolyline( xc, yc, n)
        n = 2
        call cfpolyline( xc2, yc2, n)
C
C       Display the glass for 5 seconds
C
        call sleep(5)
C
C       Terminate graphics
C
    call cfclosevws(name)
        call cfclosecgi()
        call exit()
        end
```

The next example is the FORTRAN equivalent of the program for drawing colored lines.

```
      program f77colors

          include '/usr/include/f77/cgidefs77.h'

          integer         name
      integer     x(2),y(2)
          integer         ncolors
          integer         red(8),grn(8),blu(8)
          ncolors = 8
C
C     Open CGI
C
      call cfopencgi()
C
C     Open a view surface
C
      call cfopenvws(name,0,0,0,1,CGPIXWINDD,ncolors,'Color',0,0)
C
C     Set color map
C
      call setupcolors( red, grn, blu)
C
C     Assign the color map
C
      call cfcotable(1,red,grn,blu,ncolors)
C
C   Draw the lines
C
     do 11 i = 1, ncolors
               call cflncolor(i)
               x(1) = i * 2000
               y(1) = 0
               x(1) = i * 2000
               y(2) = 30000
               call cfpolyline(x,y,2)
      11 continue
C
C     Wait 10 seconds
C
      call sleep(10)
C
C     Close CGI
C
          call cfclosevws(name)
      call cfclosecgi()
      end

C
C     Subroutine to set up the colormap
C
      subroutine setupcolors( red, grn, blu)
      integer red(8)
```

```
      integer grn(8)
      integer blu(8)

C     Set up colormap similar to the default colormap
C     on page 76 except the first color is white, and
C     the last color is black.
C
      red(1) = 255
      grn(1) = 255
      blu(1) = 255

      red(2) = 255
      grn(2) = 0
      blu(2) = 0

      red(3) = 255
      grn(3) = 255
      blu(3) = 0

      red(4) = 0
      grn(4) = 255
      blu(4) = 0

      red(5) = 0
      grn(5) = 128
      blu(5) = 128

      red(6) = 0
      grn(6) = 0
      blu(6) = 255

      red(7) = 128
      grn(7) = 0
      blu(7) = 128

      red(8) = 0
      grn(8) = 0
      blu(8) = 0

      return
      end
```

F.3. FORTRAN Interfaces to SunCGI

Note: Although all *SunCGI* procedures are declared here as functions, each may also be called as a subroutine if the user does not want to check the returned value.

Table F-1 *SunCGI FORTRAN Binding – Part I*

CGI Specification Name	*FORTRAN Binding*
Activate View Surface (SunCGI Extension)	`integer function cfactvws(name)` `integer name`

Append Text	`integer function cfaptext(flag, string)`
	`integer flag`
	`character*(*) string`

Associate	`integer function cfassoc(trigger, devclass, devnum)`
	`integer trigger`
	`integer devclass`
	`integer devnum`

Await Event	`integer function cfawaitev(timeout, valid, devclass,`
	`1 devnum, x, y, xlist, ylist, n, val, choice, string,`
	`2 segid, pickid, message_link, replost, time_stamp,`
	`3 qstat, overflow)`
	`integer timeout`
	`integer valid`
	`integer devclass`
	`integer devnum`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`
	`integer message_link`
	`integer replost`
	`integer time_stamp`
	`integer qstat`
	`integer overflow`

Bitblt Pattern Array	`integer function cfbtblpatarr(pixpat, px, py, pixtarget,`
	`1 rx, ry, ox, oy, dx, dy, name)`
	`integer pixpat`
	`integer px, py`
	`integer pixtarget`
	`integer rx, ry`
	`integer ox, oy`
	`integer dx, dy`
	`integer name`

Table F-1 *SunCGI FORTRAN Binding – Part I— Continued*

CGI Specification Name	*FORTRAN Binding*

Bitblt Patterned Source Array	`integer function cfbtblpatsouarr(pixpat, px, py, pixsource,`
	`1 sx, sy, pixtarget, rx, ry, ox, oy, dx, dy, name)`
	`integer pixpat`
	`integer px, py`
	`integer pixsource`
	`integer sx, sy`
	`integer pixtarget`
	`integer rx, ry`
	`integer ox, oy`
	`integer dx, dy`
	`integer name`

Bitblt Source Array	`integer function cfbtblsouarr(bitsource, xo, yo, xe, ye,`
	`1 bittarget, xt, yt, name)`
	`integer*4 bitsource, bittarget`
	`integer xo, yo, xe, ye, xt, yt`
	`integer name`

Cell Array	`integer function cfcellarr(px, qx, rx, py, qy, ry,`
	`1 dx, dy, colorind)`
	`integer px, py`
	`integer qx, qy`
	`integer rx, ry`
	`integer dx, dy`
	`integer colorind(*)`

Character Expansion Factor	`integer function cfcharexpfac(efac)` `real efac`
Character Height	`integer function cfcharheight(height)` `integer height`
Character Orientation	`integer function cfcharorient(bx, by, dx, dy)` `real bx, by, dx, dy`
Character Path	`integer function cfcharpath(path)` `integer path`
Character Set Index	`integer function cfcharsetix(index)` `integer index`
Character Spacing	`integer function cfcharspacing(efac)` `real efac`

Circle	`integer function cfcircle(x, y, rad)`
	`integer x`
	`integer y`
	`integer rad`

Circular Arc 3pt Close	`integer function cfcircarcthreecl(c1x, c1y, c2x, c2y,`
	`1 c3x, c3y, close)`
	`integer c1x, c1y, c2x, c2y, c3x, c3y`
	`integer close`

Circular Arc 3pt	`integer function cfcircarcthree(c1x, c1y, c2x, c2y,`
	`1 c3x, c3y)`
	`integer c1x, c1y, c2x, c2y, c3x, c3y`

Table F-1 *SunCGI FORTRAN Binding – Part I— Continued*

CGI Specification Name	*FORTRAN Binding*

Circular Arc Center Close	`integer function cfcircarccentcl(c1x, c1y, c2x, c2y,`
	`1 c3x, c3y, rad, close)`
	`integer c1x, c1y, c2x, c2y, c3x, c3y`
	`integer rad`
	`integer close`

Circular Arc Center	`integer function cfcircarccent(c1x, c1y, c2x, c2y, c3x,`
	`1 c3y, rad)`
	`integer c1x, c1y, c2x, c2y, c3x, c3y`
	`integer rad`

Clear Control	`integer function cfclrcont(soft, hard, intern, extent)`
	`integer soft, hard`
	`integer intern`
	`integer extent`

Clear View Surface	`integer function cfclrvws(name, defflag, color)`
	`integer name`
	`integer defflag`
	`integer color`

Clip Indicator	`integer function cfclipind(flag)` `integer flag`
Clip Rectangle	`integer function cfcliprect(xmin, xmax, ymin, ymax)` `integer xmin, xmax, ymin, ymax`
Close CGI (SunCGI Extension)	`integer function cfclosecgi()`
Close View Surface (SunCGI Extension)	`integer function cfclosevws(name)` `integer name`

Table F-2 *SunCGI FORTRAN Binding – Part II*

CGI Specification Name	*FORTRAN Binding*

Color Table	`integer function cfcotable(istart, ra, ga, ba, n)`
	`integer istart`
	`integer ra(*), ga(*), ba(*)`
	`integer n`

Deactivate View Surface (SunCGI Extension)	`integer function cfdeactvws(name)` `integer name`

Table F-2 *SunCGI FORTRAN Binding – Part II— Continued*

CGI Specification Name	*FORTRAN Binding*

Define Bundle Index (SunCGI Extension)	`integer function cfdefbundix(index, linetype, linewidth,`
	`1 linecolor, marktype, marksize, markcolor, intstyle,`
	`2 batchindex, pattindex, fillcolor, perimtype,`
	`3 perimwidth, perimcolor, t3extfont, textprec,`
	`4 charexpand, charspace, textcolor)`
	`integer index`
	`integer linetype`
	`real linewidth`
	`integer linecolor`
	`integer marktype`
	`real marksize`
	`integer markcolor`
	`integer intstyle`
	`integer batchindex`
	`integer pattindex`
	`integer fillcolor`
	`integer perimtype`
	`real perimwidth`
	`integer perimcolor`
	`integer t3extfont`
	`integer textprec`
	`real charexpand`
	`real charspace`
	`integer textcolor`

Device Viewport	`integer function cfdevvpt(name, xbot, ybot, xtop, ytop)`
	`integer name`
	`integer xbot, ybot, xtop, ytop`

Disable Events	`integer function cfdaevents(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Disjoint Polyline	`integer function cfdpolyline(xcoors, ycoors, n)`
	`integer xcoors(*)`
	`integer ycoors(*)`
	`integer n`

Dissociate	`integer function cfdissoc(trigger, devclass, devnum)`
	`integer trigger`
	`integer devclass`
	`integer devnum`

Ellipse	`integer function cfellipse(x, y, majx, miny)`
	`integer x, y`
	`integer majx, miny`

Elliptical Arc Close	`integer function cfelliparccl(x, y, sx, sy, ex, ey,`
	`1 majx, miny, close)`
	`integer x, y`
	`integer sx, sy`
	`integer ex, ey`
	`integer majx, miny`
	`integer close`

Table F-2 *SunCGI FORTRAN Binding – Part II— Continued*

CGI Specification Name	*FORTRAN Binding*

Elliptical Arc	`integer function cfelliparc(x, y, sx, sy, ex, ey, majx,`
	`1 miny)`
	`integer x, y`
	`integer sx, sy`
	`integer ex, ey`
	`integer majx, miny`

Enable Events	`integer function cfenevents(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Fill Area Bundle Index	`integer function cfflareabundix(index)` `integer index`
Fill Color	`integer function cfflcolor(color)` `integer color`
Fixed Font (SunCGI Extension)	`integer function cffixedfont(index)` `integer index`
Flush Event Queue	`integer function cfflusheventqu()`

Get Last Requested Input	`integer function cfgetlastreqinp(devclass, devnum, valid,`
	`1 x, y, xlist, ylist, n, val, choice, string, segid,`
	`2 pickid)`
	`integer devclass`
	`integer devnum`
	`integer valid`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

Hard Reset	`integer function cfhardrst()`
Hatch Index	`integer function cfhatchix(index)` `integer index`

Initialize LID	`integer function cfinitlid(devclass, devnum, x, y, xlist,`
	`1 ylist, n, val, choice, string, segid, pickid)`
	`integer devclass`
	`integer devnum`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

Table F-2 *SunCGI FORTRAN Binding – Part II— Continued*

CGI Specification Name	*FORTRAN Binding*

Initiate Request	`integer function cfinitreq(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Inquire Aspect Source Flags	`integer function cfqasfs(n, num, vals)`
	`integer n`
	`integer num(*)`
	`integer vals(*)`

Inquire Bitblt Alignments	`integer function cfqbtbltalign(base, width, px, py,`
	`1  maxpx, maxpy, name)`
	`integer base`
	`integer width`
	`integer px`
	`integer py`
	`integer maxpx`
	`integer maxpy`
	`integer name`

Inquire Cell Array	`integer function cfqcellarr(name, px, qx, rx, py, qy,`
	`1  ry, dx, dy, colorind)`
	`integer name`
	`integer px, py`
	`integer qx, qy`
	`integer rx, ry`
	`integer dx, dy`
	`integer colorind(*)`

Inquire Device Bitmap	`integer function cfqdevbtmp(name, map)`
	`integer name`
	`integer*4 map`

Inquire Device Class	`integer function cfqdevclass(output, input)` `integer output, input`

Table F-3 *SunCGI FORTRAN Binding – Part III*

CGI Specification Name	*FORTRAN Binding*

Inquire Device Identification	`integer function cfqdevid(name, devid)`
	`integer name`
	`character*(*) devid`

Inquire Drawing Mode	`integer function cfqdrawmode(visibility, source,`
	`1  destination, combination)`
	`integer visibility`
	`integer source`
	`integer destination`
	`integer combination`

Inquire Event Queue State	`integer function cfqevque(qstate, qoflow)`
	`integer qstate`
	`integer qoflow`

Table F-3 *SunCGI FORTRAN Binding – Part III—Continued*

CGI Specification Name	*FORTRAN Binding*

Inquire Fill Area Attributes	`integer function cfqflareaatts(style, vis, color, hindex,`
	`1 pindex, bindex, pstyle, pwidth, pcolor)`
	`integer style, vis, color`
	`integer hindex, pindex, bindex`
	`integer pstyle`
	`real pwidth`
	`integer pcolor`

Inquire Input Capabilities	`integer function cfqinpcaps(valid, numloc, numval, numstrk,`
	`1 numchoice, numstr, numtrig, evqueue, asynch, coordmap,`
	`2 echo, tracking, prompt, acknowledgement, trigman)`
	`integer valid`
	`integer numloc`
	`integer numval`
	`integer numstrk`
	`integer numchoice`
	`integer numstr`
	`integer numtrig`
	`integer evqueue`
	`integer asynch`
	`integer coordmap`
	`integer echo`
	`integer tracking`
	`integer prompt`
	`integer acknowledgement`
	`integer trigman`

Inquire LID State List	`integer function cfqlidstatelis(devclass, devnum, valid,`
	`1 state, prompt, acknowledgement, x, y, xlist, ylist, n,`
	`2 val, choice, string, segid, pickid, n, triggers,`
	`3 echotype, echosta, echodat)`
	`integer devclass`
	`integer devnum`
	`integer valid`
	`integer state`
	`integer prompt`
	`integer acknowledgement`
	`integer x`
	`integer y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`
	`integer n`
	`integer triggers(*)`
	`integer echotype`
	`integer echosta`
	`integer echodat`

Table F-3 *SunCGI FORTRAN Binding – Part III— Continued*

CGI Specification Name	*FORTRAN Binding*

Inquire LID State	`integer function cfqlidstate(devclass, devnum, valid,`
	`1 state)`
	`integer devclass`
	`integer devnum`
	`integer valid`
	`integer state`

Inquire LID Capabilities	`integer function cfqlidcaps(devclass, devnum, valid,`
	`1 sample, change, numassoc, trigassoc, prompt,`
	`2 acknowledgement, echo, echotype, n, classdep, state)`
	`integer devclass`
	`integer devnum`
	`integer valid`
	`integer sample`
	`integer change`
	`integer numassoc`
	`integer trigassoc(*)`
	`integer prompt`
	`integer acknowledgement`
	`integer echo(*)`
	`integer echotype(*)`
	`integer n`
	`character*(*) classdep`
	`integer state(*)`

Inquire Line Attributes	`integer function cfqlnatts(style, width, color, index)`
	`integer style`
	`real width`
	`integer color, index`

Inquire Marker Attributes	`integer function cfqmkatts(type, size, color, index)`
	`integer type`
	`real size`
	`integer color, index`

Inquire Output Capabilities	`integer function cfqoutcap(first, last, list)`
	`integer first, last`
	`character*80 list(*)`

Inquire Output Function Set	`integer function cfqoutfunset(level, support)`
	`integer level`
	`integer support`

Inquire Pattern Attributes	`integer function cfqpatatts(cindex, row, column, colorlis,`
	`1 x, y, dx, dy)`
	`integer cindex`
	`integer row`
	`integer column`
	`integer colorlis(*)`
	`integer x`
	`integer y`
	`integer dx`
	`integer dy`

Table F-3 *SunCGI FORTRAN Binding – Part III— Continued*

CGI Specification Name	*FORTRAN Binding*

Inquire Physical Coordinate System	`integer function cfqphyscsys(name, xbase, ybase, xext, yext,`
	`1 xunits, yunits)`
	`integer name`
	`integer xbase, ybase`
	`integer xext, yext`
	`real xunits, yunits`

Inquire Pixel Array	`integer function cfqpixarr(px, py, m, n, colorind, name)`
	`integer px, py`
	`integer m, n`
	`integer colorind(*)`
	`integer name`

Inquire Text Attributes	`integer function cfqtextatts(fontset, index, cfont, prec,`
	`1 efac, space, color, hgt, bx, by, ux, uy, path, halign,`
	`2 valign, hfac, cfac)`
	`integer fontset, index, cfont, prec`
	`real efac, space`
	`integer color, hgt`
	`real bx, by, ux, uy`
	`integer path, halign, valign`
	`real hfac, cfac`

Inquire Text Extent	`integer function cfqtextext(string, nextchar,`
	`1 conx, cony, llpx, llpy, ulpx, ulpy, urpx, urpy)`
	`character*(*) string`
	`character*(*) nextchar`
	`integer conx`
	`integer cony`
	`integer llpx`
	`integer llpy`
	`integer ulpx`
	`integer ulpy`
	`integer urpx`
	`integer urpy`

Inquire Trigger Capabilities	`integer function cfqtrigcaps(trigger, valid, change, n,`
	`1 class, assoc, maxassoc, prompt, acknowledgement,`
	`2 name, description)`
	`integer trigger`
	`integer valid`
	`integer change`
	`integer n`
	`integer class(*)`
	`integer assoc(*)`
	`integer maxassoc`
	`integer prompt`
	`integer acknowledgement`
	`character*(*) name`
	`character*(*) description`

Table F-3 *SunCGI FORTRAN Binding – Part III— Continued*

CGI Specification Name	*FORTRAN Binding*

Inquire Trigger State	`integer function cfqtrigstate(trigger, valid, state, n,`
	`1 class, assoc)`
	`integer trigger`
	`integer valid`
	`integer state`
	`integer n`
	`integer class(*)`
	`integer assoc(*)`

Inquire VDC Type	`integer function cfqvdctype(type)` `integer type`

Interior Style	`integer function cfintstyle(istyle, perimvis)`
	`integer istyle`
	`integer perimvis`

Line Color	`integer function cflncolor(index)` `integer index`
Line Endstyle (SunCGI Extension)	`integer function cflnendstyle(ttyp)` `integer ttyp`
Line Type	`integer function cflntype(ttyp)` `integer ttyp`
Line Width Specification Mode	`integer function cflnspecmode(mode)` `integer mode`

Table F-4 *SunCGI FORTRAN Binding – Part IV*

CGI Specification Name	*FORTRAN Binding*
Line Width	`integer function cflnwidth(index)` `real index`
Marker Color	`integer function cfmkcolor(index)` `integer index`
Marker Size Specification Mode	`integer function cfmkspecmode(mode)` `integer mode`
Marker Size	`integer function cfmksize(index)` `real index`
Marker Type	`integer function cfmktype(ttyp)` `integer ttyp`
Open CGI (SunCGI Extension)	`integer function cfopencgi()`

Table F-4 *SunCGI FORTRAN Binding – Part IV— Continued*

CGI Specification Name	*FORTRAN Binding*

Open View Surface (SunCGI Extension)	`integer function cfopenvws(name, screenname, windowname,`
	`1 windowfd, retained, dd, cmapsize, cmapname, flags,`
	`2 ptr)`
	`integer name`
	`character*(*) screenname`
	`character*(*) windowname`
	`integer windowfd`
	`integer retained`
	`integer dd`
	`integer cmapsize`
	`character*(*) cmapname`
	`integer flags`
	`character*(*) ptr`

Partial Polygon	`integer function cfppolygon(xcoors, ycoors, n, flag)`
	`integer xcoors(*)`
	`integer ycoors(*)`
	`integer n`
	`integer flag`

Pattern Index	`integer function cfpatix(index)` `integer index`
Pattern Reference Point	`integer function cfpatrefpt(x, y)` `integer x, y`
Pattern Size	`integer function cfpatsize(dx, dy)` `integer dx, dy`

Pattern Table	`integer function cfpattable(index, m, n, colorind)`
	`integer index`
	`integer m, n`
	`integer colorind(*)`

Pattern with Fill Color (SunCGI Extension)	`integer function cfpatfillcolor(flag)` `integer flag`
Perimeter Color	`integer function cfperimcolor(index)` `integer index`
Perimeter Type	`integer function cfperimtype(ttyp)` `integer ttyp`
Perimeter Width Specification Mode	`integer function cfperimspecmode(mode)` `integer mode`
Perimeter Width	`integer function cfperimwidth(index)` `real index`

Pixel Array	`integer function cfpixarr(px, py, m, n, colorind)`
	`integer px, py`
	`integer m, n`
	`integer colorind(*)`

Table F-4 *SunCGI FORTRAN Binding – Part IV— Continued*

CGI Specification Name	*FORTRAN Binding*

Polygon	`integer function cfpolygon(xcoors, ycoors, n)`
	`integer xcoors(*)`
	`integer ycoors(*)`
	`integer n`

Polyline Bundle Index	`integer function cfpolylnbundix(index)` `integer index`

Polyline	`integer function cfpolyline(xcoors, ycoors, n)`
	`integer xcoors(*)`
	`integer ycoors(*)`
	`integer n`

Polymarker Bundle Index	`integer function cfpolymkbundix(index)` `integer index`

Polymarker	`integer function cfpolymarker(xcoors, ycoors, n)`
	`integer xcoors(*)`
	`integer ycoors(*)`
	`integer n`

Rectangle	`integer function cfrectangle(xbot, ybot, xtop, ytop)` `integer xbot, ybot, xtop, ytop`

Release Input Device	`integer function cfrelidev(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Table F-5 *SunCGI FORTRAN Binding – Part V*

CGI Specification Name	*FORTRAN Binding*

Request Input	`integer function cfreqinp(devclass, devnum, timeout,`
	`1 valid, trigger, x, y, xlist, ylist, n, val, choice, string,`
	`2 segid, trigger, pickid)`
	`integer devclass`
	`integer devnum`
	`integer timeout`
	`integer valid`
	`integer trigger`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

Reset to Defaults	`integer function cfrsttodefs()`

Table F-5 *SunCGI FORTRAN Binding – Part V— Continued*

CGI Specification Name	*FORTRAN Binding*

Sample Input	`integer function cfsampinp(devclass, devnum, valid, x, y,`
	`1 xlist, ylist, n, val, choice, string, segid, pickid)`
	`integer devclass`
	`integer devnum`
	`integer valid`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

Selective Flush of Event Queue	`integer function cfsflusheventqu(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Set Aspect Source Flags	`integer function cfsaspsouflags(fval, fnum, n)` `integer fval(*), fnum(*), n`

Set Default Trigger Associations	`integer function cfsdefatrigassoc(devclass, devnum)`
	`integer devclass`
	`integer devnum`

Set Drawing Mode	`integer function cfsdrawmode(visibility, source,`
	`1 destination, combination)`
	`integer visibility`
	`integer source`
	`integer destination`
	`integer combination`

Set Error Warning Mask	`integer function cfserrwarnmk(action)` `integer action`
Set Global Drawing Mode (SunCGI Extension)	`integer function cfsgldrawmode(combination)` `integer combination`

Set Initial Value	`integer function cfsinitval(devclass, devnum, x, y,`
	`1 xlist, ylist, n, val, choice, string, segid, pickid)`
	`integer devclass`
	`integer devnum`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

Table F-5 *SunCGI FORTRAN Binding – Part V— Continued*

CGI Specification Name	*FORTRAN Binding*

Set Up SIGWINCH (SunCGI Extension)	`integer function cfsupsig(name, sig_function)`
	`integer name`
	`external sig_function`

Set VALUATOR Range	`integer function cfsvalrange(devnum, mn, mx)`
	`integer devnum`
	`real mn, mx`

Text Alignment	`integer function cftextalign(halign, valign, hcalind,`
	`1  vcalind)`
	`integer halign`
	`integer valign`
	`real hcalind, vcalind`

Text Bundle Index	`integer function cftextbundix(index)` `integer index`
Text Color	`integer function cftextcolor(index)` `integer index`
Text Font Index	`integer function cftextfontix(index)` `integer index`
Text Precision	`integer function cftextprec(ttyp)` `integer ttyp`

Text	`integer function cftext(x, y, string)`
	`integer x`
	`integer y`
	`character*(*) string`

Track Off	`integer function cftrackoff(devclass, devnum, tracktype,`
	`1  action)`
	`integer devclass`
	`integer devnum`
	`integer tracktype`
	`integer action`

Track On	`integer function cftrackon(devclass, devnum, echotype,`
	`1  exlow, eylow, exup, eyup, x, y, xlist, ylist, n, val,`
	`2  choice, string, segid, pickid)`
	`integer devclass`
	`integer devnum`
	`integer echotype`
	`integer exlow`
	`integer eylow`
	`integer exup`
	`integer eyup`
	`integer x, y`
	`integer xlist(*)`
	`integer ylist(*)`
	`integer n`
	`real val`
	`integer choice`
	`character*(*) string`
	`integer segid`
	`integer pickid`

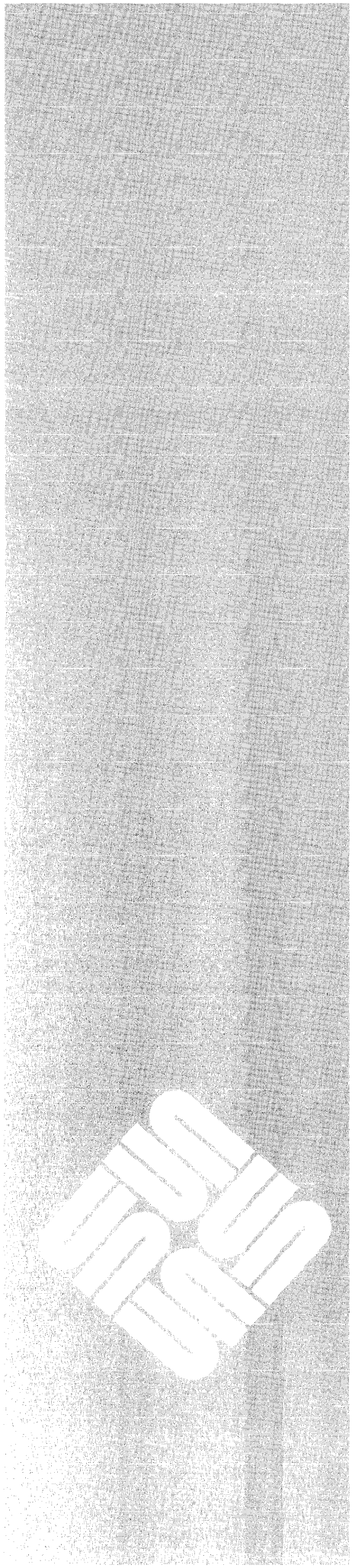
Table F-5 *SunCGI FORTRAN Binding – Part V— Continued*

CGI Specification Name	*FORTRAN Binding*
VDC Extent	`integer function cfvdcext(xbot, ybot, xtop, ytop)` `integer xbot, ybot, xtop, ytop`

VDM Text	`integer function cfvdmtext(x, y, flag, string)`
	`integer x`
	`integer y`
	`integer flag`
	`character*(*) string`

G

Short C Binding



G

Short C Binding

At the time *SunCGI* was implemented, there was no official ANSI C binding for CGI. Sun Microsystems has tried to anticipate the eventual C binding with a set of shorter function names. The *SunCGI* binding is inspired by the C language binding of GKS. These names are contained in the header file `<cgicbind.h>` which must be included in an application program using the short C binding.

Table G-1 *Correspondence Between Long and Short C Names*

Long Name	*Short Name*
`activate_vws()`	`Cactvws()`
`append_text()`	`Captext()`
`associate()`	`Cassoc()`
`await_event()`	`Cawaitev()`
`bitblt_pattern_array()`	`Cbtblpatarr()`
`bitblt_patterned_source_array()`	`Cbtblpatsouarr()`
`bitblt_source_array()`	`Cbtblsouarr()`
`cell_array()`	`Ccellarr()`
`character_expansion_factor()`	`Ccharexpfac()`
`character_height()`	`Ccharheight()`
`character_orientation()`	`Ccharorientation()`
`character_path()`	`Ccharpath()`
`character_set_index()`	`Ccharsetix()`
`character_spacing()`	`Ccharspacing()`
`circle()`	`Ccircle()`
`circular_arc_3pt()`	`Ccircarcthree()`
`circular_arc_3pt_close()`	`Ccircarcthreecl()`
`circular_arc_center()`	`Ccircarccent()`
`circular_arc_center_close()`	`Ccircarccentcl()`
`clear_control()`	`Cclrcont()`
`clear_view_surface()`	`Cclrvws()`
`clip_indicator()`	`Cclipind()`
`clip_rectangle()`	`Ccliprect()`
`close_cgi()`	`Cclosecgi()`
`close_vws()`	`Cclosevws()`
`color_table()`	`Ccotable()`
`deactivate_vws()`	`Cdeactvws()`
`define_bundle_index()`	`Cdefbundix()`

Table G-1 *Correspondence Between Long and Short C Names— Continued*

Long Name	*Short Name*
device_viewport()	Cdevvpt()
disable_events()	Cdaevents()
disjoint_polyline()	Cdpolyline()
dissociate()	Cdissoc()
echo_off()	Cechooff()
echo_on()	Cechoon()
echo_update()	Cechoupd()
ellipse()	Cellipse()
elliptical_arc()	Celliparc()
elliptical_arc_close()	Celliparccl()
enable_events()	Cenevents()
fill_area_bundle_index()	Cflareabundix()
fill_color()	Cflcolor()
fixed_font()	Cfixedfont()
flush_event_queue()	Cflusheventqu()
get_last_requested_input()	Cgetlastreqinp()
hard_reset()	Chardrst()
hatch_index()	Chatchix()
initialize_lid()	Cinitlid()
initiate_request()	Cinitreq()
inquire_aspect_source_flags()	Cqasfs()
inquire_bitblt_alignments()	Cqbtblalign()
inquire_cell_array()	Cqcellarr()
inquire_device_bitmap()	Cqdevbtmp()
inquire_device_class()	Cqdevclass()
inquire_device_identification()	Cqdevid()
inquire_drawing_mode()	Cqdrawmode()
inquire_event_queue_state()	Cqevquestate()
inquire_fill_area_attributes()	Cqflareaatts()
inquire_input_capabilities()	Cqinpcaps()
inquire_lid_capabilities()	Cqlidcaps()
inquire_lid_state()	Cqlidstate()
inquire_lid_state_list()	Cqlidstatelis()
inquire_line_attributes()	Cqlnatts()
inquire_marker_attributes()	Cqmkatts()
inquire_output_capabilities()	Cqoutcap()
inquire_output_function_set()	Cqoutfunset()
inquire_pattern_attributes()	Cqpatatts()
inquire_physical_coordinate_system()	Cqphyscsys()
inquire_pixel_array()	Cqpixarr()
inquire_text_attributes()	Cqtextatts()
inquire_text_extent()	Cqtextext()
inquire_trigger_capabilities()	Cqtrigcaps()
inquire_trigger_state()	Cqtrigstate()
inquire_vdc_type()	Cqvdctype()
interior_style()	Cintstyle()

Table G-1 *Correspondence Between Long and Short C Names— Continued*

Long Name	*Short Name*
line_color()	Clncolor()
line_endstyle()	Clnendstyle()
line_type()	Clntype()
line_width()	Clnwidth()
line_width_specification_mode()	Clnwidthspecmode()
marker_color()	Cmkcolor()
marker_size()	Cmksize()
marker_size_specification_mode()	Cmksizespecmode()
marker_type()	Cmktype()
open_cgi()	Copencgi()
open_vws()	Copenvws()
partial_polygon()	Cppolygon()
pattern_index()	Cpatix()
pattern_reference_point()	Cpatrefpt()
pattern_size()	Cpatsize()
pattern_table()	Cpattable()
pattern_with_fill_color()	Cpatfillcolor()
perimeter_color()	Cperimcolor()
perimeter_type()	Cperimtype()
perimeter_width()	Cperimwidth()
perimeter_width_specification_mode()	Cperimwidthspecmode()
pixel_array()	Cpixarr()
polygon()	Cpolygon()
polyline()	Cpolyline()
polyline_bundle_index()	Cpolylnbundix()
polymarker()	Cpolymarker()
polymarker_bundle_Index()	Cpolymkbundix()
rectangle()	Crectangle()
release_input_device()	Crelidev()
request_input()	Creqinp()
reset_to_defaults()	Crsttodefs()
sample_input()	Csampinp()
selective_flush_of_event_queue()	Cselectflusheventqu()
set_aspect_source_flags()	Csaspsouflags()
set_default_trigger_associations()	Csdefatrigassoc()
set_drawing_mode()	Csdrawmode()
set_error_warning_mask()	Cserrwarnmk()
set_global_drawing_mode()	Csgldrawmode()
set_initial_value()	Csinitval()
set_up_sigwinch()	Csupsig()
set_valuator_range()	Csvalrange()
text()	Ctext()
text_alignment()	Ctextalign()
text_bundle_index()	Ctextbundix()
text_color()	Ctextcolor()
text_font_index()	Ctextfontix()

Table G-1 *Correspondence Between Long and Short C Names— Continued*

Long Name	*Short Name*
`text_precision()`	`Ctextprec()`
`track_off()`	`Ctrackoff()`
`track_on()`	`Ctrackon()`
`vdc_extent()`	`Cvdcext()`
`vdm_text()`	`Cvdmtext()`

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