ESV Workstation

ES/PEX

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Introduction

The ESV Workstation supports PEX (PHIGS Extension to X), which gives the user access to the X Window System, the PHIGS (Programmer's Hierarchical Interactive Graphics System) standard interface, and the proposed PHIGS PLUS (PHIGS Plus Lumiere und Surfaces) standard.

PEX has not yet been released by the X Consortium. Evans & Sutherland is a sponsor of the X Consortium, and ES/PEX is based on the PEX PR2.0 sample implementation from the X Consortium. Evans & Sutherland will continue to follow the PEX development, and, upon release of the PEX extension to public domain, will provide a PEX-compatible server on the ESV Workstation.

Since the Application Programmers Interface (API) for the C language to PHIGS and PHIGS PLUS is not yet an official standard, the PEX development work by the X Consortium is being done using the Sun-defined C language interface. This is also the interface currently used by ES/PEX.

Caution: It should be emphasized that PEX is still in the development period, and it is not yet a standard. Therefore, programs that run under the current release of ES/PEX may have to be recompiled or altered for future releases.

This document contains the following sections:

- "What Is PEX?" describes the X Model, the PHIGS Model, and the PEX Model.
- "Functional Overview" contains a general discussion of the ES/PEX function types supported by the ESV Workstation.
- "PHIGS and PHIGS PLUS Functions" contains a list of all of the PHIGS and PHIGS PLUS functions and identifies those that are not currently supported.
- "OPEN PEX" describes the **OPEN PEX** function.
- "OPEN WORKSTATION" describes the **OPEN WORKSTATION** function.
- "Function Numbers" contains a list of the function numbers with the corresponding function name. Function numbers are returned with error messages.
- "Error Messages" contains a list of the error numbers with the corresponding error description. Error numbers are returned with error messages.
- "PHIGS and PHIGS PLUS Tables" contains the PHIGS Description Table, PHIGS PLUS Description Table, PHIGS Workstation Description Table, and the PHIGS PLUS Workstation Description Table.

What Is PEX?

The X Window System is a publicly available protocol that supports 2D graphics. PEX is an extension to the X Window System which allows X to support 3D graphics and gives a user application access to the PHIGS and PHIGS PLUS functions. To understand PEX, we must first look at the X Model and the PHIGS Model. Figure 1 shows a simplified schematic of the X Model, Figure 2 shows a simplified schematic of the PHIGS Model, and Figure 3 shows a simplified schematic of the PEX Model.

The X Model

The X Model is divided into two parts: the *client* and the *server*. The *server* controls the graphics display and is the interface between the client and the graphics display. The *client* is a user application that may or may not be running on the same system as the graphics display.

The X Window System defines the device-independent *protocol* between the client and the server. Xlib and the X Server are sample implementations of the X Protocol on a specific system, such as the ESV Workstation, and are device dependent. A user application calls the Xlib functions, which, in turn, generate data packets defined by the X Protocol. The X Server translates these data packets into commands that control the graphics display.

The PHIGS Model

PHIGS is a functional specification defining the interface between a user application and the graphics system that displays the application. PHIGS is device independent.

PHIGS creates application data structures that are stored in an area called the central store structure (CSS), which is also created by PHIGS. The data structures can be posted to one or more *workstations*, or *devices*, which are also created by PHIGS. A *workstation* may or may not be equivalent to a hardware system, such as the ESV Workstation.

The PEX Model

The X Window System permits the addition of extensions, which are also protocols. PEX is one extension. Other extensions on the ESV Workstation include the X Input Extension and the X Picking Extension. PEX is an addition to the X Protocol which gives a user application access to the X Window System through PHIGS and PHIGS PLUS functions.

With the PEX, X Input, and X Picking extensions added to the X Window System, a user application has access to the Xlib functions, the PHIGS and PHIGS PLUS functions, and the X Input and X Picking functions. An application call to a PHIGS or PHIGS PLUS function is translated into a PEX protocol data packet which is sent to the X Server through Xlib. The X Server recognizes the data packet as being from PEX and transfers it to the PEX routines in the X Server for processing. The X Input and X Picking data packets are processed in a similar manner.

If a PHIGS *workstation* is created on the ESV Workstation, the display surface of the PHIGS *workstation* will be mapped to an X window that is opened on the ESV Workstation. If the PHIGS *workstation* is closed, the X window will remain open but will revert to a 2D window.

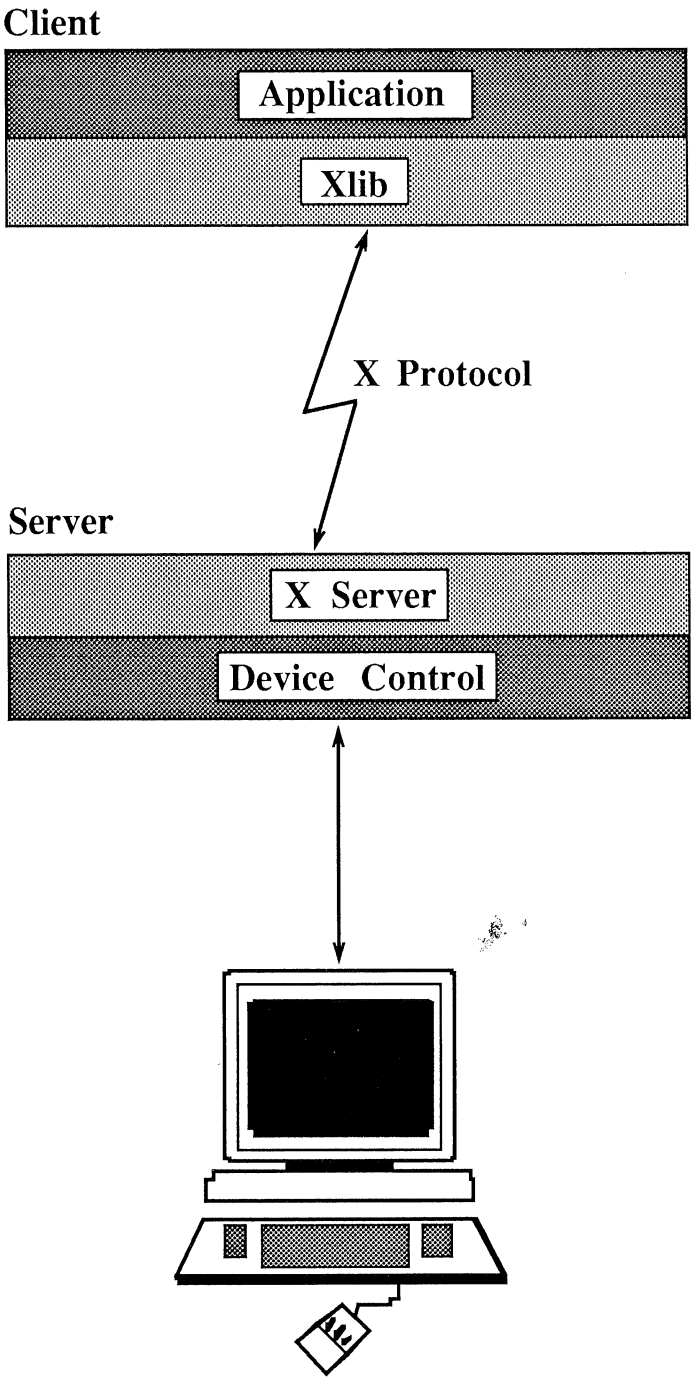

Figure 1. The X Model

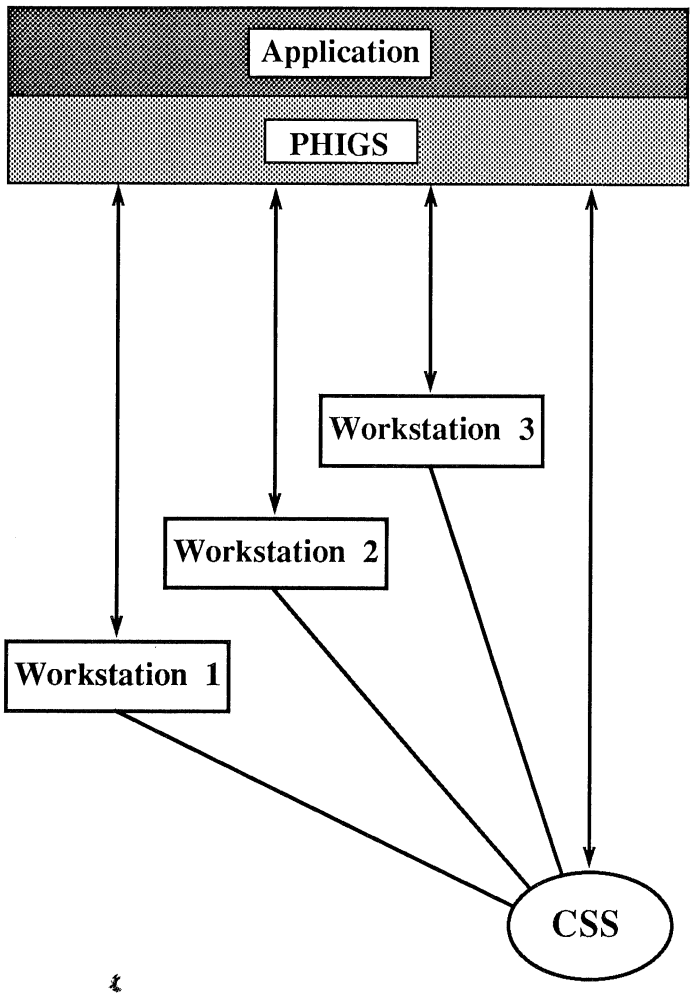

Figure 2. The PHIGS Model

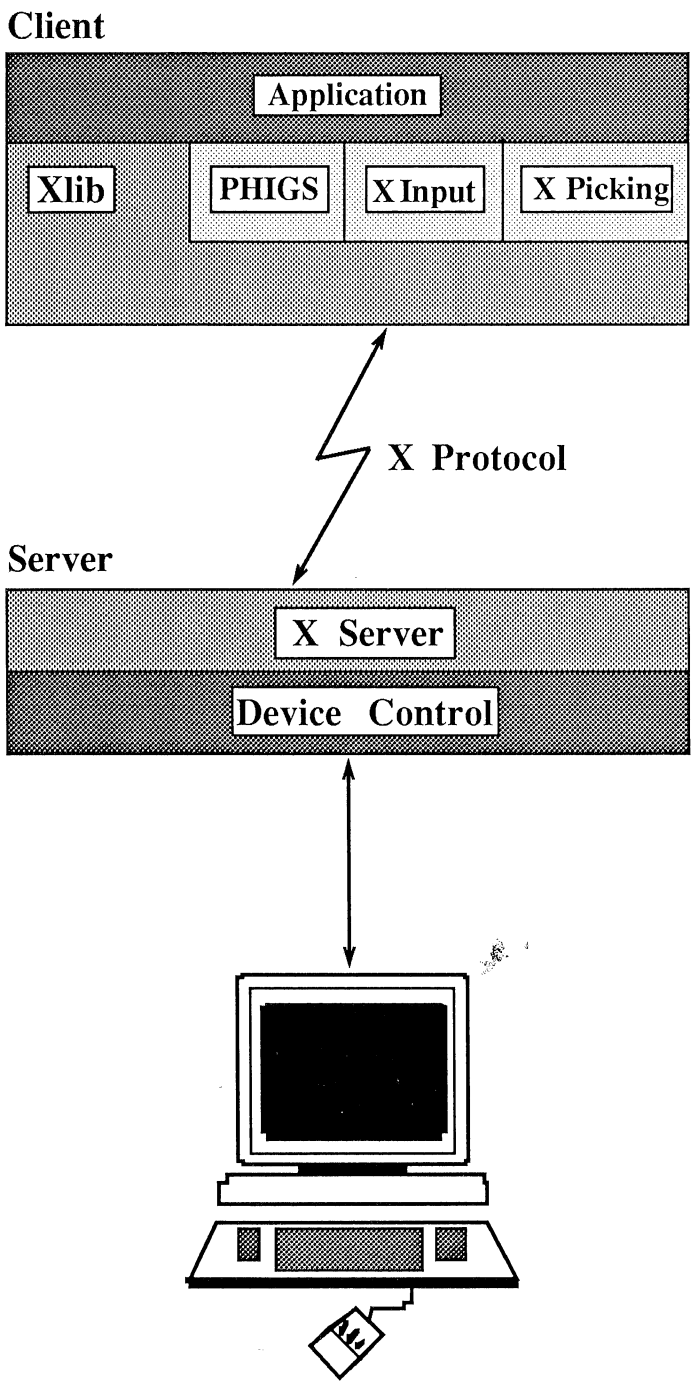

Figure 3. The PEX Model

Functional Overview

PHIGS and PHIGS PLUS capabilities are expressed by functions and the parameter ranges of those functions. It should be understood that not all implementations will be able to support all capabilities. The PHIGS standard outlines a set of minimum support criteria; and, depending on the implementation, the parameter range provided by a specific implementation may exceed the minimum criteria.

The following list is a very generalized outline of the PHIGS and PHIGS PLUS functionality not currently supported by the ESV Workstation.

- Archival
- B-spline curves and surfaces
- Cell arrays
- Curve and surface approximation by subdivision
- Escapes
- Generalized drawing primitives
- Generalized structure elements
- Incremental spatial search
- Input
- Line width
- Metafiles
- Model space clip
- Non-default line types
- Non-default marker types
- Patterning and hatching of fill areas
- Phong or dot product shading
- Quadrilateral mesh
- Raster or polygon text
- Text precision other than stroke
- Triangle strip
- Trimming curves

Interior Styles

The ESV Workstation supports interior styles **Solid**, **Empty**, and **Hollow**.

Light Source Types and Table Indices

The ESV Workstation supports the following light source types:

- **ambient** (1)
- **directional (vector)** (2)
- **positional (point)** (3)
- **positional (spot)** (4)

Linetypes and Edgetypes

The ESV Workstation supports the following four required edgetypes and linetypes:

- **solid** (1)
- **dashed** (2)
- **dotted** (3)
- **dashed-dotted** (4)

Predefined Polyline Bundles

The ESV Workstation supports the following five linetypes: **solid**, **dashed**, **dotted**, **dot-dashed**, and **long-dashed**. At present, the ESV Workstation does not support the following three linetypes: **dot-dashed-dot-dotted**, **center**, and **phantom**.

Text Font and Precision Pairs

The ESV Workstation supports one distinct text font (1). This font supports the **Stroke** precision only.

Workstation Category and Type

The ESV Workstation only supports a workstation of type **OUTPUT**. The X Input Extension and X Picking Extension are used for input.

PHIGS/PHIGS PLUS Functions

In the following list, functions shown in **bold** are currently supported by the ESV Workstation, and functions shown in *italics* are not currently supported by the ESV Workstation. PHIGS PLUS functions are indicated with a (+). The **OPEN PHIGS** function is supported only through the **OPEN PEX** function.

Function Name

ADD NAMES TO SET
ANNOTATION TEXT RELATIVE
ANNOTATION TEXT RELATIVE 3
APPLICATION DATA
ARCHIVE ALL STRUCTURES
ARCHIVE STRUCTURE NETWORKS
ARCHIVE STRUCTURES
AWAIT EVENT
BUILD TRANSFORMATION MATRIX
BUILD TRANSFORMATION MATRIX 3
CELL ARRAY
CELL ARRAY 3
CHANGE STRUCTURE IDENTIFIER
CHANGE STRUCTURE IDENTIFIER AND REFERENCES
CHANGE STRUCTURE REFERENCES
CLOSE ARCHIVE FILE
CLOSE PHIGS
CLOSE STRUCTURE
CLOSE WORKSTATION
COMPOSE MATRIX
COMPOSE MATRIX 3
COMPOSE TRANSFORMATION MATRIX
COMPOSE TRANSFORMATION MATRIX 3
COMPUTE FILL AREA SET GEOMETRIC NORMAL (+)
COPY ALL ELEMENTS FROM STRUCTURE
DELETE ALL STRUCTURES
DELETE ALL STRUCTURES FROM ARCHIVE
DELETE ELEMENT
DELETE ELEMENT RANGE
DELETE ELEMENTS BETWEEN LABELS
DELETE STRUCTURE
DELETE STRUCTURE NETWORK
DELETE STRUCTURE NETWORKS FROM ARCHIVE
DELETE STRUCTURES FROM ARCHIVE
ELEMENT SEARCH
EMERGENCY CLOSE PHIGS
EMPTY STRUCTURE
ERROR HANDLING
ERROR LOGGING

ESCAPE
EVALUATE VIEW MAPPING MATRIX
EVALUATE VIEW MAPPING MATRIX 3
EVALUATE VIEW ORIENTATION MATRIX
EVALUATE VIEW ORIENTATION MATRIX 3
EXECUTE STRUCTURE
EXTENDED CELL ARRAY 3 (+)
FILL AREA
FILL AREA 3
FILL AREA 3 WITH DATA (+)
FILL AREA SET
FILL AREA SET 3
FILL AREA SET 3 WITH DATA (+)
FLUSH DEVICE EVENTS
GENERALIZED DRAWING PRIMITIVE
GENERALIZED DRAWING PRIMITIVE 3
GENERALIZED STRUCTURE ELEMENT
GET CHOICE
GET ITEM TYPE FROM METAFILE
GET LOCATOR
GET LOCATOR 3
GET PICK
GET STRING
GET STROKE
GET STROKE 3
GET VALUATOR
INCREMENTAL SPATIAL SEARCH
INCREMENTAL SPATIAL SEARCH 3
INITIALIZE CHOICE
INITIALIZE CHOICE 3
INITIALIZE LOCATOR
INITIALIZE LOCATOR 3
INITIALIZE PICK
INITIALIZE PICK 3
INITIALIZE STRING
INITIALIZE STRING 3
INITIALIZE STROKE
INITIALIZE STROKE 3
INITIALIZE VALUATOR
INITIALIZE VALUATOR 3
INQUIRE ALL CONFLICTING STRUCTURES
INQUIRE ANNOTATION FACILITIES
INQUIRE ARCHIVE FILES
INQUIRE ARCHIVE STATE VALUE
INQUIRE CHOICE DEVICE STATE
INQUIRE CHOICE DEVICE STATE 3

INQUIRE COLOUR FACILITIES
INQUIRE COLOUR MAPPING FACILITIES (+)
INQUIRE COLOUR MAPPING METHOD FACILITIES (+)
INQUIRE COLOUR MAPPING REPRESENTATION (+)
INQUIRE COLOUR MAPPING STATE (+)
INQUIRE COLOUR MODEL
INQUIRE COLOUR MODEL FACILITIES
INQUIRE COLOUR REPRESENTATION
INQUIRE CONFLICT RESOLUTION
INQUIRE CONFLICTING STRUCTURES IN NETWORK
INQUIRE CURRENT ELEMENT CONTENT
INQUIRE CURRENT ELEMENT TYPE AND SIZE
INQUIRE CURVE AND SURFACE FACILITIES (+)
INQUIRE DEFAULT CHOICE DEVICE DATA
INQUIRE DEFAULT CHOICE DEVICE DATA 3
INQUIRE DEFAULT DISPLAY UPDATE STATE
INQUIRE DEFAULT LOCATOR DEVICE DATA
INQUIRE DEFAULT LOCATOR DEVICE DATA 3
INQUIRE DEFAULT PICK DEVICE DATA
INQUIRE DEFAULT PICK DEVICE DATA 3
INQUIRE DEFAULT STRING DEVICE DATA
INQUIRE DEFAULT STRING DEVICE DATA 3
INQUIRE DEFAULT STROKE DEVICE DATA
INQUIRE DEFAULT STROKE DEVICE DATA 3
INQUIRE DEFAULT VALUATOR DEVICE DATA
INQUIRE DEFAULT VALUATOR DEVICE DATA 3
INQUIRE DEPTH CUE FACILITIES (+)
INQUIRE DEPTH CUE REPRESENTATION (+)
INQUIRE DIRECT COLOUR MODEL FACILITIES (+)
INQUIRE DISPLAY SPACE SIZE
INQUIRE DISPLAY SPACE SIZE 3
INQUIRE DISPLAY UPDATE STATE
INQUIRE DYNAMICS OF STRUCTURES
INQUIRE DYNAMICS OF WORKSTATION ATTRIBUTES
INQUIRE EDGE FACILITIES
INQUIRE EDGE REPRESENTATION
INQUIRE EDIT MODE
INQUIRE ELEMENT CONTENT
INQUIRE ELEMENT POINTER
INQUIRE ELEMENT TYPE AND SIZE
INQUIRE ERROR HANDLING MODE
INQUIRE EXTENDED DYNAMICS OF WORKSTATION ATTRIBUTES (+)
INQUIRE EXTENDED EDGE REPRESENTATION (+)
INQUIRE EXTENDED INTERIOR FACILITIES (+)
INQUIRE EXTENDED INTERIOR REPRESENTATION (+)
INQUIRE EXTENDED PATTERN REPRESENTATION (+)

INQUIRE EXTENDED POLYLINE FACILITIES (+)
INQUIRE EXTENDED POLYLINE REPRESENTATION (+)
INQUIRE EXTENDED POLYMARKER REPRESENTATION (+)
INQUIRE EXTENDED TEXT REPRESENTATION (+)
INQUIRE EXTENDED WORKSTATION STATE TABLE LENGTHS (+)
INQUIRE GENERALIZED DRAWING PRIMITIVE
INQUIRE GENERALIZED DRAWING PRIMITIVE 3
INQUIRE GENERALIZED STRUCTURE ELEMENT FACILITIES
INQUIRE HIGHLIGHTING FILTER
INQUIRE HLHSR FACILITIES
INQUIRE HLHSR MODE
INQUIRE INPUT QUEUE OVERFLOW
INQUIRE INTERIOR FACILITIES
INQUIRE INTERIOR REPRESENTATION
INQUIRE INVISIBILITY FILTER
INQUIRE LIGHT SOURCE FACILITIES (+)
INQUIRE LIGHT SOURCE REPRESENTATION (+)
INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES
INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES 3
INQUIRE LIST OF AVAILABLE GENERALIZED STRUCTURE ELEMENTS
INQUIRE LIST OF AVAILABLE WORKSTATION TYPES
INQUIRE LIST OF COLOUR INDICES
INQUIRE LIST OF COLOUR MAPPING INDICES (+)
INQUIRE LIST OF DEPTH CUE INDICES (+)
INQUIRE LIST OF EDGE INDICES
INQUIRE LIST OF INTERIOR INDICES
INQUIRE LIST OF LIGHT SOURCE INDICES (+)
INQUIRE LIST OF PATTERN INDICES
INQUIRE LIST OF POLYLINE INDICES
INQUIRE LIST OF POLYMARKER INDICES
INQUIRE LIST OF TEXT INDICES
INQUIRE LIST OF VIEW INDICES
INQUIRE LOCATOR DEVICE STATE
INQUIRE LOCATOR DEVICE STATE 3
INQUIRE MODELLING CLIPPING FACILITIES
INQUIRE MORE SIMULTANEOUS EVENTS
INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES
INQUIRE NUMBER OF DISPLAY PRIORITIES SUPPORTED
INQUIRE OPEN STRUCTURE
INQUIRE PATHS TO ANCESTORS
INQUIRE PATHS TO DESCENDANTS
INQUIRE PATTERN FACILITIES
INQUIRE PATTERN REPRESENTATION
INQUIRE PHIGS FACILITIES
INQUIRE PICK DEVICE STATE
INQUIRE PICK DEVICE STATE 3

INQUIRE POLYLINE FACILITIES
INQUIRE POLYLINE REPRESENTATION
INQUIRE POLYMARKER FACILITIES
INQUIRE POLYMARKER REPRESENTATION
INQUIRE POSTED STRUCTURES
INQUIRE PREDEFINED COLOUR MAPPING REPRESENTATION (+)
INQUIRE PREDEFINED COLOUR REPRESENTATION
INQUIRE PREDEFINED DEPTH CUE REPRESENTATION (+)
INQUIRE PREDEFINED EDGE REPRESENTATION
INQUIRE PREDEFINED EXTENDED EDGE REPRESENTATION (+)
INQUIRE PREDEFINED EXTENDED INTERIOR REPRESENTATION (+)
INQUIRE PREDEFINED EXTENDED PATTERN REPRESENTATION (+)
INQUIRE PREDEFINED EXTENDED POLYLINE REPRESENTATION (+)
INQUIRE PREDEFINED EXTENDED POLYMARKER REPRESENTATION (+)
INQUIRE PREDEFINED EXTENDED TEXT REPRESENTATION (+)
INQUIRE PREDEFINED INTERIOR REPRESENTATION
INQUIRE PREDEFINED LIGHT SOURCE REPRESENTATION (+)
INQUIRE PREDEFINED PATTERN REPRESENTATION
INQUIRE PREDEFINED POLYLINE REPRESENTATION
INQUIRE PREDEFINED POLYMARKER REPRESENTATION
INQUIRE PREDEFINED TEXT REPRESENTATION
INQUIRE PREDEFINED VIEW REPRESENTATION
INQUIRE RENDERING COLOUR MODEL FACILITIES (+)
INQUIRE SET OF OPEN WORKSTATIONS
INQUIRE SET OF WORKSTATIONS TO WHICH POSTED
INQUIRE STRING DEVICE STATE
INQUIRE STRING DEVICE STATE 3
INQUIRE STROKE DEVICE STATE
INQUIRE STROKE DEVICE STATE 3
INQUIRE STRUCTURE IDENTIFIERS
INQUIRE STRUCTURE STATE VALUE
INQUIRE STRUCTURE STATUS
INQUIRE SYSTEM STATE VALUE
INQUIRE TEXT EXTENT
INQUIRE TEXT FACILITIES
INQUIRE TEXT REPRESENTATION
INQUIRE VALUATOR DEVICE STATE
INQUIRE VALUATOR DEVICE STATE 3
INQUIRE VIEW FACILITIES
INQUIRE VIEW REPRESENTATION
INQUIRE WORKSTATION CATEGORY
INQUIRE WORKSTATION CLASSIFICATION
INQUIRE WORKSTATION CONNECTION AND TYPE
INQUIRE WORKSTATION STATE TABLE LENGTHS
INQUIRE WORKSTATION STATE VALUE
INQUIRE WORKSTATION TRANSFORMATION

INQUIRE WORKSTATION TRANSFORMATION 3
INTERPRET ITEM
LABEL
MESSAGE
OFFSET ELEMENT POINTER
OPEN ARCHIVE FILE
OPEN PHIGS
OPEN STRUCTURE
OPEN WORKSTATION
NON-UNIFORM B-SPLINE CURVE (+)
NON-UNIFORM B-SPLINE SURFACE (+)
POLYLINE
POLYLINE 3
POLYLINE SET 3 WITH DATA (+)
POLYMARKER
POLYMARKER 3
POST STRUCTURE
QUADRILATERAL MESH 3 WITH DATA (+)
READ ITEM FROM METAFILE
REDRAW ALL STRUCTURES
REMOVE NAMES FROM SET
REQUEST CHOICE
REQUEST LOCATOR
REQUEST LOCATOR 3
REQUEST PICK
REQUEST STRING
REQUEST STROKE
REQUEST STROKE 3
REQUEST VALUATOR
RESTORE MODELLING CLIPPING VOLUME
RETRIEVE ALL STRUCTURES
RETRIEVE ANCESTORS OF STRUCTURE
RETRIEVE DESCENDANTS OF STRUCTURE
RETRIEVE STRUCTURE IDENTIFIERS
RETRIEVE STRUCTURE NETWORKS
RETRIEVE STRUCTURES
ROTATE
ROTATE X
ROTATE Y
ROTATE Z
SAMPLE CHOICE
SAMPLE LOCATOR
SAMPLE LOCATOR 3
SAMPLE PICK
SAMPLE STRING
SAMPLE STROKE

SAMPLE STROKE 3
SAMPLE VALUATOR
SCALE
SCALE 3
SET ANNOTATION STYLE
SET ANNOTATION TEXT ALIGNMENT
SET ANNOTATION TEXT CHARACTER HEIGHT
SET ANNOTATION TEXT CHARACTER UP VECTOR
SET ANNOTATION TEXT PATH
SET AREA PROPERTIES (+)
SET BACK AREA PROPERTIES (+)
SET BACK INTERIOR COLOUR (+)
SET BACK INTERIOR REFLECTANCE EQUATION (+)
SET BACK INTERIOR SHADING METHOD (+)
SET BACK INTERIOR STYLE (+)
SET BACK INTERIOR STYLE INDEX (+)
SET BACK PARAMETRIC SURFACE CHARACTERISTICS (+)
SET CHARACTER EXPANSION FACTOR
SET CHARACTER HEIGHT
SET CHARACTER SPACING
SET CHARACTER UP VECTOR
SET CHOICE MODE
SET COLOUR MAPPING INDEX (+)
SET COLOUR MAPPING REPRESENTATION (+)
SET COLOUR MODEL
SET COLOUR REPRESENTATION
SET CONFLICT RESOLUTION
SET CURVE APPROXIMATION CRITERIA (+)
SET DEPTH CUE INDEX (+)
SET DEPTH CUE REPRESENTATION (+)
SET DISPLAY UPDATE STATE
SET EDGE COLOUR (+)
SET EDGE COLOUR INDEX
SET EDGE FLAG
SET EDGE INDEX
SET EDGE REPRESENTATION
SET EDGETYPE
SET EDGEWIDTH SCALE FACTOR
SET EDIT MODE
SET ELEMENT POINTER
SET ELEMENT POINTER AT LABEL
SET ERROR HANDLING MODE
SET EXTENDED EDGE REPRESENTATION (+)
SET EXTENDED INTERIOR REPRESENTATION (+)
SET EXTENDED PATTERN REPRESENTATION (+)

SET EXTENDED POLYLINE REPRESENTATION (+)
SET EXTENDED POLYMARKER REPRESENTATION (+)
SET EXTENDED TEXT REPRESENTATION (+)
SET FACE CULLING MODE (+)
SET FACE DISTINGUISHING MODE (+)
SET GLOBAL TRANSFORMATION
SET GLOBAL TRANSFORMATION 3
SET HIGHLIGHTING FILTER
SET HLHSR IDENTIFIER
SET HLHSR MODE
SET INDIVIDUAL ASF
SET INTERIOR COLOUR (+)
SET INTERIOR COLOUR INDEX
SET INTERIOR INDEX
SET INTERIOR REFLECTANCE EQUATION (+)
SET INTERIOR REPRESENTATION
SET INTERIOR SHADING METHOD (+)
SET INTERIOR STYLE
SET INTERIOR STYLE INDEX
SET INVISIBILITY FILTER
SET LIGHT SOURCE REPRESENTATION (+)
SET LIGHT SOURCE STATE (+)
SET LINETYPE
SET LINEWIDTH SCALE FACTOR
SET LOCAL TRANSFORMATION
SET LOCAL TRANSFORMATION 3
SET LOCATOR MODE
SET MARKER SIZE SCALE FACTOR
SET MARKER TYPE
SET MODELLING CLIPPING INDICATOR
SET MODELLING CLIPPING VOLUME
SET MODELLING CLIPPING VOLUME 3
SET OF FILL AREA SET 3 WITH DATA (+)
SET PARAMETRIC SURFACE CHARACTERISTICS (+)
SET PATTERN REFERENCE POINT
SET PATTERN REFERENCE POINT AND VECTORS
SET PATTERN REPRESENTATION
SET PATTERN SIZE
SET PICK FILTER
SET PICK IDENTIFIER
SET PICK MODE
SET POLYLINE COLOUR (+)
SET POLYLINE COLOUR INDEX
SET POLYLINE INDEX

SET POLYLINE REPRESENTATION
SET POLYLINE SHADING METHOD (+)
SET POLYMARKER COLOUR (+)
SET POLYMARKER COLOUR INDEX
SET POLYMARKER INDEX
SET POLYMARKER REPRESENTATION
SET RENDERING COLOUR MODEL (+)
SET STRING MODE
SET STROKE MODE
SET SURFACE APPROXIMATION CRITERIA (+)
SET TEXT ALIGNMENT
SET TEXT COLOUR (+)
SET TEXT COLOUR INDEX
SET TEXT FONT
SET TEXT INDEX
SET TEXT PATH
SET TEXT PRECISION
SET TEXT REPRESENTATION
SET TRIMMING CURVE APPROXIMATION CRITERIA (+)
SET VALUATOR MODE
SET VIEW INDEX
SET VIEW REPRESENTATION
SET VIEW REPRESENTATION 3
SET VIEW TRANSFORMATION INPUT PRIORITY
SET WORKSTATION VIEWPORT
SET WORKSTATION VIEWPORT 3
SET WORKSTATION WINDOW
SET WORKSTATION WINDOW 3
TEXT
TEXT 3
TRANSFORM POINT
TRANSFORM POINT 3
TRANSLATE
TRANSLATE 3
TRIANGLE STRIP 3 WITH DATA (+)
UNPOST ALL STRUCTURES
UNPOST STRUCTURE
UPDATE WORKSTATION
WRITE ITEM TO METAFILE

OPEN PEX

Name

OPEN PEX - open and initialize the PEX environment

Synopsis

Syntax

```
void
popenpex(error_file,memory)
Pchar           *error_file;
Plong           memory;
Popenpexinfo    *xinfo;
```

Input Parameters

error_file — **error_file** is a pointer to the error file where PEX error messages are logged. The error file can be either a pointer to a valid UNIX file name or a null pointer (*e.g.*, **(Pchar*)0**). A null pointer implies that standard error is to be used as the error file. If a file name is specified, PEX will attempt to access the file for writing. If this attempt fails, **OPEN PEX** will fail and the appropriate error will be reported to standard error.

The error file argument passed to **OPEN PEX** will be passed to **ERROR HANDLING**. **ERROR HANDLING** will also pass this argument to **ERROR LOGGING**. If for some reason **ERROR LOGGING** cannot access the specified error file, the error message will be written to standard error. **ERROR LOGGING** appends messages to the error file, and it does not truncate the file when **OPEN PEX** is called. If the specified file does not exist, it will only be created if **ERROR LOGGING** is called.

ERROR LOGGING writes the PHIGS or PHIGS PLUS function name, the error number, and an error description to the error file. If for some reason the text for the function name and/or error description cannot be determined, **ERROR LOGGING** will just write the function number and the error number.

memory — **memory** is ignored by the API.

xinfo — **xinfo** is a pointer to a **Popenpexinfo** structure (defined in **phigs.h**). It allows the specification of some runtime options.

Popenpexinfo Structure

```
typedef struct {
Display             *display;
XrmDatabase         rdb;
char                *name;
char                *classname;
int                 *argc_p;
char                **argv;
struct {
    unsigned no_monitor: 1;
    unsigned force_client_SS;
        }           flags;
} Popenpexinfo;
```

Popenpexinfo Parameters

display	**display** is the display pointer for the server connection to use, rather than creating a connection to the default server. It must be either NULL or a valid display pointer. If a valid display pointer is specified, then the API will use it as the start-up server. If display is NULL, the API will attempt to connect to the default server.
rdb	**rdb** is not used.
name	**name** is not used.
classname	**classname** is not used.
argc_p	**argc_p** is not used.
argv	**argv** is not used.
flags.no_monitor	This parameter should be set to 1.
flags.force_client_SS	This parameter should be set to 0.

Description

OPEN PEX initializes the PEX environment and enables access to the PEX functions. **OPEN PEX** must be called prior to calling any other PEX functions. The API makes its own connections to X servers during **OPEN PEX** if a display is not specified.

A maximum of 14 workstations can be open at any one time. This limit may be reduced, however, by the unavailability of operating system or server resources. Open workstations may exist on any servers to which the application has access. There is no requirement that all workstations be open on a common server.

Execution

After the **Popenpexinfo** structure is checked, **OPEN PEX** calls **OPEN PHIGS**. Errors detected during **OPEN PHIGS** will return the error code associated with **OPEN PHIGS**, not **OPEN PEX**, even though the application called **OPEN PEX**. **OPEN PHIGS** is supported only through **OPEN PEX**. **OPEN PHIGS** should not be called.

OPEN WORKSTATION

Name

OPEN WORKSTATION - create a PHIGS workstation

Synopsis

Syntax

```
void
popenws(ws_id,conn_id,ws_type)
Pint            ws_id;
Pconnid         conn_id;
Pwstype         ws_type;
```

Input Parameters

ws_id **ws_id** is the workstation ID.

conn_id **conn_id** is the connection ID. The drawable and display are specified in this parameter. A **Pconnid_x_drawable** structure (defined in **phigs.h**) should be provided for this parameter. Refer to the code example at the bottom of the page.

ws_type **ws_type** is the available workstation type, **phigs_ws_type_x_drawable**. **phigs_ws_type_x_drawable** uses the drawable specified in the **conn_id** for the output surface of the workstation.

Pconnid_x_drawable Structure

```
typedef char *Pconnid;                  /* defined in phigs.h */
typedef struct {
        Display         *display;
        XID             drawable_id;
} Pconnid_x_drawable;                   /* defined in phigs.h */
```

Description

Following is a code example.

```
Pconnid_x_drawable          conn_id;
                    .
                    .
                    .
conn_id.display = my_open_display;
conn_id.drawable_id = my_existing_drawable;
popenws(my_ws_id,(Pconnid*)&conn_id,
    phigs_ws_type_x_drawable);
```

The API uses the specified drawable and display for the workstation output surface.

Function Numbers

The function numbers listed in the left-hand column are returned by error messages. The corresponding function name is listed in the right-hand column.

In the following list, PHIGS and PHIGS PLUS functions shown in **bold** are supported by the ESV Workstation, and PHIGS and PHIGS PLUS functions shown in *italics* are not currently supported by the ESV Workstation. PHIGS PLUS functions are indicated with a (+).

Number	Function Name
-5	**OPEN PEX**
0	**OPEN PHIGS**
1	**CLOSE PHIGS**
2	**OPEN WORKSTATION**
3	**CLOSE WORKSTATION**
4	**REDRAW ALL STRUCTURES**
5	**UPDATE WORKSTATION**
6	**SET DISPLAY UPDATE STATE**
7	*MESSAGE*
8	**POLYLINE 3**
9	**POLYLINE**
10	**POLYMARKER 3**
11	**POLYMARKER**
12	**TEXT 3**
13	**TEXT**
14	**ANNOTATION TEXT RELATIVE 3**
15	**ANNOTATION TEXT RELATIVE**
16	**FILL AREA 3**
17	**FILL AREA**
18	**FILL AREA SET 3**
19	**FILL AREA SET**
20	*CELL ARRAY 3*
21	*CELL ARRAY*
22	*GENERALIZED DRAWING PRIMITIVE 3*
23	*GENERALIZED DRAWING PRIMITIVE*
24	**SET POLYLINE INDEX**
25	**SET POLYMARKER INDEX**
26	**SET TEXT INDEX**
27	**SET INTERIOR INDEX**
28	**SET EDGE INDEX**
29	**SET LINETYPE**
30	**SET LINEWIDTH SCALE FACTOR**
31	**SET POLYLINE COLOUR INDEX**
32	**SET MARKER TYPE**
33	**SET MARKER SIZE SCALE FACTOR**

Number	Function Name
34	**SET POLYMARKER COLOUR INDEX**
35	**SET TEXT FONT**
36	**SET TEXT PRECISION**
37	**SET CHARACTER EXPANSION FACTOR**
38	**SET CHARACTER SPACING**
39	**SET TEXT COLOUR INDEX**
40	**SET CHARACTER HEIGHT**
41	**SET CHARACTER UP VECTOR**
42	**SET TEXT PATH**
43	**SET TEXT ALIGNMENT**
44	**SET ANNOTATION TEXT CHARACTER HEIGHT**
45	**SET ANNOTATION TEXT CHARACTER UP VECTOR**
46	**SET ANNOTATION TEXT PATH**
47	**SET ANNOTATION TEXT ALIGNMENT**
48	**SET ANNOTATION STYLE**
49	**SET INTERIOR STYLE**
50	**SET INTERIOR STYLE INDEX**
51	**SET INTERIOR COLOUR INDEX**
51	**SET EDGE FLAG**
53	**SET EDGETYPE**
54	*SET EDGEWIDTH SCALE FACTOR*
55	**SET EDGE COLOUR INDEX**
56	*SET PATTERN SIZE*
57	*SET PATTERN REFERENCE POINT AND VECTORS*
58	*SET PATTERN REFERENCE POINT*
59	**ADD NAMES TO SET**
60	**REMOVE NAMES FROM SET**
61	**SET INDIVIDUAL ASF**
62	**SET POLYLINE REPRESENTATION**
63	**SET POLYMARKER REPRESENTATION**
64	**SET TEXT REPRESENTATION**
65	**SET INTERIOR REPRESENTATION**
66	**SET EDGE REPRESENTATION**
67	*SET PATTERN REPRESENTATION*
68	**SET COLOUR REPRESENTATION**
69	**SET HIGHLIGHTING FILTER**
70	**SET INVISIBILITY FILTER**
71	*SET COLOUR MODEL*
72	**SET HLHSR IDENTIFIER**
73	**SET HLHSR MODE**
74	**SET LOCAL TRANSFORMATION 3**
75	**SET LOCAL TRANSFORMATION**

Number	Function Name
76	**SET GLOBAL TRANSFORMATION 3**
77	**SET GLOBAL TRANSFORMATION**
78	*SET MODELLING CLIPPING VOLUME 3*
79	*SET MODELLING CLIPPING VOLUME*
80	*SET MODELLING CLIPPING INDICATOR*
81	*RESTORE MODELLING CLIPPING VOLUME*
82	**SET VIEW INDEX**
83	**SET VIEW REPRESENTATION 3**
84	**SET VIEW REPRESENTATION**
85	*SET VIEW TRANSFORMATION INPUT PRIORITY*
86	**SET WORKSTATION WINDOW 3**
87	**SET WORKSTATION WINDOW**
88	**SET WORKSTATION VIEWPORT 3**
89	**SET WORKSTATION VIEWPORT**
90	**OPEN STRUCTURE**
91	**CLOSE STRUCTURE**
92	**EXECUTE STRUCTURE**
93	**LABEL**
94	**APPLICATION DATA**
95	*GENERALIZED STRUCTURE ELEMENT*
96	**SET EDIT MODE**
97	*COPY ALL ELEMENTS FROM STRUCTURE*
98	**SET ELEMENT POINTER**
99	**OFFSET ELEMENT POINTER**
100	**SET ELEMENT POINTER AT LABEL**
101	**DELETE ELEMENT**
102	**DELETE ELEMENT RANGE**
103	**DELETE ELEMENTS BETWEEN LABELS**
104	**EMPTY STRUCTURE**
105	**DELETE STRUCTURE**
106	*DELETE STRUCTURE NETWORK*
107	**DELETE ALL STRUCTURES**
108	*CHANGE STRUCTURE IDENTIFIER*
109	*CHANGE STRUCTURE REFERENCES*
110	*CHANGE STRUCTURE IDENTIFIER AND REFERENCES*
111	**POST STRUCTURE**
112	**UNPOST STRUCTURE**
113	**UNPOST ALL STRUCTURES**
114	*OPEN ARCHIVE FILE*
115	*CLOSE ARCHIVE FILE*
116	*ARCHIVE STRUCTURES*
117	*ARCHIVE STRUCTURE NETWORKS*

Number	Function Name
118	*ARCHIVE ALL STRUCTURES*
119	*SET CONFLICT RESOLUTION*
120	*RETRIEVE STRUCTURE IDENTIFIERS*
121	*RETRIEVE STRUCTURES*
122	*RETRIEVE STRUCTURE NETWORKS*
123	*RETRIEVE ALL STRUCTURES*
124	*RETRIEVE ANCESTORS OF STRUCTURE*
125	*RETRIEVE DESCENDANTS OF STRUCTURE*
126	*DELETE STRUCTURES FROM ARCHIVE*
127	*DELETE STRUCTURE NETWORKS FROM ARCHIVE*
128	*DELETE ALL STRUCTURES FROM ARCHIVE*
129	**SET PICK IDENTIFIER**
130	*SET PICK FILTER*
131	*INITIALIZE LOCATOR 3*
132	*INITIALIZE LOCATOR*
133	*INITIALIZE STROKE 3*
134	*INITIALIZE STROKE*
135	*INITIALIZE VALUATOR 3*
136	*INITIALIZE VALUATOR*
137	*INITIALIZE CHOICE 3*
138	*INITIALIZE CHOICE*
139	*INITIALIZE PICK 3*
140	*INITIALIZE PICK*
141	*INITIALIZE STRING 3*
142	*INITIALIZE STRING*
143	*SET LOCATOR MODE*
144	*SET STROKE MODE*
145	*SET VALUATOR MODE*
146	*SET CHOICE MODE*
147	*SET PICK MODE*
148	*SET STRING MODE*
149	*REQUEST LOCATOR 3*
150	*REQUEST LOCATOR*
151	*REQUEST STROKE 3*
152	*REQUEST STROKE*
153	*REQUEST VALUATOR*
154	*REQUEST CHOICE*
155	*REQUEST PICK*
156	*REQUEST STRING*
157	*SAMPLE LOCATOR 3*
158	*SAMPLE LOCATOR*
159	*SAMPLE STROKE 3*

Number	Function Name
160	*SAMPLE STROKE*
161	*SAMPLE VALUATOR*
162	*SAMPLE CHOICE*
163	*SAMPLE PICK*
164	*SAMPLE STRING*
165	*AWAIT EVENT*
166	*FLUSH DEVICE EVENTS*
167	*GET LOCATOR 3*
168	*GET LOCATOR*
169	*GET STROKE 3*
170	*GET STROKE*
171	*GET VALUATOR*
172	*GET CHOICE*
173	*GET PICK*
174	*GET STRING*
175	*WRITE ITEM TO METAFILE*
176	*GET ITEM TYPE FROM METAFILE*
177	*READ ITEM FROM METAFILE*
178	*INTERPRET ITEM*
179	**SET ERROR HANDLING MODE**
180	*ESCAPE*
201	**POLYLINE SET 3 WITH DATA** (+)
202	**FILL AREA 3 WITH DATA** (+)
203	**FILL AREA SET 3 WITH DATA** (+)
205	*TRIANGLE STRIP 3 WITH DATA* (+)
206	*QUADRILATERAL MESH 3 WITH DATA* (+)
207	**POLYHEDRON 3 WITH DATA** (+)
208	*NON-UNIFORM B-SPLINE CURVE* (+)
210	*NON-UNIFORM B-SPLINE SURFACE* (+)
211	*EXTENDED CELL ARRAY 3* (+)
212	*COMPUTE FILL AREA SET GEOMETRIC NORMAL* (+)
213	**SET DEPTH CUE INDEX** (+)
216	**SET AREA PROPERTIES** (+)
217	**SET BACK AREA PROPERTIES** (+)
218	**SET POLYLINE SHADING METHOD** (+)
220	**SET BACK INTERIOR STYLE** (+)
221	**SET BACK INTERIOR STYLE INDEX** (+)
222	**SET INTERIOR SHADING METHOD** (+)
223	**SET BACK INTERIOR SHADING METHOD** (+)
224	**SET INTERIOR REFLECTANCE EQUATION** (+)
225	**SET BACK INTERIOR REFLECTANCE EQUATION** (+)
226	**SET LIGHT SOURCE STATE** (+)

Number	Function Name
227	**SET FACE DISTINGUISHING MODE** (+)
228	**SET FACE CULLING MODE** (+)
229	**SET POLYLINE COLOUR** (+)
230	**SET POLYMARKER COLOUR** (+)
231	**SET TEXT COLOUR** (+)
232	**SET INTERIOR COLOUR** (+)
233	**SET BACK INTERIOR COLOUR** (+)
234	**SET EDGE COLOUR** (+)
235	*SET CURVE APPROXIMATION CRITERIA* (+)
236	*SET TRIMMING CURVE APPROXIMATION CRITERIA* (+)
237	*SET SURFACE APPROXIMATION CRITERIA* (+)
239	*SET EXTENDED POLYLINE REPRESENTATION* (+)
240	*SET EXTENDED POLYMARKER REPRESENTATION* (+)
241	*SET EXTENDED TEXT REPRESENTATION* (+)
242	*SET EXTENDED EDGE REPRESENTATION* (+)
243	*SET EXTENDED INTERIOR REPRESENTATION* (+)
245	*SET EXTENDED PATTERN REPRESENTATION* (+)
246	**SET DEPTH CUE REPRESENTATION** (+)
247	**SET LIGHT SOURCE REPRESENTATION** (+)

Error Messages

The numbers in the left-hand column are returned by error messages, and the corresponding error description is listed in the right-hand column.

Error	Description
-317	X Bad Implementation Error.
-316	X Bad Length Error.
-315	X Bad Name Error.
-314	X Bad ID Choice Error.
-313	X Bad GC Error.
-312	X Bad Colour Error.
-311	X Bad Alloc Error.
-310	X Bad Access Error.
-309	X Bad Drawable Error.
-308	X Bad Match Error.
-307	X Bad Font Error.
-306	X Bad Cursor Error.
-305	X Bad Atom Error.
-304	X Bad Pixmap Error.
-303	X Bad Window Error.
-302	X Bad Value Error.
-301	X Bad Request Error.
-264	PEX output command error.
-263	PEX structure error.
-262	PEX search context error.
-261	PEX renderer error.
-260	PEX pipeline context error.
-259	PEX pick measure error.
-258	PEX PHIGS workstation error.
-257	PEX font error.
-256	PEX path error.
-255	PEX name set error.
-254	PEX lookup table error.
-253	PEX label error.
-252	PEX floating point format error.
-251	PEX rendering state error.
-250	PEX colour type error.
-202	Ignoring function. An X allocation error has occurred.
-201	Ignoring function. The specified X Server does not support a compatible PEX extension.
-200	Ignoring function. Cannot connect to the designated or default server.
-167	Ignoring function. Opening this workstation would exceed the maximum number of simultaneously open canvas region workstations on a canvas.
-165	Ignoring function. The length of specified edge data lists is inconsistent with the length of corresponding vertices lists.
-164	Ignoring function. The specified number of vertices or sets of vertices is less than zero.

Error	Description
-163	Ignoring function. The specified edge flag is invalid.
-162	Ignoring function. The specified vertex flag is invalid.
-161	Ignoring function. The specified facet flag is invalid.
-160	Ignoring function. The specified function is not available on the specified workstation.
-159	Ignoring function. The requested information is not available.
-157	Warning. The specified GDP is not available on one or more workstations in this implementation. The GDP will be processed by those workstations on which it is available.
-156	Ignoring function. Specified font is not available for character set.
-155	Specified character set is invalid.
-153	List length is less than zero. Zero will be used.
-152	Ignoring function. Not implemented.
-151	Ignoring function. Nameset or filter contains name outside supported range.
-150	Ignoring function. The specified number of points or sets of points is less than zero.
-100	Ignoring function. Workstation type is a default type or bound to a workstation and cannot be modified.
-57	Kernel not configured with shared-memory. IPC facility needed for PEX SI communication.
-55	Ignoring function. Cannot open PHIGS. Cannot open font files.
-54	Ignoring function. Cannot locate SI support file.
-53	Ignoring function. SI support file path invalid.
-52	Ignoring function. **PEXAPIDIR** path is too long.
-51	Ignoring function. Cannot open PHIGS. Cannot locate SI file **phigsmon**.
-50	Communication error.
-6	Could not allocate additional dynamic memory during structure traversal.
-2	Ignoring function. Cannot open PHIGS. Cannot create server.
-1	Ignoring function. Cannot open PHIGS. Cannot create communication channel.
0	No error.
1	Ignoring function. Function requires state (**PHCL**,**WSCL**,**STCL**,**ARCL**).
2	Ignoring function. Function requires state (**PHOP**,*,*,*).
3	Ignoring function. Function requires state (**PHOP**,**WSOP**,*,*).
4	Ignoring function. Function requires state (**PHOP**,**WSCL**,**STCL**,**ARCL**).
5	Ignoring function. Function requires state (**PHOP**,*,**STOP**,*).
6	Ignoring function. Function requires state (**PHOP**,*,**STCL**,*).
7	Ignoring function. Function requires state (**PHOP**,*,*,**AROP**).
50	Ignoring function. Connection identifier not recognized by the implementation.
51	Ignoring function. This information is not yet available for this generic workstation type. Open a workstation of this type and use the specific workstation type.
52	Ignoring function. Workstation type not recognized by the implementation.
53	Ignoring function. Workstation identifier already is in use.
54	Ignoring function. The specified workstation is not open.
55	Ignoring function. Workstation cannot be opened for an implementation dependent reason.
56	Ignoring function. Specified workstation is not of category **MO**.

Error	Description
57	Ignoring function. Specified workstation is of category **MI**.
58	Ignoring function. Specified workstation is not of category **MI**.
59	Ignoring function. The specified workstation does not have output capability (*i.e.*, the workstation category is neither **OUTPUT**, **OUTIN**, nor **MO**).
60	Ignoring function. Specified workstation is not of category **OUTIN**.
61	Ignoring function. Specified workstation is neither of category **INPUT** nor of category **OUTIN**.
62	Ignoring function. This information is not available for this **MO** workstation type.
63	Ignoring function. Opening this workstation would exceed the maximum number of simultaneously open workstations.
64	Ignoring function. The specified workstation type is not able to generate the specified generalized drawing primitive.
100	Ignoring function. The bundle index value is less than one.
101	The specified representation has not been defined.
102	Ignoring function. The specified representation has not be predefined on this workstation.
103	Ignoring function. Setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table.
104	Ignoring function. The specified linetype is not available on the specified workstation.
105	Ignoring function. The specified marker type is not available on the specified workstation.
106	Ignoring function. The specified font is not available for the requested text precision on the specified workstation.
107	Ignoring function. The specified edgetype is not available on the specified workstation.
108	Ignoring function. The specified interior style is not available on the workstation.
109	Ignoring function. Interior style **PATTERN** is not supported on the workstation.
110	Ignoring function. The specified colour model is not available on the workstation.
111	Ignoring function. The specified **HLHSR** mode is not available on the specified workstation.
112	Ignoring function. The pattern index value is less than one.
113	Ignoring function. The colour index value is less than zero.
114	Ignoring function. The view index value is less than zero.
115	Ignoring function. The view index value is less than one.
116	Ignoring function. One of the dimensions of pattern colour array is less than 1.
117	Ignoring function. One of the dimensions of the colour index array is less than 0.
118	Ignoring function. One of the components of the colour specification is out of range. The valid range is dependent upon the current colour mode.
119	Ignoring function. Depth cue index is less than 0.
120	Ignoring function. Depth cue index is less than 1.
122	Ignoring function. The specified polyline shading method is not available on the workstation.
123	Ignoring function. The specified interior shading method is not available on the workstation.

Error	Description
124	Ignoring function. The specified interior reflectance equation is not available on the workstation.
129	Ignoring function. The light source index is less than 1.
130	Ignoring function. Invalid reference planes. **DQMIN > DQMAX.**
131	Ignoring function. The specified light source type is not available on the workstation.
132	Ignoring function. The specified spot light spread angle is out of range.
133	Ignoring function. One of the entries in the activation list or the deactivation list is less than 1.
135	Ignoring function. The same entry exists in both the activation and the deactivation list.
150	Ignoring function. Setting this view table entry would exceed the maximum number of entries allowed in the workstation's view table.
151	Ignoring function. Invalid window. **XMIN ≥ XMAX**, **YMIN ≥ YMAX**, or **ZMIN > ZMAX.**
152	Ignoring function. Invalid viewport. **XMIN ≥ XMAX**, **YMIN ≥ YMAX**, or **ZMIN > ZMAX.**
153	Ignoring function. Invalid view clipping limits. **XMIN ≥ XMAX**, **YMIN ≥ YMAX**, or **ZMIN > ZMAX.**
154	Ignoring function. The view clipping limits are not within NPC range.
155	Ignoring function. The projection viewport limits are not within NPC range.
156	Ignoring function. The workstation window limits are not within NPC range.
157	Ignoring function. The workstation viewport is not within display space.
158	Ignoring function. Front plane and back plane distances are equal when *z*-extent of the projection viewport is 0.
159	Ignoring function. The view plane normal vector has length 0.
160	Ignoring function. The view up vector has length 0.
161	Ignoring function. The view up and view plane normal vectors are parallel thus the viewing coordinate system cannot be established.
162	Ignoring function. The projection reference point is between the front and back planes.
163	Ignoring function. The projection reference point cannot be positioned on the view plane.
164	Ignoring function. The back plane is in front of the front plane.
200	Warning. Ignoring structures that do not exist.
201	Ignoring function. The specified structure does not exist.
202	Ignoring function. The specified element does not exist.
203	Ignoring function. Specified starting path not found in CSS.
204	Ignoring function. Specified search ceiling index out of range.
205	Ignoring function. The label does not exist in the open structure between the element pointer and the end of the structure.
206	Ignoring function. One or both of the labels does not exist in the open structure between the element pointer and the end of the structure.
207	Ignoring function. The specified path depth is less than 0.
208	Ignoring function. The display priority is out of range.

Error	Description
250	Ignoring function. The specified device is not available on the specified workstation.
251	Ignoring function. The function requires the input device to be in **REQUEST** mode.
252	Ignoring function. The function requires the input device to be in **SAMPLE** mode
253	Warning. The specified prompt/echo type is not available on the specified workstation. Prompt/echo type one will be used in its place.
254	Ignoring function. Invalid echo area/volume. **XMIN** ≥ **XMAX**, **YMIN** ≥ **YMAX**, or **ZMIN** > **ZMAX**.
255	Ignoring function. One of the echo area/volume boundary points is outside the range of the device.
256	Warning. One input queue has overflowed.
257	Ignoring function. Input queue has not overflowed.
258	Warning. Input queue has overflowed, but associated workstation has been closed.
259	Ignoring function. The input device class of the current input report does not match the class being requested.
260	Ignoring function. One of the fields within the input device data record is in error.
261	Ignoring function. Initial value is invalid.
262	Ignoring function. Number of points in the initial stroke is greater than the buffer size.
263	Ignoring function. Length of the initial string is greater than the buffer size.
300	Ignoring function. Item type is not allowed for user items.
301	Ignoring function. Item length is invalid.
302	Ignoring function. No item is left in Metafile input.
303	Ignoring function. Metafile item is invalid.
304	Ignoring function. Item type is unknown.
305	Ignoring function. Content of item data record is invalid for the specified item type.
306	Ignoring function. Maximum item data record length is invalid.
307	Ignoring function. User item cannot be interpreted.
350	Warning. The specified escape is not available on one or more workstations in this implementation. The escape will be processed by those workstations on which it is available.
351	Ignoring function. One of the fields within the escape data record is in error.
400	Ignoring function. The archive file cannot be opened.
401	Ignoring function. Opening this archive file would exceed the maximum number of simultaneously open archive files.
402	Ignoring function. Archive file identifier already in use.
403	Ignoring function. The archive file is not a PHIGS archive file.
404	Ignoring function. The specified archive file is not open.
405	Ignoring function. Name conflict occurred while conflict resolution flag has value **ABANDON**.
406	Warning. The archive file is full. Any structures that were archived were archived in total.
407	Warning. Some of the specified structures do not exist on the archive file.
408	Warning. Some of the specified structures do not exist on the archive file. PHIGS will create empty structures in their places.
450	Ignoring function. The specified error file is invalid.
500	Ignoring function. The specified order is less than 1.

Error	Description
501	Ignoring function. Not enough control points for specified order.
502	Ignoring function. The specified order is inconsistent with number of knots and control points.
503	Ignoring function. The knot sequence is not non-decreasing.
504	Ignoring function. One or more of the vertex indices is out of range.
505	Warning. The fill area is degenerate.
506	Ignoring function. Parameter range is inconsistent with the knots.
900	Storage overflow has occurred in PHIGS.
901	Storage overflow has occurred in CSS.
902	Input/Output error has occurred while reading.
903	Input/Output error has occurred while writing.
904	Input/Output error has occurred while sending data to a workstation.
905	Input/Output error has occurred while receiving data from a workstation.
906	Input/Output error has occurred during program library management.
907	Input/Output error has occurred while reading workstation description table.
908	Arithmetic error has occurred.
2200	Buffer overflow in input or inquiry function.
2201	Start index out of range.
2000	Ignoring function. Enumeration type out of range.
2001	Ignoring function. Output parameter size insufficient.
2002	Ignoring function. List or set element not available.
2003	Ignoring function. Invalid data record.
2004	Ignoring function. Input parameter size out of range.
2005	Ignoring function. Invalid list of point lists.
2006	Ignoring function. Invalid list of filters.

PHIGS/PHIGS PLUS Tables

PHIGS Description Table

Data Type Abbreviations

I	Integer
E	Enumeration Type
L(type)	List of Values of a Given Type
MCV	Modeling Clipping Volume
P3	3D Point
R	Real
SET(NM)	Set of Eligible Names
V2/V3	2D/3D Vector
W	Workstation Type
n/s	Not Supported

PHIGS Description Table Entry	Data Type	Default or Initial Value
number of available workstation types	I	1
list of available workstation types	L(W)	See Table 1
maximum number of simultaneously open workstations	I	14
maximum number of simultaneously open archive files	I	0
number of available names for name sets	I	64
number of available character sets	I	1
character set	I	0
maximum length of normal filter list for ISS	I	n/s
maximum length of inverted filter list for ISS	I	n/s
polyline index	I	1
linetype	I	1
linewidth scale factor	R	1.0
polyline colour index	I	1
linetype ASF	E	INDIVIDUAL
linewidth scale factor ASF	E	INDIVIDUAL
polyline colour index ASF	E	INDIVIDUAL
polymarker index	I	1
marker type	I	3
marker size scale factor	R	1.0
polymarker colour index	I	1
marker type ASF	E	INDIVIDUAL
marker size scale factor ASF	E	INDIVIDUAL
polymarker colour index ASF	E	INDIVIDUAL
text index	I	1
text font	I	1 (Monospaced Roman Simplex)

PHIGS Description Table Entry	Data Type	Default or Initial Value
text precision	E	STROKE
character expansion factor	R	1.0
character spacing	R	0.0
text colour index	I	1
text font ASF	E	INDIVIDUAL
text precision ASF	E	INDIVIDUAL
character expansion factor ASF	E	INDIVIDUAL
character spacing ASF	E	INDIVIDUAL
text colour index ASF	E	INDIVIDUAL
character height	R	0.01
character up vector	V2	(0.0,1.0)
character width	R	n/s
character base vector	V2	n/s
text path	E	RIGHT
text alignment (horizontal & vertical)	2xE	(NORMAL,NORMAL)
annotation text character height	R	0.01
annotation text character up vector	V2	(0.0,1.0)
annotation text character width	R	n/s
annotation text character base vector	V2	n/s
annotation text path	E	RIGHT
annotation text alignment (horizontal & vertical)	2xE	(NORMAL,NORMAL)
annotation style	I	1 (unconnected)
interior index	I	1
interior style	E	HOLLOW
interior style index	I	1
interior colour index	I	1
interior style ASF	E	INDIVIDUAL
interior style index ASF	E	INDIVIDUAL
interior colour index ASF	E	INDIVIDUAL
edge index	I	1
edge flag	E	OFF
edgetype	I	1
edgewidth scale factor	R	1.0
edge colour index	I	1
edge flag ASF	E	INDIVIDUAL
edgetype ASF	E	INDIVIDUAL
edgewidth scale factor ASF	E	INDIVIDUAL
edge colour index ASF	E	INDIVIDUAL
pattern size	2xR	n/s

PHIGS Description Table Entry	Data Type	Default or Initial Value
pattern reference point	P3	n/s
pattern reference vectors	2xV3	n/s
pick identifier	I	0
view index	I	0
HLHSR identifier	I	0
name set	SET(NM)	no classes (empty set)
global modelling transformation	4x4xR	Identity
local modelling transformation	4x4xR	Identity
modelling clipping volume	MCV	n/s
modelling clipping indicator	E	NOCLIP
number of available generalized structure elements	I	0
maximum number of distinct planes in modelling clipping volumes	I	0
number of available modelling clipping operators	I	0
list of available modelling clipping operators		empty

PHIGS PLUS Description Table

Data Type Abbreviations

I	Integer
E	Enumeration Type
GCOLR	General Colour
L(type)	List of Values of a Given Type
MCV	Modeling Clipping Volume
P3	3D Point
R	Real
SET(NM)	Set of Eligible Names
V2/V3	2D/3D Vector
W	Workstation Type
n/s	Not Supported

PHIGS PLUS Description Table Entry	Data Type	Default or Initial Value
polyline colour	GCOLR	(RGB,WHITE)
polyline shading method	I	1(NONE)
polyline shading method ASF	E	INDIVIDUAL
polymarker colour	GCOLR	(RGB,WHITE)
text colour	GCOLR	(RGB,WHITE)
face distinguishing mode	E	NONE
face culling mode	E	NONE
interior colour	GCOLR	(RGB,WHITE)
interior shading method	I	1(NONE)
ambient reflection coefficient	R	1.0
diffuse reflection coefficient	R	1.0
specular reflection coefficient	R	1.0
specular colour	GCOLR	(RGB,WHITE)
specular exponent	R	0.0
reflectance characteristics	I	1(NONE)
interior shading method ASF	E	INDIVIDUAL
reflectance properties ASF	E	INDIVIDUAL
reflectance characteristics ASF	E	INDIVIDUAL
back interior style	E	HOLLOW
back interior style index	I	1
back interior colour	GCOLR	(RGB,WHITE)
back interior shading method	I	1(NONE)
back ambient reflection coefficient	R	1.0
back diffuse reflection coefficient	R	1.0
back specular reflection coefficient	R	1.0
back specular colour	GCOLR	(RGB,WHITE)
back specular exponent	R	0.0

PHIGS PLUS Description Table Entry	Data Type	Default or Initial Value
back reflectance characteristics	I	1(NONE)
back interior style ASF	E	INDIVIDUAL
back interior style index ASF	E	INDIVIDUAL
back interior colour ASF	E	INDIVIDUAL
back interior shading method ASF	E	INDIVIDUAL
back reflectance properties ASF	E	INDIVIDUAL
back reflectance characteristics ASF	E	INDIVIDUAL
light source state	L(I)	empty
edge colour	GCOLR	(RGB,WHITE)
curve approximation criteria type	I	0 or n/s
curve approximation criteria value	R	0 or n/s
curve approximation criteria ASF	E	INDIVIDUAL
surface approximation criteria type	I	n/s
surface approximation criteria value	2xR	n/s
surface approximation criteria ASF	E	n/s
rendering colour model	I	n/s
depth cue index	I	0
colour mapping index	I	n/s

PHIGS Workstation Description Table

Data Type Abbreviations

B	Bounding Range
CC	Chromaticity Coefficient
D	Data Record
E	Enumeration Type
FP	Font/Precision Pair
I	Integer
L(type)	List of values of a given type
P3	3D Point
R	Real
n/s	Not Supported

PHIGS Workstation Description Table Entry	Data Type	Initial Value
workstation type	W	See Table 1
workstation category	E	See Table 1
device coordinate units	E	OTHER
maximum display space size:		
in device coordinates	3xR	(1.0,1.0,1.0)
in device address units	3xI	(1280,1024, 24 *z*-buffer planes)
number of available HLHSR identifiers	I	2
list of available HLHSR identifiers	L(I)	NONE,ZBUFF
number of available HLHSR modes	I	2
list of available HLHSR modes	L(I)	NONE,ZBUFF
number of predefined view indices (representations)	I	6
table of predefined view representations:		
view orientation matrix	4x4xR	Identity
view mapping matrix	4x4xR	Identity
view clipping limits	3xB	(0,1,0,1,0,1)
x-*y* clipping indicator	E	CLIP
back clipping indicator	E	CLIP
front clipping indicator	E	CLIP
workstation classification	E	RASTER
dynamic modification accepted for:		
view representation	E	IRG
polyline bundle representation	E	IRG
polymarker bundle representation	E	IRG
text bundle representation	E	IRG
interior bundle representation	E	IRG
edge bundle representation	E	IRG
pattern representation	E	IRG

PHIGS Workstation Description Table Entry	Data Type	Initial Value
colour representation:	E	IRG
workstation transformation	E	IRG
highlighting filter	E	IRG
invisibility filter	E	IRG
HLHSR mode	E	IRG
default value for deferral state:		
deferral mode	E	ASAP
modification mode	E	NIVE
number of available linetypes	L(I)	See Table 2
number of available linewidths	I	1
nominal linewidth	R	1.0 (pixel)
minimum linewidth	R	1.0
maximum linewidth	R	1.0
number of predefined polyline indices (bundles)	I	5
table of predefined polyline bundles		See Table 3
number of available marker types	I	8
list of available marker types	L(I)	See Table 4
number of available marker sizes	I	0 (continuous)
nominal marker size	R	1.0 (9 pixels)
minimum marker size	R	0
maximum marker size	R	unlimited
number of predefined polymarker indices (bundles)	I	5
table of predefined polymarker bundles		See Table 5
number of text font and precision pairs	I	4
list of text font and precision pairs	L(FP)	See Table 6
number of available character expansion factors	I	0 (continuous)
minimum character expansion factor	R	0.0
maximum character expansion factor	R	unlimited
number of available character heights	I	0 (continuous)
minimum character height	R	0.0
maximum character height	R	unlimited
number of predefined text indices (bundles)	I	6
table of predefined text bundles		See Table 7
number of available annotation styles	I	2
list of available annotation styles	L(I)	See Table 12
number of available interior styles	I	3
list of available interior styles	L(E)	See Table 8
number of available hatch styles	I	0
list of available hatch styles	L(I)	empty

PHIGS Workstation Description Table Entry	Data Type	Initial Value
number of predefined interior indices (bundles)	I	5
table of predefined interior bundles		See Table 9
number of available edgetypes	I	4
list of available edgetypes	L(I)	See Table 2
number of available edgewidths	I	1
nominal edgewidth	R	1.0 (pixel)
minimum edgewidth	R	1.0
maximum edgewidth	R	1.0
number of predefined edge indices (bundles)	I	5
table of predefined edge bundles		See Table 10
number of predefined pattern indices (representations)	I	0
table of predefined pattern representations		empty
number of available colour models	I	2
list of available colour models	L(I)	1 (RGB)
default colour model	I	1 (RGB)
colour available	E	COLOUR
number of predefined colour indices (representations)	I	8
table of predefined colour representations		See Table 11
number of available generalized drawing primitives 3 (GDP3)	I	0
list of available generalized drawing primitives 3 (GDP3)		empty
number of available generalized drawing primitives (GDP)	I	0
list of available generalized drawing primitives (GDP)		empty
number of display priorities supported	I	0 (unlimited)
maximum number of polyline bundle table entries	I	20
maximum number of polymarker bundle table entries	I	20
maximum number of text bundle table entries	I	20
maximum number of interior bundle table entries	I	20
maximum number of edge bundle table entries	I	20
maximum number of pattern table entries	I	0
maximum number of colour indices	I	256
maximum number of view indices	I	20
dynamic modification accepted for:		
structure content modification	E	IRG
post structure	E	IRG
unpost structure	E	IRG
delete structure	E	IRG
reference modification	E	IRG
number of logical devices of class LOCATOR	I	0
number of logical input devices of class STROKE	I	0

PHIGS Workstation Description Table Entry	Data Type	Initial Value
number of logical input devices of class VALUATOR	I	0
number of logical devices of class CHOICE	I	0
number of logical input devices of class PICK	I	0
number of logical input devices of class STRING	I	0

PHIGS PLUS Workstation Description Table

Data Type Abbreviations

B	Bounding Range
CC	Chromaticity Coefficient
D	Data Record
E	Enumeration Type
FP	Font/Precision Pair
I	Integer
L(type)	List of values of a given type
P3	3D Point
R	Real
n/s	Not Supported

PHIGS PLUS Workstation Description Table Entry	Data Type	Initial Value
number of available directly specifiable colour models	I	1 (RGB)
list of available directly specifiable color models	I	1 (RGB)
number of available rendering colour models	I	1 (RGB)
list of available rendering colour models	I	1 (RGB)
dynamic modification accepted for:		
data mapping representation	E	IRG
reflectance representation	E	IRG
parametric surface representation	E	IRG
light source representation	E	IRG
depth cue representation	E	IRG
colour mapping representation	E	IRG
table of predefined polyline bundles		See Table 3
table of predefined polymarker bundles		See Table 5
table of predefined text bundles		See Table 7
table of predefined interior bundles		See Table 9
table of predefined edge bundles		See Table 10
maximum number of data mapping bundle table entries	I	n/s
number of predefined data mapping bundles	I	n/s
maximum number of reflectance bundle table entries	I	20
number of predefined reflectance bundles	I	1
for every entry:		
reflectance index	I	1
reflectance characteristics	I	1
ambient reflection coefficient	R	1.0
diffuse reflection coefficient	R	1.0
specular reflection coefficient	R	1.0
specular colour	GCOLR	1
specular exponent	R	1.0

PHIGS PLUS Workstation Description Table Entry	Data Type	Initial Value
maximum number of parametric surface bundle table entries	I	n/s
number of predefined parametric surface bundles	I	n/s
number of predefined pattern representations	I	0
maximum number of light source table entries	I	12
number of predefined light source table indices	I	1
table of predefined light sources		See Table 18
maximum number of depth cue table entries	I	6
number of predefined depth cue indices	I	2
table of predefined depth cue representations		See Table 17
maximum number of colour mapping table entries	I	n/s
number of predefined colour mapping table entries	I	0 (n/s)
table of predefined colour mappings		n/s
number of available polyline shading models	I	2
list of available polyline shading methods		See Table 13
number of available interior styles		See Table 8
number of available data mapping methods	I	n/s
list of available data mapping methods	L(I)	n/s
number of available interior shading methods	I	2
list of available interior shading methods	L(I)	See Table 14
number of available reflectance characteristics values	I	4
list of available reflectance characteristics		See Table 16
maximum non-uniform b-spline curve order	I	n/s
maximum trimming curve order	I	0 (n/s)
number of available curve approximation criteria types	I	0
list of available curve approximation criteria types	L(I)	n/s
maximum non-uniform b-spline surface order	I	0 (n/s)
number of available surface approximation criteria types	I	0
list of available surface approximation criteria types	L(I)	n/s
number of available trimming curve approximation criteria types	I	0
list of available trimming curve approximation criteria types	L(I)	n/s
number of available parametric surface characteristics types	I	n/s
list of available parametric surface characteristics types	L(I)	n/s
number of available light source types	I	4
list of available light source types		See Table 15
maximum number of simultaneously active non-ambient light sources	I	12
number of available colour mapping methods	I	n/s

PHIGS PLUS Workstation Description Table Entry	Data Type	Initial Value
list of available colour mapping methods	L(I)	n/s
number of available true colours	I	2^{24}
maximum number of pseudo colours entries	I	n/s

Table 1. Workstation Type and Category

Type	C Name	Category
X drawable	**phigs_ws_type_x_drawable**	OUTPUT

Table 2. Available Line and/or Edge Types

Type	C Name	Meaning
1	**PLN_SOLID**	Solid
2	**PLN_DASH**	Dashed
3	**PLN_DOT**	Dotted
4	**PLN_DOTDASH**	Dot-dashed

Table 3. Predefined Extended† Polyline Bundle Table

Bundle Index	Linetype	Line Width Scale Factor	Colour Index‡	Shading Method†	Approx. Type†	Approx. Value†
1	Solid	1.0	1	None	N/A	N/A

†PHIGS PLUS extension.

‡All Predefined Extended Polymarker Bundle entries use colour model INDIRECT.

Table 4. Available Marker Types

Value	C Name	Meaning
1	**PMK_POINT**	Point
2	**PMK_PLUS**	Plus
3	**PMK_PSTAR**	Asterisk
4	**PMK_O**	Circle
5	**PMK_X**	Cross
0	to be determined	Asterisk
-1	to be determined	Diamond
-2	to be determined	Fast dot

Table 5. Predefined Polymarker Bundle Table

Bundle Index	Marker Type	Marker Size Scale Factor	Colour Index†
1	Asterisk	1.0	1

†All Predefined Extended Polymarker Bundle entries (PHIGS PLUS extension) use colour model INDIRECT.

Table 6. Available Text Fonts and Precisions

Font Number	C Name	Precisions Supported
1	**PFONT_MONO**	STROKE

Table 7. Predefined Extended Text Bundle Table

Bundle Index	Font Number	Text Precision	Expansion Factor	Character Spacing	Colour Index†
1	1	STROKE	1.0	0.0	1

†All Predefined Extended Polymarker Bundle entries (PHIGS PLUS extension) use colour model INDIRECT.

Table 8. Available Interior Styles

C Name	Meaning
PHOLLOW	Hollow
PSOLID	Solid-filled
PEMPTY	Empty

Table 9. Predefined Fill Area Interior Bundle Table

Bundle Index	Interior Style	Interior Style Index	Colour Index	Reflectance Equation†	Shading Method
1	Hollow	1	1	None	None

†All Predefined Extended Edge Bundle entries (PHIGS PLUS extension) use colour model INDIRECT; have back attribute values identical to the front; and have the following area properties:

Ambient Coefficient	Diffuse Coefficient	Specular Coefficient	Specular Colour	Specular Exponent	Transparency Coefficient
1.0	1.0	1.0	(RGB,1.0,1.0,1.0)	0.0	0.0

Table 10. Predefined Edge Bundle Table

Bundle Index	Edge Flag	Edgetype	Edgewidth Scale Factor	Colour Index†
1	ON	Solid	1.0	1

†All Predefined Extended Edge Bundle entries (PHIGS PLUS extension) use colour model INDIRECT.

Table 11. Predefined Colour Table

Colour Index	Red	Green	Blue	Description
0	0.0	0.0	0.0	Black
1	1.0	1.0	1.0	White
2	1.0	0.0	0.0	Red
3	0.0	1.0	0.0	Green
4	0.0	0.0	1.0	Blue
5	1.0	1.0	0.0	Yellow
6	0.0	1.0	1.0	Cyan
7	1.0	0.0	1.0	Magenta
≥ 8	1.0	1.0	1.0	White

Table 12. Available Annotation Styles

Value	C Name	Meaning
1	**PAN_UNCON**	Unconnected
2	**PAN_LEADLINE**	Lead Line

Table 13. Polyline Shading Methods

Value	C Name	Meaning
1	**PSD_NONE**	No Shading
2	**PSD_COLOUR**	Colour Shading

Table 14. Available Interior Shading Methods

Value	C Name	Meaning
1	**PSD_NONE**	No Shading
2	**PSD_COLOUR**	Colour Shading

Table 15. Available Light Source Types

Value	C Name	Meaning
1	**PLIGHT_AMBIENT**	Ambient Light Source
2	**PLIGHT_DIRECTIONAL**	Directional Light Source
3	**PLIGHT_POSITIONAL**	Positional Light Source

Table 16. Available Reflectance Characteristics

Value	C Name	Meaning
1	**PREFL_NONE**	No Reflectance Calculation Performed
2	**PREFL_AMBIENT**	Use Ambient Term
3	**PREFL_AMB_DIFF**	Use Ambient and Diffuse Terms
4	**PREFL_AMB_DIFF_SPEC**	Use Ambient, Diffuse, and Specular Terms

Table 17. Predefined Depth Cue Table

Depth Cue Index	Depth Cue Mode	Depth Cue Reference Planes	Depth Cue Scale Factors	Depth Cue Colour
0	SUPPRESSED	(0.0,1.0)	(1.01.0)	(INDIRECT,0)
0	ALLOWED	(0.0,1.0)	(0.01.0)	(INDIRECT,0)

Table 18. Predefined Light Sources

Index	Type	Data Record
1	DIRECTIONAL	(RGB,1.0,1.0,1.0),0.0,0.0,1.0