From: Evans & Sutherland
Interactive Systems Division
Customer Engineering

Subject: PS 390 Document Set

Date: January 4, 1988

Dear PS 390 User:

Accompanying this letter is your new PS 390 Document Set. It is intended to replace some of the documentation previously sent to you, including the PS 300 Document Set, preliminary PS 390 user documentation, and PS 390 Release Notes through version A2.V02. It does not replace your Site Preparation and Customer Support Guide (E&S #901194-090), Customer Guide(s) to Performance Verification Tests (E&S #901194-081 and 901194-086), nor any of the Customer Installation and User Manuals for host-to-PS 390 interfaces. These manuals were shipped with the system firmware and should be inserted behind the appropriate tabs in your new document set.

The PS 390 Document Set includes many sections that are revised and updated sections from the PS 300 Document Set, such as *IS3 Operation and Communication* and *GT13 Polygonal Rendering*. It also includes several entirely new sections, such as *GT12 Video Output Control* and *RM16 Index*. A few sections, such as *RM8 System Function Network*, have not yet been updated, but may, nevertheless, be useful until revisions can be made available to you.

The new document set requires some assembly. The printed spine inserts must be slipped into the spine pockets. This is best done while the binder is still empty and can be held fully open with the outside cover toward you. Since the inserts fit very snugly in the pockets, you may find it necessary to trim the right edge of the insert (about one-eighth inch) so that it will slide more easily to the bottom of the pocket. Each volume of the set is wrapped with its appropriate tabs. You will need to collate the tabs into their sections. A sheet of paper with the section title reverse-printed along the right edge marks the position where each tab is to be inserted. Replace these sheets with the tabs and put the volumes in the binders.

Thank you for your patience in waiting for the new document set. We hope that its usefulness will soon outweigh any inconvenience that you have experienced.

IASCE Technical Publications Dept.

READER COMMENT FORM **Publication Number** _____

Title _____

Your comments will help us provide you with more accurate, complete, and useful documentation. After making your comments in the space below, cut and fold this form as indicated, and tape to secure (please do not staple). This form may be mailed free within the United States. Thank you for your help.

How did you use this publication?

- ☐ General information
- ☐ Guide to operating instructions
- ☐ As a reference manual
- ☐ Other _____

Please rate the quality of this publication in each of the following areas.

	EXCELLENT	GOOD	FAIR	POOR
Technical Accuracy Is the manual technically accurate?	☐	☐	☐	☐
Completeness Does the manual contain enough information?	☐	☐	☐	☐
Readability Is the manual easy to read and understand?	☐	☐	☐	☐
Clarity Are the instructions easy to follow?	☐	☐	☐	☐
Organization Is it easy to find needed information?	☐	☐	☐	☐
Illustrations and Examples Are they clear and useful?	☐	☐	☐	☐
Physical Attractiveness What do you think of the overall appearance?	☐	☐	☐	☐

What errors did you find in the manual? (Please include page numbers)_____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____ **Street** _____

Title _____ **City** _____

Department _____ **State** _____

Company _____ **Zip Code** _____

All comments and suggestions become the property of Evans & Sutherland.

Fold

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 4632 SALT LAKE CITY, UTAH

POSTAGE WILL BE PAID BY ADDRESSEE

EVANS & SUTHERLAND
580 Arapeen Drive
Salt Lake City, Utah 84108

ATTN: IAS TECHNICAL PUBLICATIONS

Fold

Cut along dotted line

EVANS & SUTHERLAND PS 300 SUPPORT SERVICES

CUSTOMER ENGINEERING CONTACTS

CUSTOMER SERVICE HOTLINE:	**1-800-582-4375**
UTAH CUSTOMER ONLY CALL:	**582-5847 extension 4848**
Eastern Regional Office	(518) 885-4639
Western Regional Office	(916) 448-0355

Your PS 300 Equipment Tag Number PS-3098

Customer Site Number: _____

PREPARING YOUR SITE FOR PS 300 INSTALLATION

The PS 300 Site Preparation and Customer Support Guide (E&S No. 901172-054) contains instructions on getting your site ready for PS 300 installation. When your system is shipped from the factory, you will be contacted to schedule the installation. When you receive your PS 300, please do not unpack the boxes or you may void the warranty.

INSTALLATION

After installing your PS 300, the E&S customer engineer runs a Performance Verification Test (PVT). You witness this test and sign off the PVT form to indicate a successful installation. Signing the PVT form initiates your warranty, which provides 60 days of maintenance service covering hardware, firmware, and software.

If you have any questions, please use the Customer Service hotline.

MAINTENANCE PLANS

Continuous Maintenance Service

Complete and continuous preventative and remedial maintenance of PS 300 hardware, firmware, and software.

Guaranteed service response time.

Highest priority level service.

Automatic software, firmware, and documentation updates.

Toll-free hotline number.

A single monthly service fee which covers parts, labor, and **all** travel expenses. Price includes field ECOs and updates.

Requested Maintenance Service

Per-call service upon request. Response time depends upon available staff and resources. Requires receipt of a purchase order before the service will be supplied.

Hotline service provided at an hourly rate.

All parts, labor, and travel expenses are billed against customer purchase order at prevailing rates.

Special Service Plans

Individually designed for customers whose needs exceed the standard coverage--for example, on-site maintenance teams, non-standard service hours, non-standard response times, and/or guaranteed system availability.

Volume Discounts - Contact your E&S salesperson.

PS 300 GRAPHICS FIRMWARE UPDATES

Graphics Firmware updates expand PS 300 capabilities, enhance performance, and correct firmware problems. Continuous Maintenance Service contract holders receive updates automatically; others are notified that updates are available for purchase.

DOCUMENTATION

The following documentation is supplied with PS 300 systems;

PS 300 Site Preparation and Customer Support Guide - Covers site preparation, the installation process, and performance testing.

PS 300 Documentation Set - This five-volume set contains installation, operation, programming, and system management information.

Customer Installation and User Manuals - Each PS 300 interface and option has its own manual containing installation requirements and user notes.

If you need information on additional E&S documentation and how it may be ordered, contact your E&S salesperson.

*Documentation is subject to change without notice.

EVANS & SUTHERLAND

P.O. Box 8700, 580 Arapeen Drive
Salt Lake City, Utah 84108
Telephone 801-582-5847
Telex: 389492 Twx: 910-925-5818

Section IS1
Reader's Guide

The PS 390 Document Set (E&S #901194–400) contains operation and programming information and is organized into five volumes. Each volume has been given a two-letter abbreviation, and all sections within each volume are sequentially numbered using the volume abbreviation.

The five volumes and their abbreviation are:

- Introduction and Support (IS)
- Graphics Tutorials (GT)
- Tools and Techniques (TT)
- Reference Materials (RM)
- Advanced Programming (AP)

The document set is designed and sequenced to be helpful both to the novice and to the experienced programmer. The document set contents are described by volume in the following sections.

1. Introduction and Support (IS)

The Introduction and Support (IS) volume provides general information about the PS 390 graphics system and its use. The IS volume should be read by all users.

IS1. Reader's Guide

This section contains abstracts of each volume and section in the PS 390 Document Set.

IS2. PS 390 System Overview

The System Overview section is a summary of system capabilities and an introduction to PS 390 terminology. It describes the basic PS 390 system configuration, including a discussion of interactive devices and the display. This section also covers information on the runtime firmware and the host-resident software.

IS3. Operation and Communication

Read this section before attempting to start up the machine, boot Graphics Firmware, operate the keyboard, or enter the tutorial commands.

Step-by-step instructions for starting and operating the PS 390 using a variety of host interfaces are presented in this section.

IS4. Maintenance and Services

This section supplies Software and Documentation Hotline numbers, along with descriptions of E&S maintenance plans and training programs.

IS5. PS 390 Site Preparation and Customer Support Guide

Place the Site Preparation and Customer Support Guide (E&S #901194–091) you received prior to receiving your system in this section. The guide includes information on installing the PS 390 and interactive devices.

IS6. PVT Guide

Place the *Customer Guide to PS 300 System Performance Verification Test* (E&S #901194–081) which was delivered with your software diskettes in this section. This guide accompanies the performance verification software and explains the PVT program. If you purchased the rendering option, the *Customer Guide to the PS 390 Rendering Performance Verification Test* (E&S #901194–086) was also delivered with the software diskettes.

2. Graphics Tutorials (GT)

The Graphics Tutorials (GT) volume is a self-paced tutorial that teaches graphics programming for the PS 390. It is designed as an introduction to users who have no experience in programming the PS 390. Programmers experienced with other graphics systems should read those sections which explain concepts and operations that are specific to the PS 390. This volume can also be used as a review of programming procedures where needed. Because of its length, this volume is separated into two parts: *GT 1–7* and *GT 8–16*.

GT1. Hands-On Experience

This section steps through simple operations to introduce the user to several basic PS 390 programming concepts. It is designed to give the user practical knowledge of basic system functions.

GT2. Graphics Principles

This section discusses basic graphics operations and principles, and how these operations are performed using the PS 390. Included is information covering polygonal rendering and shading capability.

The Graphics Principles section should be read by all graphics programmers. For novices, it introduces essential concepts taught in the remaining tutorial sections. For the advanced programmer who does not plan to study the tutorials, it is background information for the remaining volumes in the PS 390 Document Set.

GT3. PS 390 Tutorial Demonstrations

This section is designed to accompany the tutorial demonstration programs. These demonstrations are selected to illustrate and clarify concepts taught in the GT sections. The package should be used as a supplemental learning tool with each section. This package also contains graphics primitives for use in the rest of the tutorial sections.

GT4. Modeling

This section details how to design a display structure for a model, including designing an organizational hierarchy, designing a detailed display structure, and designing a complex model.

GT5. Command Language

This section explains the command language used create and modify display structures, create and modify function networks, and instruct the display processor and command interpreter.

GT6. Function Networks I

The first Function Networks section covers the basic knowledge you need to interact with a model created for display. It covers the PS 390 dials that allow you to rotate, scale, and translate the displayed model.

GT7. Function Networks II

This section is a continuation of Function Networks I. It covers using the PS 390 dials for multiple interactions, and using the function keys to select sets of operations.

GT8. Viewing Operations

This section discusses the two types of viewing transformations: line of sight and windowing. Also included are setting intensity ranges for depth cueing, setting displays, and setting color.

GT9. Conditional Referencing

Conditional referencing is a way to display selected branches of a display structure without displaying other branches. This section covers the three attribute settings for conditional referencing: conditional bit, level of detail, and rate settings.

GT10. Text Modeling and String Handling

Text is handled in the PS 390 the same as any other graphical item. This section covers the creation and manipulation of character strings using commands and the interactive devices. Included is how to use and create different fonts.

GT11. Picking

Picking allows the user to retrieve information about a selection (pick) made on displayed data. Information can include the name of the data node that the picked portion of the object is associated with, names of nodes along the branch of the display structure, or an index into the vector list. This section defines the elements involved in picking operations and explains how to perform picking operations.

GT12. PS 390 Video Output Control

This section explains how to control the video output of the PS 390. It describes the use of filters to implement antialiasing, setting intensity modulation, selecting the color of the screen cursor, selecting background/foreground color, and selecting a video timing format.

GT13. Polygonal Rendering

This section covers the commands used to define objects eligible for polygonal rendering. Included is how to perform hidden-line removal, backface removal, sectioning, cross-sectioning, and shading operations.

GT14. Raster Programming

This section explains how the PS 390 system can be used as an image buffer to display host-generated images. It includes information on run-length encoding of host data and using color lookup tables.

GT15. Sample Programs

This section contains code examples of various PS 390 programs that demonstrate programming techniques and applications. The programs are designed to be used in conjunction with the tutorials in this volume.

GT16. Glossary

The glossary contains definitions of terms used in all five volumes of the PS 390 Document Set.

3. Tools and Techniques (TT)

The Tools and Techniques (TT) volume describes programming aids for the PS 390. It includes information such as helpful hints, how to use the various graphics editors, and explanations of other utilities and applications.

TT1. Application Notes

This section is collection of useful samples and applications for PS 390 users. Contributions to the Notes come from PS 390 users inside and outside Evans & Sutherland.

TT2. Helpful Hints

This section contains task-oriented information such as defining break keys, using the SITE.DAT file, name suffixing, and CPK rendering. This section assumes a good working knowledge of the PS 390 and some programming experience.

TT3. Using the GSRs

This section is an introduction to using the graphic support routines (GSRs). The GSRs are a method of communicating graphics data to the PS 390. The GSRs can be used with FORTRAN, Pascal, or C programming languages.

TT4. Function Network Editor

This section describes NETEDIT, a program which allows the user to create a function network using a diagram on the PS 390 display rather than directly inputting commands to a file. Editing menus are used to build a network of "black boxes" which may contain more detailed representations of parts of the network. When the diagram is complete, an ASCII code file can be generated which contains the PS 390 commands needed to build the network.

TT5. Function Network Debugger

This section describes NETPROBE, a utility developed at Evans & Sutherland to be used as a guide for a user-written network debugging program.

TT6. Data Structure Editor

This section describes STRUCTEDIT, a graphical display structure editor for the PS 390 that allows the user to sketch out a display structure, then converts the diagram into ASCII PS 390 commands or a routine that can be included as part of a FORTRAN, Pascal, C, or LISP program.

TT7. Character Font Editor

This section describes MAKEFONT, a program that allows the user to edit an existing character font or create a new one. It is an interactive, menu-driven program that displays characters in a 128- or 256-character font. Each character can be edited to create a new shape. Different fonts can be combined into a new font, and original fonts can be created from scratch.

TT8. ASCII-to-GSR Converter

This section explains how to run the ASCII-to-GSR conversion program. The program is a host-resident PS 390 option that allows you to combine ASCII programming with the faster data communication speeds available through the GSRs.

TT9. Transformed Data and Writeback

This section provides information on how to retrieve transformed data, such as a matrix or vector-list representation of transformation operations.

TT10. Crash Dump File

The crash dump file is created when a system crash occurs. This section explains how to read back the file and includes an example of a Pascal host program that writes the information from the PS 390 crash file into a host file.

4. Reference Materials (RM)

The Reference Materials (RM) volume provides reference information on PS 390 commands, functions, GSRs, utilities, and communication protocols. Also included is information on peripherals, interfaces, options, and a list of system errors. Because of its length, this volume is separated into two parts: *RM 1–4* and *RM 5–16.*

RM1. Command Summary

This is an alphabetically organized summary of the ASCII form of every PS 390 command. It contains the full command, the acceptable abbreviated form of the command, options, parameters, default values, and, where appropriate, notes and comments. If a command creates a node in a display structure, the inputs and acceptable data types for that node are shown.

RM2. Intrinsic Functions

This section describes in alphabetical order the PS 390 intrinsic user functions and intrinsic system functions. Each description gives a brief overview of the function and a diagram showing input queues, outputs, and the data types for all inputs and outputs. Notes and comments are included where appropriate.

RM3. Initial Function Instances

This section provides information about PS 390 initial function instances. Each description gives a brief overview of the initial function instance and a diagram showing input queues, outputs, and the data type for all inputs and outputs. Notes and comments are included where appropriate.

RM4. Graphics Support Routines

This is an alphabetically organized summary of the host-resident GSRs. FORTRAN, Pascal, and C routine names, parameters, and descriptions are provided. The corresponding PS 390 command and syntax is also included.

RM5. Host Communications

This section includes RS-232 and RS-449 interface specifications and pin connector definitions, PS 390 transmission protocol, port values and defaults, and the PS 390 system data reception functions.

RM6. Interfaces / Options

This section covers general information about PS 390/host interfaces and options. Its main purpose, however, is to provide a place for the insertion of Customer Installation and User Manuals for any interfaces and options ordered with the system (or subsequently). These manuals are typically shipped prior to E&S hardware installation so that customers can adequately prepare the site and their host computer.

RM7. Host Input Data Flow

This section covers information on the input data flow, including using routing bytes, routing byte definitions, and routing functions.

RM8. System Function Network

This section contains diagrams of the PS 390 system network. The diagrams show the logical paths of routing bytes and functions.

RM9. Initial Structures

This section describes initial data structures created by the runtime firmware. Configure mode is discussed and a "runtime" system is defined.

RM10. Terminal Emulator

Instructions are given in this section for changing the modes and features of the Terminal Emulator by either sending escape sequences from the host, entering PS 390 commands in the SITE.DAT file, or sending the appropriate ASCII characters to terminal emulator functions.

RM11. System Errors

This is a compendium of all error messages (informational, warning, recoverable, and fatal) that a user might encounter. Error messages are listed in numerical order. The text of the message is given with an indication of common causes of the error and, where appropriate, ways to correct it.

RM12. Diagnostic Utilities

This is a reference for the utility commands that are on the PS 390 diagnostic utility diskette.

RM13. Interactive Devices

This section provides hardware and data-transmission descriptions of the PS 390 interactive devices. Descriptions are included for the peripheral multiplexer, keyboard, data tablet, function buttons, control dials, mouse and display.

RM14. GSR Internals

This section describes the data formats expected by the PS 390 command interpreter. It is provided for advanced programmers to write their own GSRs.

RM15. Release Notes

A divider tab is provided for information supplied with future releases of software.

RM16. Index

This section is provided as a reference to all five volumes of the PS 390 Document Set.

5. Advanced Programming (AP)

This volume contains information for performing advanced programming. Included is information on PS 390 internal processing, mass memory structures, physical I/O, user-written functions, and data and operation node formats.

IS2. PS 390 SYSTEM OVERVIEW

CONTENTS

ILLUSTRATIONS

Section IS2
PS 390 System Overview

The PS 390 graphics system was developed to put the power of sophisticated computer graphics in the hands of users who are primarily designers involved in complex design and analysis tasks. The machine takes much of the burden of graphics processing and interactive-device handling away from the host computer and, more importantly, the user. The user is free to concentrate on the application task for which the PS 390 is being used. The PS 390's own high-level ASCII command language was designed to let the user program in a way that is closer to how a designer thinks. Memory is treated not as a set of addresses where data is stored, but as a collection of structured objects created and accessed by name. Minimum knowledge of matrix arithmetic is needed to manipulate graphical data since the system automatically performs all transformation processing and the necessary matrix concatenations. The result is a system which is several steps removed from traditional graphics machines, much as a high-level programming language differs from assembly languages.

1. Features of a High Performance Machine

The PS 390 allows the user to create, display, modify, and manipulate complex 2D and 3D wireframe models interactively. Using Evans & Sutherland's Shadowfax™ technology, the PS 390 combines the real-time interaction capability and line quality of a calligraphic system with the flicker-free images of a raster system. With the purchase of the Advanced 3D Visualization Option, high-quality shaded static images of models can be rendered locally on a full display or in selected portions of the display. The PS 390 also provides a variety of user-selectable shading styles and a range in the quality of the anti-aliased lines for tailoring speed, quality, and performance characteristics to specific applications. The following is a summary of important features of the PS 390 graphics system.

- Hierarchically Structured Models

  The PS 390 system allows the user to create three-dimensional objects as lines, polygons, and characters and to store them in the system's own

mass memory. Models are created as hierarchical groupings of graphical data (points and lines or planes), mathematical operations (transformations) which are applied to the data, and attributes of the model such as color and intensity. Hierarchical structuring allows complex objects to be created from simpler parts. Individual components of a model can be used again and again. Changes can be made to individual parts of the structure without the need to recreate the whole structure.

- Control of 3D Models

  Using commands or interactive devices, the user can manipulate wireframe images of models, translating (moving), scaling, and rotating the images by any amount in any direction.

- Local Manipulation of Models

  The PS 390 controls the interactive manipulation of models locally. Values which are input from the various interactive devices (dials, keys, data tablet, buttons, and mouse) are sent through user-designed function networks to interaction points in the model's structure. The host computer never has to participate in handling the interactive devices.

- Real-Time Interaction

  Real-time interaction refers to the ability of an image to respond instantly to input from an interactive device. The PS 390 lets the user interact with displayed images of complex 3D models in real time within a dynamic viewport on its raster screen.

- Perspective Views

  The system is capable of displaying objects in perspective to enhance the illusion of three dimensions. In perspective views, lines which recede from the eye appear to converge. When an object viewed in perspective is manipulated on the screen (translated, rotated, or scaled) the system maintains a true perspective view of the object.

- Depth Cueing

  To further enhance the illusion of depth, the system performs depth cueing. This is a visual effect to allow the viewer to perceive three dimensions on a two-dimensional screen. A line in a picture which represents the depth dimension (into the screen) grows dimmer the "farther away" it is from the viewer.

- Text as a Graphical Item

  The system treats text as any other graphical item, allowing interactive translation, rotation, and scaling of characters and text strings. The PS 390 has a standard character font. Commands are available to create, modify, and use any other style or size of character font.

- Use of Color

  In graphical renditions of complex three-dimensional structures, color can be an important asset in analyzing the design. The system gives the programmer the option of displaying parts of a model in different colors in a dynamic viewport on the display.

- Optional Advanced 3D Visualization of Solid Objects

  The PS 390 also allows users to create objects as polygons and to display hidden line–removed and sectioned views of polygonally defined wireframe objects. Smooth-shaded renderings of polygonal models can be displayed that take advantage of numerous attribute settings for color, multiple light sources, specularity, transparency, and polygon edge enhancement. In addition the PS 390 can be used as a frame buffer for the display of host-generated, run length–encoded images.

- Distributed Processing

  PS 390 systems allow high-performance interactive graphics in a distributed graphics environment. The high degree of local intelligence of the systems allows the PS 390 to store the graphical data base, perform all transformation and display processing, and handle data from the interactive devices without intervention from the host.

- Host Independence

  No specific size or make of host computer is dictated for the PS 390. The system communicates over a low-bandwidth interface to virtually any host that can accept RS-232-C and RS-449 asynchronous serial communications using START/STOP protocol. Other PS 390/host computer interfaces are available for high-speed data transfers to several models of DEC and IBM computers.

2. PS 390 System Configuration

The basic system configuration for the PS 390 is the control unit and display, various interactive devices, and a host computer.

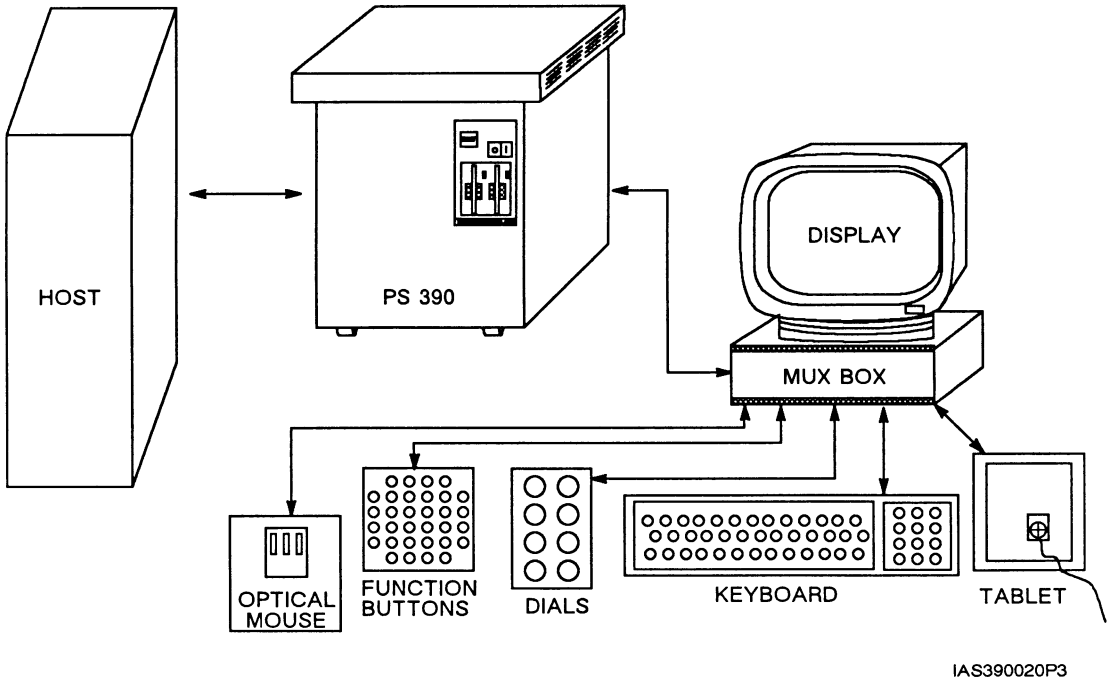


Figure 2-1. Basic System Configuration

2.1 The Control Unit

The PS 390 control unit is housed in the cabinet which contains the power supplies, the standard and optional circuit cards for the system, and the floppy diskette drives for loading the PS 390 firmware and data files.

The free-standing control unit is approximately 53 cm (21 in.) wide, 71 cm (28 in.) deep, 67 cm (26.5 in.) high, and weighs 55 kg (120 lbs.). The top holds over 250 pounds static weight or 180 pounds rolling load.

There are two external controls on the PS 390 control unit. One is the ON/OFF toggle switch, located at the top right of the front panel. A RESET switch is located just left of the ON/OFF switch. The RESET switch allows the system to be reset instead of powered off during a system lock or reboot.

The PS 390 floppy disk drives are located at the front of the unit near the upper right corner. The system uses double-sided, quad-density, 5-1/4 inch minifloppy diskettes capable of storing 737,280 formatted bytes on 160 tracks.

2.2 Port Configuration

The PS 390 supports four asynchronous RS-232 ports on the communications connector panel. Port 0 and Port 2 are physically present but not usable. See Figure 2-2.

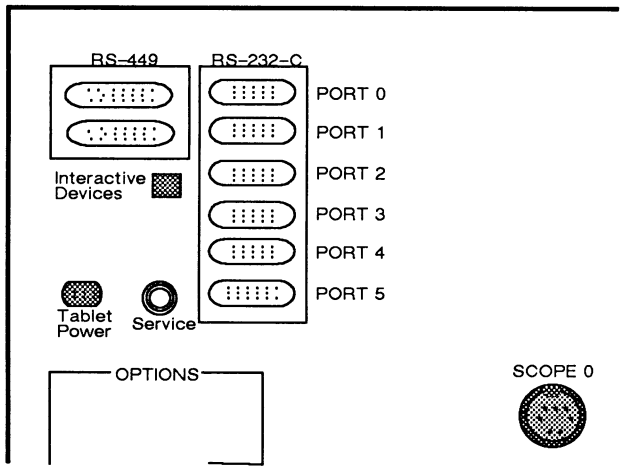


Figure 2-2. PS 390 Communication Ports

The port configuration for the PS 390 is as follows:

- Port 1 is the host port.
- Port 3 is the debug port, for diagnostic purposes.
- Port 4 may be used for special interface applications, including an alternate diagnostic port.
- Port 5 is the peripheral multiplexer port.

2.3 The Display

The PS 390 supports a color raster display. The PS 390 provides interactive manipulation of high quality anti-aliased wireframe images, as well as the rendering of shaded images in a variety of shading styles. Many combinations of viewports can be defined for the display of multiple views and renderings of objects.

2.4 Power Requirements

The following power requirements apply to the PS 390:

- 110V, single phase (± 10%), 47–63 Hz, 12 amps (max) for the control unit
- 115V, single phase (± 10%), 50–60 Hz, 1.5 amps (max) for the color raster display
- 90–130V, single phase, 47–63 Hz, 0.6 amps (max) for the peripheral multiplexer

2.5 Basic Card Set

There are five basic circuit cards: Joint Control Processor (JCP), Arithmetic Control Processor (ACP), Pipeline Subsystem (PLS), Raster Backend Bit-slice Processor (RBE/BP) and Raster Backend Video Controller (RBE/VC). The last four of these cards can be grouped into a functional unit called the display processor.

2.5.1 The Joint Control Processor

The JCP consists of two (optionally three) sections: control processor, mass memory, and interface sections. The JCP is based on a 68000 10-MHz microprocessor with a 24-bit address space. The JCP contains 512K bytes of local memory which is loaded with graphics firmware when the system is powered on. There is a local path to the JCP-resident mass memory which provides access from the 68000. The JCP also contains communications controllers for host and interactive-device handling and for bus-interface circuitry.

The JCP's mass-memory section has two megabytes of memory. Part of memory is taken up with system networks and structures. These are loaded from the firmware diskette when the system is booted. The rest of memory is available for storing data bases of models and function networks.

The JCP manages memory automatically. The user does not have to worry about buffering schemes, addresses, or garbage collection. The user accesses memory by the names of the structures that are created.

The JCP's optional interface section provides a location for an IBM 3278 interface. This option allows the PS 390 to communicate with an IBM 3274 control unit over a 56KB line.

The JCP performs the following tasks:

- Controls communications with the host.
- Provides the terminal emulator capability (DEC VT100 or IBM 3278).
- Processes commands and creates data structures and function networks in mass memory.
- Performs memory management.
- Handles interactive devices by executing user-designed function networks.
- Synchronizes updates so that complex interacting motion does not appear disjointed.

The JCP can be enhanced with General Purpose Interface Option (GPIO) cards. These handle high-speed communications with DEC and IBM hosts other than the IBM 3278 (which is a configurable option on the JCP itself).

2.5.2 The Display Processor

The display processor section of the PS 390 consists of four cards: ACP, PLS, RBE/BP and RBE/VC.

The display processor accesses data in mass memory and generates a picture for display on the screen. It traverses the structures of objects to be displayed, performs the transformations indicated, and generates the lines to be drawn on the screen.

The patented Shadowfax™ technology is contained within the display processor and is located on the RBE/BP and RBE/VC cards. Shadowfax™ technology consists of the custom VLSI circuitry which produces the calligraphic-quality (anti-aliased) lines on a raster display. Shadowfax VLSI subpixel processing mathematically divides each pixel into 64 subpixels. This provides addressability and image quality of 8192 by 6912 on the 1024 by 864 pixel display.

The display processor performs the following tasks:

- Reads and traverses structures in mass memory.
- Performs character generation.
- Does geometric character matrix concatenations. These only affect text, not three-dimensional data.

- Does 3x3 matrix concatenation affecting text and data
- Performs 3D translation concatenations
- Does 4x4 windowing concatenation, including perspective
- Performs all data transformation through matrices
- Performs clipping
- Performs viewport mapping
- Controls blinking
- Handles picking
- Performs digital-to-analog line conversion, including color, for circuitry in the PS 390 display
- Performs high-quality anti-aliasing of lines

2.5.3 Optional Cards

Currently, the optional cards supported for the PS 390 are the GPIO and Mass Memory (MM) cards.

The PS 390 runtime firmware supports up to two GPIO interfaces of differing types installed in the same system, as well as asynchronous communications. The default configuration is asynchronous but the user has the ability to configure any interface when the system is booted.

It is also possible to change the configuration without rebooting the PS 390 because the runtime software determines which of the interfaces are in the system and initializes them all. This is achieved through runtime identification of up to two GPIOs at the first two addresses assigned to GPIO interface cards. However, there are some limitations to the use of multiple GPIOs. First, there cannot be two of the same type GPIOs in the same system. Second, the IBM 3278 option is regarded as a GPIO interface, although it is included as an optional interface on the JCP rather than a separate interface card. This means that only one additional GPIO may be added when the IBM 3278 option is used.

The following are available GPIO options.

- Ethernet — Allows a PS 390 to communicate with a DEC VAX host via an Ethernet network.
- IBM 5080 — Allows a PS 390 to interface to an IBM host computer via an IBM 5088 control unit.

- Unibus Parallel Interface — offers 16-bit parallel direct memory access (DMA) communication between the PS 390 and a DEC VAX host. The interface is a bidirectional differential-driven data path. It can transfer data at a rate of one megabyte per second.
- IBM 3278 — Available as an optional interface section on the JCP card. It provides a location for an IBM 3278 interface. This option allows the PS 390 to communicate with an IBM 3274 control unit over a 56KB line.

The PS 390 mass memory can be expanded with two optional MM cards separate from the mass memory which exists on the JCP card. Each separate MM card contains one megabyte of mass memory. Total mass memory is expandable to four megabytes.

The JCP communicates with separate MM cards across a 16-bit path, creating structures in memory or sending data to function networks or interaction points in a model's structure. The display processor communicates with the mass memory over a 32-bit path to traverse the structures of models. This broad path ensures fast display access time. Figure 2-3 provides a simplified functional overview of the PS 390 graphics system.

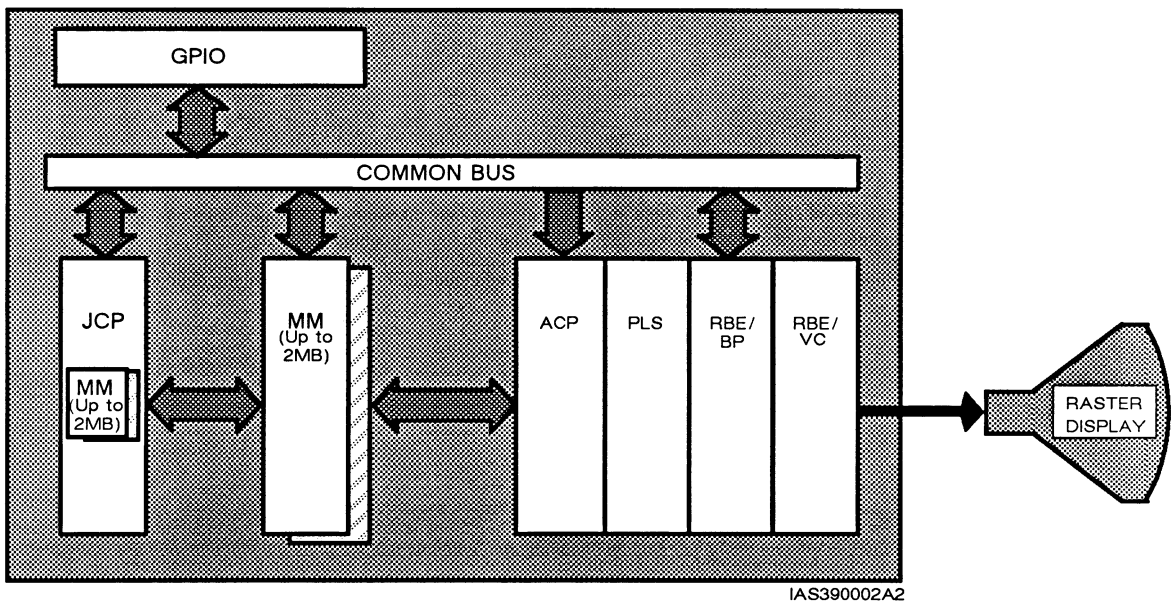


Figure 2-3. PS 390 Architectural Overview

2.6 Card Configuration

The following is the proper card configuration for the PS 390 as seen from the back of the control unit.

```
GPIO*(2)  MM*(2)  JCP  ACP  PLS  RBE/VC (blank)  RBE/BS
```

* optional cards (2). There are two available slots for these options.

2.7 Interactive Devices

Several optional interactive devices are available with the PS 390 systems. Two styles of interactive devices are available: the PS 300 style and the PS 390 style. The two styles cannot be mixed on the same system. They are programmable, easy-to-use devices which allow a PS 390 user to interact with the images displayed on the screen. All devices have local intelligence provided by a microprocessor. Details on the interactive devices are contained in Section *RM13*.

2.7.1 Peripheral Multiplexer

Interactive devices for the PS 390 are connected to the peripheral multiplexer (mux box) contained in a three-inch pedestal that supports the raster scope. All interactive device connections for the mouse, function buttons, control dials, keyboard and data tablet are clearly marked on the front panel of the mux box. Figure 2-4 shows the front view of the mux box.

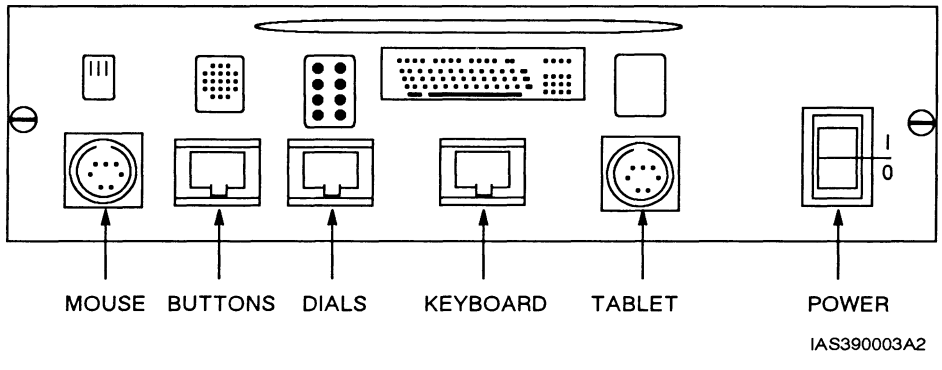


Figure 2-4. Front Panel for PS 300 Interactive Devices

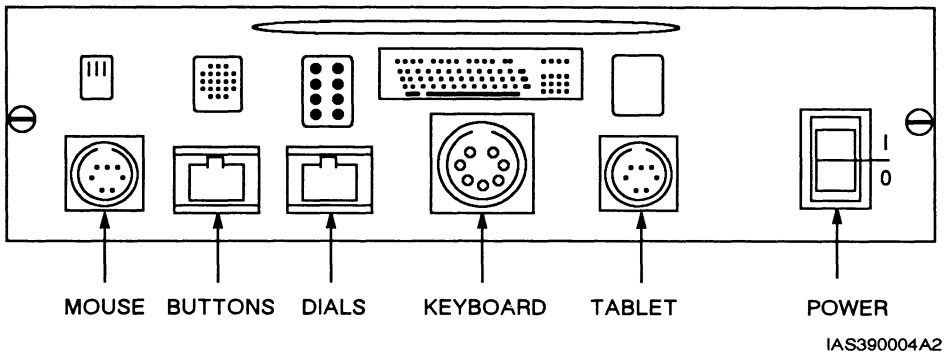


Figure 2-5. Front Panel for PS 390 Interactive Devices

The back panel of the mux box has an RS232-C connection and two external power connections. All cables and connections are clearly marked. To maintain EMI integrity, the screws on the RS232-C shielded cable must be tightly turned on the connection. Figure 2-6 shows the rear panel of the mux box.

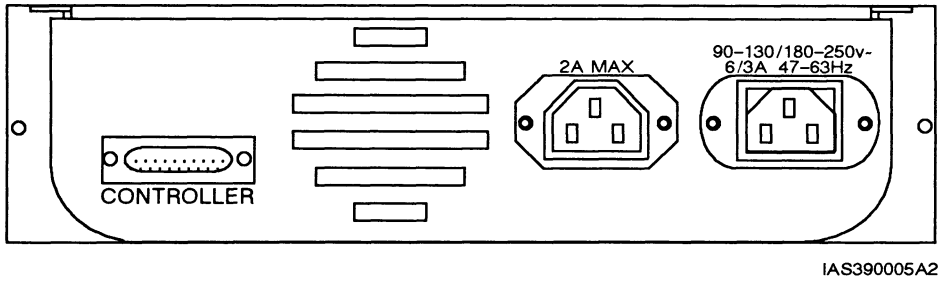


Figure 2-6. Peripheral Multiplexer Back Panel

2.7.2 Keyboards

The basic PS 390 keyboard includes all standard alphanumeric keys, a separate numeric keyblock, typical typewriter control keys, symbols, and a set of 12 function keys which can be programmed to perform interactive graphics functions.

The 8-character optional LEDs on keyboards are usually programmed to display prompts to aid the operator or labels that describe the operations being performed (e.g., ROTATE IN X).

2.7.3 Function Buttons

A unit containing 32 programmable function buttons is available with the PS 390. The function buttons are arranged with one row of four buttons, four rows of six buttons, and a final row of four buttons. Pressing a function button results in a user-specified action. The buttons are usually programmed to display different views of the same object or to switch between views of different objects.

2.7.4 Control Dials

A set of eight programmable control dials is available with the PS 390. The control dials are used to control size, position, and orientation of displayed objects, and for other programmed functions. The dials are mounted in two rows of four dials. Above each control dial is an 8-digit optional LED display which can be programmed to display the function of the dial or other information associated with the use of the dial.

2.7.5 Data Tablet

There are two data tablets available for the PS 390. One is a 6-inch square tablet, the other is a 12-inch square tablet. Both tablets have four-button "pucks." They are alike except for their active areas. Both tablets are normally used as an interactive pointing and positioning device to control the cursor on the display.

2.7.6 Optical Mouse

An optical mouse is available with the PS 390. The mouse sends X- and Y-axis position data to the JCP. The position information provided by the mouse is similar to that provided by the data tablets.

3. Host Communications

The PS 390 does not rely on a host to perform any of the graphics processing or handling of data from the interactive devices. In most applications, the host is used for analysis programs and for file storage. Since the PS 390 does not store commands or save files which create objects and function networks, most users create files on the host and transfer them to the PS 390.

3.1 Host Interfaces

The standard data communication interfaces to the PS 390 are asynchronous serial line RS-232-C or RS-449 using START/STOP protocol. These two interfaces are ideal for interfacing to most host computers in applications requiring a maximum data transfer rate of 19.2K baud. RS-232-C is recommended for distances up to 50 feet between the PS 390 and the host. For runs longer than 50 feet, RS-449 is recommended. A maximum cable length of 3,000 feet is available for 19.2K baud transfers.

In addition to the standard interfaces, different types of high-speed data transfer interfaces are available for selected IBM and DEC computers. These offer faster transfer rates and allow greater distances between the PS 390 and the host. Up to two of these interfaces can be configured in the PS 390, and the user is able to toggle between the two. This is described in detail in Section *RM6*.

3.2 Communication Lines

Asynchronous communication between the PS 390 and the host can take place over one or two lines.

In single-line communications, graphics commands and the terminal emulator for the host are multiplexed over one line. Control characters preceding and following the data are used to route information to the terminal emulator software or to the the PS 390 command interpreter.

In dual-line communications, one line is used to communicate graphics commands, and the other is used for terminal emulation. No multiplexing occurs with dual-line communication.

4. Distributed Media: PS 390 Firmware and Host Software

The distributed media that accompanies all PS 390 systems includes the PS 390 graphics firmware diskettes, other distributed system diskettes, and the PS 390 host-resident software that are distributed on magtape.

4.1 Other Diskettes Shipped With the System

The PS 390 system is shipped with several other system diskettes in addition to the PS 390 graphics firmware diskettes. These include:

- The PS 390 Performance Verification Test
- The PS 390 Rendering Performance Verification Test
- The PS 390 Demonstration Package diskettes
- The PS 390 Diagnostic Utility diskette

Guides to the Performance Verification Tests are shipped with the diskettes. Section *IS6* of this volume has been provided for placement of those guides. Documentation for running the PS 390 Demonstration Package is in Section *GT3*.

The Diagnostic Utility diskette contains Utility Commands that are used to copy diskettes and to delete files on diskettes. Refer to Section *RM12* for the definition and use of the diagnostic utilities.

4.2 Host Resident Software

Along with the system diskettes, E&S distributes files on magtape that will be loaded onto the host system. These files contain various applications and utilities that are used for PS 390/host communication. The magtape can contain the following files:

- A README file that describes the files on the magtape.
- PS 390/Host communication tests.
- The PS 390 Graphics Support Routines source code.
- A SITE.DAT file for setting up dual-line configuration of the terminal emulator.
- Instructions for installing the cross-compatibility software for both IBM and DEC operating systems.
- A file with the execs or jobstreams to be used as examples for installation procedures for both IBM and DEC operating systems.
- Three programming utilities (For VAX/VMS users only): NETEDIT, NETPROBE, and MAKEFONT.
- The E&S supplied files that are used in developing and transporting user-written functions.

4.3 The Graphics Support Routines

The PS 390 Graphics Support Routines (GSRs) are a set of software routines developed and supported by Evans & Sutherland that allow for faster graphics transactions on the PS 390 System.

The GSRs are distributed as either callable FORTRAN, Pascal, or UNIX/C routines. It is the responsibility of the user to load, compile, and link the routines with their application program. Installation instructions for the GSRs are provided in Section *TT3*.

The source code for the GSRs contains all files necessary for the customer to compile and link the GSRs, once the tape is loaded on the host. The file names and descriptions are included in the installation instructions.

The GSRs are supported in DEC VAX/VMS, DEC/UNIX, IBM VM/SP CMS, and IBM OS/VS2-TSO environments.

The documentation for the GSRs is provided in Section *RM4*.

5. The PS 390 Command Language

The PS 390 has its own command language which has two equivalent representations: ASCII and binary. Both forms can be used over most communications lines.

The ASCII form of the language consists of English-like commands which closely reflect typical operations that are performed in computer graphics applications. For example, the ROTATE command rotates an object through any angle around any axis; the VECTOR_LIST command creates an object as a list of vectors; the DISPLAY command produces an image of an object on the screen, and so on. The ASCII commands were designed to simplify graphics programming for users who are primarily structural designers and analysts, not experienced graphics programmers.

Using PS 390 commands, the user builds structures which represent the objects and models to display and interact with. Because of the PS 390 "naming convention," however, the user never has to treat the data which defines an object as addresses in memory. Instead, memory is treated as a collection of objects, each created with a name and accessed by that name using the system's commands.

Objects are named groupings of graphical data, mathematical operations called transformations which are applied to the data, and attributes such as color and level-of-detail. Once created, a single named definition of a graphical object can be used again and again like a template to build an endless number of other objects. It can be included in other structures by a simple reference to its name.

For example, a scientist modeling a molecule of water could first create Atom as a primitive object from which the hydrogen and oxygen atoms can be built. By scaling the original atom, objects named *Hydrogen_Atom* and *Oxygen_Atom* can be created. These objects are created as named entities and worked with as named entities. To create and position an additional hydrogen atom, a translation can be applied to *Hydrogen_Atom* to give *Hydrogen_1*. Another translate operation applied to *Hydrogen_Atom* will yield *Hydrogen_2*. An object named *Water_Molecule* can then be created. Its structure uses one instance of *Oxygen_Atom*, one instance of *Hydrogen_1*, and one instance of *Hydrogen_2*, each correctly positioned to simulate the structure of the molecule. Whenever the scientist accesses *Water_Molecule* to change its definition, to display it on the screen, or rotate it using a dial, it is accessed by name.

Both the form of the PS 390 command language and the treatment of graphical data as named entities in memory reflect the design of the PS 390 as a tool for designers and analysts, not just graphics programmers.

Commands fall into the following categories:

- Function
- General
- Modeling
- Rendering
- Structure
- Viewing

Function commands connect and disconnect inputs and outputs of functions, set the inputs of functions to be constant, and send data to inputs of functions.

General commands display and remove objects from the screen, alter the structures of objects by including, prefixing, or following named objects

with other named objects, and build function networks which allow the user to interact with the model by connecting interactive devices to places in the structure of the object.

Modeling commands create primitive objects as vector lists, curves, and polygons, and perform three-dimensional modeling transformations (rotate, translate, scale) on objects and two-dimensional transformations on characters.

Rendering commands declare polygon objects to be surfaces or solids so that rendering operations may be performed on them, and specify the characteristics of polygons (such as hue, saturation and intensity) used in the creation of shaded renderings.

Structure commands are used for creating the structure of objects, naming objects, explicitly and implicitly referencing objects, and conditionally referencing other objects. They create display structures which are the structured grouping of graphical data, transformations, and attributes which define an object.

Viewing commands create different views of objects by letting the user specify a line of sight, orthographic views, perspective views, and viewports, and set and change appearance attributes of a model such as the color or the intensity of the lines displayed.

5.1 Using the Command Language

Each command directs the machine to perform a graphical operation which would require several statements in a conventional programming language such as FORTRAN or Pascal. Once a command is entered, the command itself no longer exists. Instead, the command is interpreted and an action is taken or an entity is created in mass memory. PS 390 commands can be entered in command mode or downloaded in a file from the host system. Commands entered in command mode are immediately interpreted by the PS 390. As the PS 390 does not store data entities between power-up cycles, when the system is turned off memory is cleared and existing entities are lost.

The terminal emulator mode is provided to allow the PS 390 to log on to the host system. In terminal emulator mode, the PS 390 keyboard and display can emulate either a DEC VT100 terminal or an IBM 3278 terminal.

Commands can be entered into a file on the host system and then downloaded to the PS 390. This method uses the host as a storage device for data files.

PS 390 commands are transmitted in ASCII or in binary format. The PS 390 has its own command interpreter which checks the syntax of commands and puts them into effect. When commands are sent in ASCII, they pass through a system function that parses and packages the data into binary data packets that are accepted by the command interpreter.

The GSRs are the binary form of the PS 390 command language, and allow for more efficient communication between the PS 390 and the host system. These routines prepackage all commands into binary packets on the host and provide much faster throughput for downloading PS 390 command files from the host. They are available in FORTRAN and Pascal for DEC VAX/VMS systems and IBM systems, and in C for DEC/UNIX systems.

5.2 Structures are Hierarchical

The structures that are created in memory are structured groupings of the graphical data which define shapes and the transformations which are performed on the data. These structures form a set of instructions which the display hardware processes to generate a picture on the screen. Elements in the structure are organized hierarchically. Implicit in this hierarchical organization are the operations and transformations that should be applied down any one path.

In a hierarchical structure, each element is used as a reference to all elements below it. So in the structure for Water_Molecule:

Atom references the vector list which defines a basic atom.

Hydrogen_Atom and *Oxygen_Atom* reference scaling operations that are applied to *Atom*.

Hydrogen_1 and *Hydrogen_2* reference translation operations that are applied to *Hydrogen_Atom*.

Water_Molecule references the two scale operations applied to *Atom*, and the translations applied to the scaling operations applied to *Atom*.

This type of structure is typical of the structures of objects you create when programming the PS 390. It is referred to as a display structure. Each element in the structure is called a node. A node is either a data node, such as *Sphere*; an operation node, such as *Hydrogen_Atom* (scale) or *Hydrogen_1* (translate); or an instance node, such as *Water_Molecule*, which groups other elements under a single name. Display structures can be drawn as diagrams which represent the hierarchical structuring of data and operations which define an object. A display structure for *Water_Molecule* is shown in Figure 2-7.

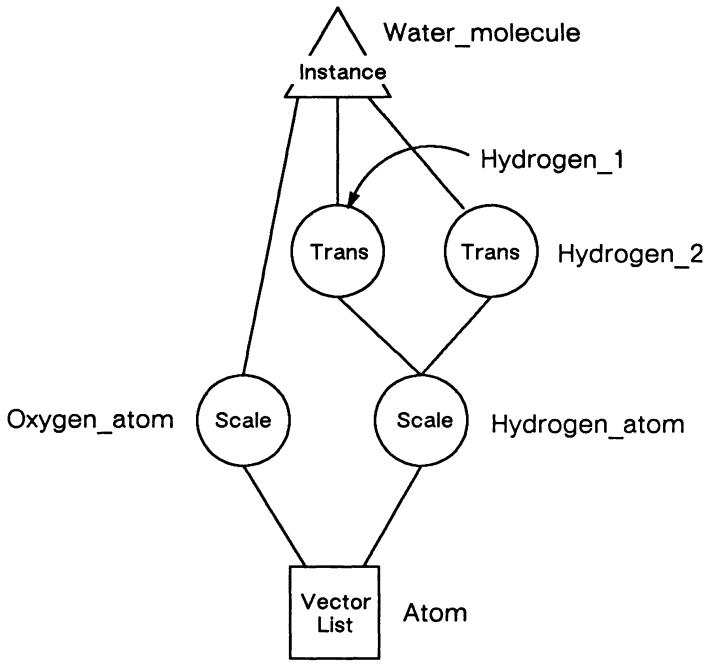


Figure 2-7. Display Structure for Water_Molecule

Data nodes are shown as squares, operation nodes as circles, and instance nodes as triangles. Nodes are connected by branches. The branches in the display structure determine what paths the display processor will take when it traverses the object's structure in memory. The content of each node in the structure determines either the operations the display processor will perform as it travels a branch or the data that will be transformed.

PS 390 display structures are more properly described as acyclic directed graphs. In a directed graph, an entity may have more than one ancestor. In PS 390 display structures, a data node may be the terminal node for more than one branch, as is the case for Atom in Water_Molecule. An acyclic graph does not allow recursion; that is, an element cannot refer back to itself. In PS 390 display structures, no path out of a node can be a loop back to that node.

6. Local Processing

The PS 390 was designed to perform locally all transformation processing, display processing, and interaction with the picture. Traditionally, the host computer has performed most of these operations.

6.1 Transformation Processing

The system performs most of the transformation and display processing involved in modeling and viewing objects without intervention from the user. This greatly reduces the graphics programming task and frees the programmer to concentrate on the design and analysis aspects of the application for which the PS 390 is being used. The main aspects of the transformation processing which the PS 390 performs are outlined below.

- Traversing Structures in Memory

  The programmer creates objects in memory as display structures with named nodes. The nodes define both the graphical data that determine primitive shapes and the transformations that are applied to the data. The programmer issues a single command to display a picture of the object. Then, during each refresh and update cycle, the system traverses the structure, performs all necessary transformations, and produces an image on the screen. The programmer does not have to issue commands for every step in this process.

- Matrix Concatenation

  All graphical transformations are applied to objects through a matrix called a transformation matrix. The display structure indicates the type of transformations and the order in which they are to be performed. The PS 390 performs the concatenation of matrices that this involves, so the programmer does not have to do this explicitly.

- Transformation and Clipping of the Data

  When the programmer manipulates an image on the screen using interactive devices, the system itself performs all the calculations needed to draw the image at each new position on the screen. The system traverses the display structure which defines the object, updating the image as new data is received from the interactive devices. If parts of the image move out of screen boundaries, the image is clipped automatically without any intervention from the programmer.

- Perspective Viewing

  Much of the "realism" of computer graphics is imparted by displaying views of objects in true perspective projection. The PS 390 produces perspective views of objects and maintains a true perspective view as the objects are in motion. The programmer creates a perspective view with a sequence of viewing commands. The processing which maintains the perspective view while the object is interactively manipulated is performed without intervention from the programmer.

- Viewport Mapping

  The PS 390 automatically performs viewport mapping. A viewport is an area of the screen in which pictures are displayed. The programmer defines a window, an area of world coordinate space that will be displayed on the screen. No matter what size of viewport the programmer specifies, the system maps the contents of the window to the viewport, ensuring that the view which the programmer wants will fit in the specified area of the screen.

  The PS 390 allows multiple dynamic and static viewports. Dynamic viewports allow interactive manipulation of objects displayed in them; static viewports allow objects to be displayed with various kinds of shading operations applied.

- Generating Characters

  The PS 390 supplies a standard character font of the characters, numerals, and marks and symbols that are usually found on typewriter keyboards. The programmer does not have to generate the vectors that compose a character in the standard font, although the PS 390 does allow the programmer to create, modify, and use other character fonts.

6.2 Display Processing

The main aspects of display processing which the PS 390 performs are outlined below.

- Digital to Analog Data Conversion

  Part of the display processing functions of virtually all CRT graphics devices is the conversion of digital data defining the vectors that need to be drawn to analog signals that drive the CRT. With the PS 390, this process is performed in the display processing hardware and requires no intervention from the programmer. The conversion of data from digital to analog happens very late in the processing cycle. The system keeps data in digital form through most of the display processing to enhance the processing speed and to allow the update rate to equal the refresh rate.

- Color Specification

  To generate colors, the programmer simply creates "color" nodes in the display structure, indicating the desired colors. The hardware itself does all the processing needed to display those colors.

- Blinking

  The PS 390 performs blinking as an integral part of display processing. The programmer enters a command with values for the number of frames to display the image and the number of frames to blank the display. The machine itself determines which lines to draw and which not to draw at any time.

- Picking

  Picking allows a graphics system user to select any portion of a randomly positioned three-dimensional image and get back information about the part of the object's structure it represents. The PS 390 performs this task with a minimum of intervention from the programmer.

6.3 Interactive Device Handling

The PS 390 lets users manipulate views of objects with all the interactive devices. These include:

- Keyboard with Function Keys
- Function Buttons
- Data Tablet
- Control Dials
- Optical Mouse

The devices are programmed through user-defined software known as function networks. These networks accept data from devices, manipulate the data as programmed in the network, and send new values to interaction points in a display structure of an object. The user programs the interactive devices by designing networks which manipulate the image as desired. The devices themselves convert analog data (such as the amount a dial is turned) into digital form.

6.4 Interacting With the Picture

Interaction with an object means changing the image on the screen. Typically, objects can be rotated or translated in any direction, and scaled by any amount along any axis. The PS 390 allows real-time interaction through the interactive devices. Real time means that when the programmer turns a dial that has been programmed to rotate an object, the delay between the dial turning and the object rotating is imperceptible.

Interaction is achieved by changing the values in an operation node or data node in the display structure. If new values are sent to a scale operation node, for example, the object will appear to grow smaller or larger on the screen. Interaction points in the structure accept new values from function networks connected to interactive devices.

6.5 Functions and Function Networks

The path between a device and an interaction node in a structure is a function network, created by the user to customize input from the interactive

devices. A network is composed of individual functions, each function being thought of as a "black box" with inputs and outputs, as shown below.

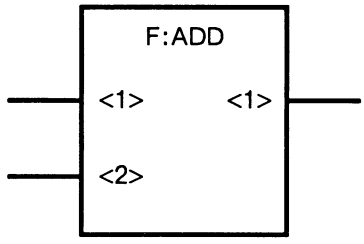


Figure 2-8. Representation of a Function

Each function performs a mathematical, logical, routing, or selecting operation, such as add, multiply, and, or, route, or choose. The programmer combines functions into networks which manipulate the data from interactive devices usually to produce an effect on a displayed image.

Function identifiers are of the form **F:name** and have numbered inputs and outputs which accept only certain data types. There are nine categories of functions available with the PS 390. They are as follows.

- Arithmetic and Logical

  These functions perform all arithmetic operations (add, divide, subtract, multiply, square root, sine, and cosine) and logical operations (and, or, exclusive–or, and complement).

- Character Transformation

  These functions are used to position, rotate, and scale text interactively.

- Comparison

  These functions test whether values are greater than, less than, equal to, not equal to, greater than or equal to, and less than or equal to other values.

- Data Conversion

  These functions change matrices into rows, rows into scalar elements, and real numbers to integers or vectors. Data can be output in decimal or exponential format.

- Data Input and Output

  These functions set up and control the interactive devices (dials, function keys, function buttons, data tablet, and keyboard) and output values to the optional LED labels which several of the devices have. They also handle communications with the host.

- Data Selection and Manipulation

  These functions are used to switch functions selectively, choose outputs, and route data.

- Object Transformation

  These functions connect to modeling operation nodes in display structures to rotate, translate, and scale objects interactively.

- Viewing Transformation

  These functions connect to viewing operation nodes in display structures to change line-of-sight, window size, and viewing angle, interactively.

- Miscellaneous

  Other functions set up and control clocking, timing, and synchronizing operations.

  Most functions are general purpose but have been designed specifically for graphics operations. For example, an arithmetic function such as "multiply" not only accepts two scalar numbers as inputs and outputs their product, it also performs matrix multiplication, accepting two matrices and outputting a concatenated matrix.

  Using the set of "master" functions as templates, the programmer creates uniquely named instances of functions and connects them to form a network using PS 390 commands. A function in the network accepts data from an interactive device or another function, performs its specific operation, and outputs the result to another function in a network or to an interaction point in a display structure. The flow of data through a function network is shown in Figure 2-9.

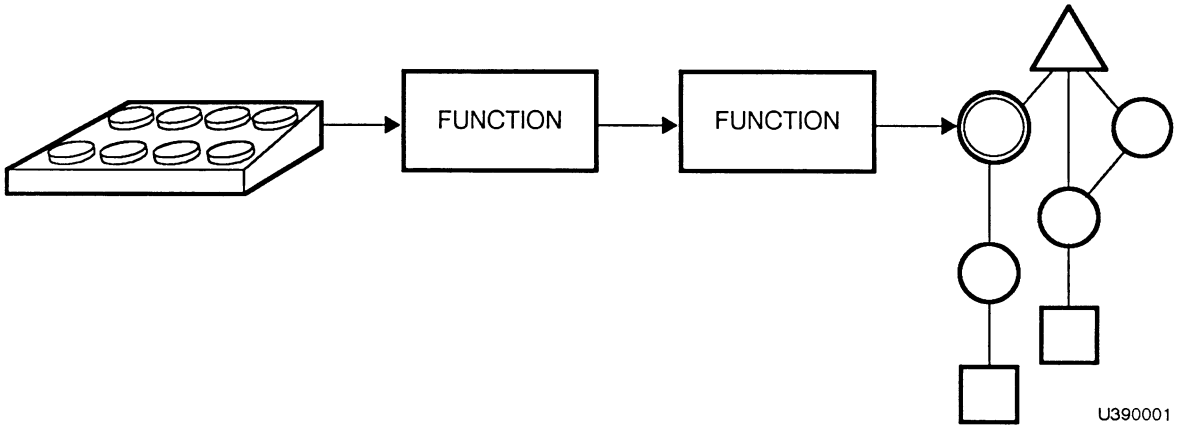


Figure 2-9. The Flow of Data Through a Network

Function networks differ from programs written in conventional programming languages to handle data from interactive devices in that function networks are data driven. That is, networks are dormant until a function receives data at its input queues. Then the function becomes active, processes the data, passes on the output, and becomes dormant again. In this way, the computer does not have to spend time polling the interactive devices to see if any activity has occurred.

IS3. OPERATION AND COMMUNICATION

CONTENTS

ILLUSTRATIONS

Section IS3
Operation and Communication

This section instructs a PS 390 user in how to operate the PS 390 Graphics System. When different types of host systems have operational differences, the operation is documented in separate subsections, one subsection for each host system. For example, some keyboard operations are different depending on whether the host is a DEC or an IBM system.

The first part, *Booting*, gives instructions for booting the PS 390.

The second part, *Confidence Testing*, provides a general discussion of the power-up confidence tests.

The third part, *Graphics Firmware*, gives a specific description of the Graphics Firmware usually loaded at boot time. Included in the description are: the CONFIG.DAT file, the SITE.DAT file, and methods that are available to conform PS 390 firmware or software to specific site needs.

The fourth part, *Interactive Devices*, includes a brief description of the interactive devices that can be used with the PS 390 Systems: keyboard, control dials, data tablet, function buttons, and optical mouse.

The fifth part, *Operation*, deals with the general operation of the PS 390 display and keyboard, and the features available with the PS 390 terminal emulator package.

The sixth part, *Communication*, discusses PS 390 host communication and PS 390 local communication, including the E&S supported software package that uses host-resident routines to prepare data prior to sending it to the PS 390.

1. Booting the PS 390 Graphics System

Please read the following information carefully before installing any diskette in the floppy diskette drives or turning on the PS 390 control unit and display. PS 390 firmware requires two floppy diskettes. These diskettes are booted from the two drives on the front of the control unit.

1.1 Preparation

Booting the PS 390 is a simple procedure. Before starting the booting process, please check the following.

1. Make sure that the control unit, display station, and peripheral multiplexer are turned off. The "ON-OFF" power switch for the control unit is located on the front panel of the control unit on the upper-right side. This is a toggle switch. The "ON-OFF" power control for the display station is the lower pushbutton switch located on the right side of the display. "ON-OFF" power for the peripheral multiplexer is a toggle switch located on the far right side of the front panel of the mux box. The control unit has an orange power-on indicator behind the ON-OFF switch; the display station has a green power-on indicator on the bottom front of the display.
2. Check that the control unit, display station, and peripheral multiplexer power cords are plugged into active wall outlets of adequate capacity.
3. There should be either a keyboard with LED displays or an auxiliary ASCII terminal available to monitor the progress of the PS 390 confidence tests during the power-up sequence if necessary, and to allow commands to be entered once the PS 390 is booted.
4. The peripheral multiplexer must be connected to port 5 on the control unit.
5. The display AC cable should be connected to the peripheral multiplexer. The video cable from the display must be connected to the control unit.
6. The interactive devices should be connected to the peripheral multiplexer.

1.2 Booting The System

1. Install the appropriate PS 390 system diskettes in the disk drives. For basic PS 390 graphics operations, use the current version of the PS 390 graphics firmware diskettes (Not the DEMO diskettes). To install the diskettes:
   - Push down the latch on the left-hand drive (drive 1), and with the write-protect slot up (usually covered with foil) and the manufac-

turer's or E&S label facing right, install the firmware labeled "DISK A" in the drive.

- Push the latch up to a horizontal position when the diskette is in place. The latch must be closed to activate the drive.
- The right-hand drive is labeled as drive 2. Install the diskette labeled "DISK B" in drive 2, observing the same disk orientation as used with DISK A. Push the latch up to a horizontal position.

CAUTION

While the system is booting, do not transmit from the host to the PS 390, press any keys on the keyboard or auxiliary terminal, or use any interactive device.

2. Turn on the PS 390 control unit, the display, and the peripheral multiplexer to initiate the booting sequence.
3. The PS 390 begins a series of power-up confidence tests as soon as the control unit is turned on. Refer to section 2 for monitoring these tests. These tests output alphanumeric sequences beginning with

```
A B C D E F G H I J K L M N O P 0 1 2 3 4 5 Q R 0 1 2 3 S T
```

The characters A through O will appear only on a debug terminal set to 300-baud. A beep sounds after the successful completion of several of the tests (before "J" and at "O"). The remaining characters of the sequence can be seen on either the keyboard LEDs or the auxiliary terminal set to 9600-baud. When the confidence tests are complete and the files on the firmware (or other) diskettes have been loaded, the keyboard LEDs or the auxiliary terminal will display the following:

```
PS 390:  System VXXX A: (date) I: (date)
```

The version number (XXX) and dates depend on the version of the software that is booted.

1.3 Trouble-shooting Tips

If the booting process is not complete after three to five minutes, something is wrong. There are several things that should be checked before trying to boot the system again.

1. If, after installing the diskettes and turning on the control unit, display, and peripheral multiplexer, the system goes longer than 50 seconds without beeping, a confidence test has failed and the booting process should be repeated. At this point it is best to perform a "warm" reset by pressing the RESET button located on the front of the control unit next to the ON/OFF switch. If the confidence tests still fail to complete, start over by turning off the control unit and taking out the diskettes. Then reinsert the diskettes, close the drives, and turn the control unit back on.
2. Make sure the display and peripheral multiplexer are turned on.
3. Check to make sure that the diskettes are properly inserted and that the drive latches are closed.
4. Check all power and cabling connections to make sure that host line(s) and debug terminal line(s) are in correct ports for the firmware being booted.
5. Check to make sure that you have the proper diskettes in the drives.
6. If the confidence tests run successfully through "O", but the diskette names and the version number do not appear on the display, the problem is related to trouble in reading the diskette files. If you have other copies of the diskettes, attempt to reboot using them.

2. Confidence Tests

Before the firmware is loaded into the system, a series of hardware confidence tests is performed. The status of this testing is indicated as a series of alphabetic characters, with each character reporting the successful completion of a different portion of the test. The start-up confidence tests are located in ROM in the Joint Control Processor (JCP). They are not booted with the PS 390 Graphics Firmware.

The debug terminal should be set to 300-baud to monitor these confidence tests. It is not necessary to monitor the initial confidence tests unless the system fails to boot properly.

If the hardware confidence tests are monitored, all letters of the alphabet A through O should appear on the 300-baud debug terminal as the confidence test steps are completed and the firmware is loaded. The letters appear at varying time intervals because some tests take longer than others. The audible alarm sounds upon successful completion of the confidence tests. Further characters that appear after the letter O are not related to the confidence test phase of power-up, and are under control of the program loaded from the diskette. These tests can be monitored on the keyboard LED displays or the auxiliary terminal.

If the system goes longer than 50 seconds without issuing the audible alarm, a confidence test step has failed, and the power-on sequence must be repeated. The last letter appearing on the terminal should give a clue as to what went wrong. For instance, if the last character appearing is L, the diskette is probably not mounted in the drive.

Failures after the confidence tests complete (after O is displayed) are almost always related to problems reading the diskette files.

The confidence tests are initiated when the JCP receives a Reset signal while in RUN mode. This reset may be generated either by a power-up condition or by pressing the RESET button. The confidence tests evaluate a minimal hardware configuration and then read in an executable program from the PS 390 floppy diskette. Because some components must work for the confidence tests to run, several components are assumed operational at this point: the MC68000 microprocessor, the two EPROMs, a serial port, and the logic between these components.

The confidence tests perform the following operations:

- Initialize serial output ports.
- Perform a quick check of the MC68000 microprocessor.
- Perform a checksum operation to verify EPROM.
- Verify memory refresh.
- Verify error detection and correction.
- Test local memory.
- Test the floppy diskettes.
- Load the boot file from the diskettes and begin executing.

When the entire test is completed, a BEL character sounded from the keyboard provides an audio indication that the system is functioning correctly. Control is then passed to a program loaded in from the floppy diskette.

The non-resident code that is read in may continue with the self-testing, as the Graphics Control Program does, or the non-resident code may be an operating system for diagnostics. Whenever a confidence test fails, Debug mode is entered automatically. Whenever the program designated to be read in cannot be located on the diskette, the Debug mode is entered automatically on the debug terminal connected to Port 3. If there is no debug terminal, the user will not see that the debug mode has been entered.

2.1 Graphics Firmware Self Tests

After the confidence tests have been completed successfully, self-testing continues under control of the program code that was loaded in from the diskette. This code tests and/or initializes all PS 390 components not tested or initialized by the confidence tests (i.e., all serial ports, the clock timer, mass memory). If the system fails to initialize these properly, the "runtime debug" mode is entered and the system prompts the user to see if a restart is desired. Once the entire system has been tested and initialized, the Graphics Control Program is loaded and the PS 390 enters the normal mode of operation.

3. The PS 390 Graphics Firmware

The PS 390 Graphics System Firmware is distributed on 5 1/4-inch floppy diskettes. All versions of the system firmware contain files that perform the described functions.

Microcode defines the functions of the Display Processor.

Runtime code defines the PS 390 command language and functions. This is made up of various files and includes:

- THULE.DAT file contains code that is loaded into mass memory.
- CONFIG.DAT file links the microcode and the runtime code into a coherent system function network.
- SITE.DAT file allows users to enter PS 390 commands into a readable file to change system default parameters for the specific site. This is not a required file.
- INTFCFG.DAT file allows the user to boot the PS 390 with different interface options.

3.1 The Runtime Code

The runtime code contains all definitions for system level commands and functions, as well as the definitions for user-accessible commands and functions. These definitions are loaded into the JCP local memory.

During the loading of the PS 390 firmware, all intrinsic system and user functions are "instanced" by the system. "Instancing" is the process of creating a unique case of the function. This case includes all the information necessary to identify the specific case, including an index pointing to the Pascal-callable routine that performs the required function, the input source(s), the output destination(s), the priority value assigned for scheduling purposes, and the current status of the function.

User-accessible functions and commands are documented in the Section *RM1 Command Summary* and Section *RM2 Intrinsic Functions*.

3.2 The CONFIG.DAT File

The CONFIG.DAT file contains the instances and connections to link the system functions into a system network. This file is written in the PS 390 command language and is similar to any function network built to manipulate graphical data. The design of the configuration file allows for flexibility in changing the initial environment; the change to the file is loaded and read from the disk, rather than being a change to a program. This means that changing the design features of a system does not require recompiling and relinking code and it reduces the size of executable code in the system.

The CONFIG.DAT file is interpreted by an instance of the command interpreter. While reading this file, the command interpreter is in a privileged mode of operation called the "configure mode." The command interpreter must be in the configure mode to configure any system functions.

One of the final commands in the CONFIG.DAT file is a command that will attempt to read the SITE.DAT file, which may or may not reside on the firmware diskette, depending on whether it has been written to the diskette. This file normally contains commands to tailor PS 390 system default parameters to the requirements of that particular site.

The command interpreter will read the SITE.DAT file and exit the CONFIGURE mode. If no SITE.DAT exists on the diskette, the command interpreter will execute the final commands in the CONFIG.DAT and then exit the configure mode.

3.3 The SITE.DAT File

The final file on the PS 390 Graphics Firmware is the SITE.DAT file. This file is not required, but when used enables the user to change default features for the PS 390 system in a bootable file. The file is assumed to contain a stream of ASCII commands. Because of limited disk space, the file can only contain a small number of commands.

The SITE.DAT file allows users to store information across power-up sequences. The actual values and parameters that may be set or changed using the SITE.DAT are described in the pertinent sections.

Section *RM5 Host Communications*, describes the port values that may be changed.

Section *RM7 Host Input Data Flow*, describes certain data packet and routing characters that can be changed.

Section *RM10 Terminal Emulator*, describes the keyboard and display features that can be changed or set.

There are three methods for creating and installing the SITE.DAT file:

- Creating the SITE.DAT file (an ASCII file) on the host and downloading to the PS 390 over an asynchronous line.
- Entering the PS 390 command mode and typing the SITE.DAT commands directly to the diskette from the PS 390 keyboard. This method is not recommended since it involves writing directly to diskette and does not provide for error correction.
- Using the GSRs.

Refer to Section *TT2 Helpful Hints* for instructions on creating the SITE.DAT file.

4. Interactive Devices

This section contains descriptions and typical uses of interactive devices that can be configured with the PS 390. Two sets of interactive devices are available with the PS 390: the PS 300-style devices and the PS 390-style devices. Interactive devices from the two styles cannot be mixed with the exception of the data tablets and the optical mouse. These devices are common to both styles. With each device description there are operational instructions.

Setup procedures, brief maintenance information, and a description of the control codes generated by the interactive devices are provided in Section *RM13 Interactive Devices*.

The interactive devices that can be configured with the PS 390 include the following:

PS 300 Style Devices

- Peripheral multiplexer
- Keyboard with LEDs
- Control dials unit with LEDs
- Data tablet (6X6) with 4-button cursor
- Data tablet (12X12) with 4-button cursor
- 32 Function buttons unit
- Optical mouse

PS 390 Style Devices

- Peripheral multiplexer
- Keyboard without LEDs
- Control dials unit without LEDs
- Data tablet (6X6) with 4-button cursor
- Data tablet (12X12) with 4-button cursor
- 32 Function buttons unit
- Optical mouse

The acceptable inputs and programmable outputs from these devices are found in Section *RM2 Intrinsic Functions*, and Section *RM3 Initial Function Instances*. The interactive devices are sensitive and should be handled and stored in an appropriate manner. Normal considerations should be taken in use; liquids or foreign objects spilled or dropped on any of the devices may damage them or cause them to malfunction.

4.1 Keyboard and Dial LED/Softlabel Display Operation

The PS 300-style keyboard and the PS 300-style control dials unit have LED displays. These are used to display character strings that serve the following purposes:

- Fatal error messages are displayed on the keyboard LEDs.
- The LEDs can be programmed by the user to name or display information about the use of the function key or control dial located directly below each LED display segment.

Most users will use PS 390 function networks to set up and send character strings to the LED display. Information for sending characters and text to the keyboard LEDs is found in Section *RM2 Intrinsic Functions* and Section *RM3 Initial Function Instances.*

On the PS 390 style keyboard and the PS 390 style control dials unit a "softlabels" network can be used to display function key labels and the control dial labels. The softlabels network redefines the dynamic viewport on the PS 390 to allow the left edge of the display to be used as a display area for the labels. Refer to Section *TT2 Helpful Hints* for instructions on using softlabels.

4.2 The Keyboard Function Keys

The keyboard function keys are the top row of 12 keys on the two keyboard styles. These keys typically act as graphics input devices to user function networks. They can be used for internal control of or communication back to an application program on the host. The mode of the keyboard also determines the function of the keys. In local mode, the functions keys supply values to user designed function networks; in terminal emulator mode the function keys are configured to act as input keys that send data to the host system. The keys can be set to act as graphics input devices (as in local mode) in all modes by using the terminal emulator SETUP feature.

These keys can be used to do such things as:

- Switch the input of the control dials between function networks
- Send specific information back to an application program
- Determine the function of other interactive devices (e.g., control dials, data tablet).

4.3 Control Dials Unit

The control dials unit consists of eight dials with LED displays on the PS 300 style and no LEDs on the PS 390 style. The dials are used to communicate dynamic, incrementing, and decrementing data to the PS 390. The control dials unit connects to the port beneath the DIALS icon on the peripheral multiplexer.

In typical applications, the control dials can be used to perform the following operations.

- Rotate objects about the X, Y, or Z axis, each type of rotation typically using a different dial.
- Zoom in or out.
- Translate objects in X, Y, and Z, each translation typically using a different dial.

Refer to Section *GT6 Function Networks I* for information on using the control dials as an input device to user-created function networks.

The information that describes system-level data formats and codes exchanged in dial and LED display operation is found in Section *RM13 Interactive Devices.*

4.4 Data Tablet

The data tablet consists of a tablet and a four-button cursor called a "puck." Puck position information is sent to the PS 390 in digital form that expresses a two-dimensional coordinate value (X,Y). The data tablet connects to the port below the TABLET icon on the peripheral multiplexer.

Maps, diagrams, and drawings may be used as overlays on the surface of the tablet.

The operating mode and sampling rate of the PS 390 data tablet are both controlled by the JCP. The following modes are available.

- Point Mode - Pressing the puck button at a given tablet location causes one X,Y coordinate pair (sample) to be transmitted.
- Stream Mode - X,Y coordinate pairs are generated continuously at the selected sampling rate when the puck is near the tablet surface.
- Switched Stream Mode - Pressing the button on the puck causes X,Y coordinate pairs to be output continuously at the selected sampling rate until the puck button is released.

4.5 Function Buttons Unit

The function buttons unit is a set of 32 programmable buttons. Each button is backed by a light that can be used to indicate the button setting. The function buttons unit is connected to the port below the BUTTONS icon on the peripheral multiplexer.

The only controls on the function buttons unit are the 32 buttons. They are arranged with one row of four buttons, four rows of six buttons, and a final row of four buttons. The buttons are not numbered but are counted from left to right, beginning at the top row of four buttons. A button is triggered by pressing it down and releasing it. The lights backing the buttons are programmable and can be set to on or off.

As with the function keys on the keyboard, the function buttons are used to send inputs to user-created function networks. Typical applications are selecting menus and selecting data structures for display.

4.6 Optical Mouse

The Optical Mouse consists of a three-button mouse unit with a reflective pad. The optical mouse transforms X and Y-axis position information to a digital form acceptable to the PS 390. The optical mouse unit is connected to the port below the MOUSE icon on the peripheral multiplexer.

The control logic in the mouse translates directional information into relative X and Y movement information. The data is transmitted serially to the PS 390 through the peripheral multiplexer.

Interfacing the mouse to an application can be accomplished with the MOUSEIN initial function instance.

5. Operation

The operational instructions for the PS 390 begin with the very basic features of the PS 390 display and keyboard. It is important to read the information to get an idea of the design and implementation of the system.

5.1 The PS 390 Display

The PS 390 display has no particular operating instructions other than turning it on and off, and adjusting the brightness and contrast of the screen.

The display should be turned on before powering up the PS 390 control unit. The display is turned on using the ON/OFF switch located on the lower right-hand side of the display. The ON/OFF switch is the bottom of the two switches. The switch above the ON/OFF switch is the DeGauss switch. The two thumbwheel knobs above the switches are used to control contrast and brightness to reach a desired intensity. The top thumbwheel regulates the contrast; the bottom regulates brightness. Intensity is controlled by the use of both these controls.

The main area of the screen is used for viewing text or graphics. The terminal emulator viewing area is 80 columns wide and 24 lines high. The screen space used for viewing is dependent on the application. (Refer to section 5.3.5 below for information on adjusting the viewing area of the screen.) The graphics viewing area is a 10.5 inch square in the center of the screen.

The bottom line on the PS 390 screen is the message display area. This line will display a memory-alert warning message when the user is running out of mass memory space and can be used to display messages generated by a user application program. The line can be "blanked" by the user. When memory usage drops below the alert status, the message display area will automatically blank.

5.2 The PS 390 Keyboards

The PS 390 has two available keyboards: the PS 300 style keyboard and the PS 390 style keyboard. Both keyboards operate as a standard ASCII keyboard. The PS 300 style keyboard has an optional LED array located on the top of the keyboard panel that can display a full line of text or text segments. The LEDs can be used to label the action performed when a function key is selected. They also display error messages generated by a fatal error and provide visual feedback during the runtime self-tests.

The keyboard is activated when the system is booted. The keyboard connector cable should be plugged into the appropriate port on the peripheral multiplexer. The keyboard's grounding wire must be connected to the grounding screw on the front of the peripheral multiplexer box.

The keyboard keys fall into eight categories.

- **Keyboard Function Control Keys** — These keys are the CTRL (control), SHIFT, CAPS LOCK, and REPT keys. They are local control keys that modify the signal generated by other keys when struck in combination with them.

- **Alphabetic Keys, Standard Numeric, and Special Character Keys** — These keys all generate standard ASCII character codes and are used to display uppercase and lowercase characters. The keys may be struck alone, or in combination with the keyboard function control keys.

- **Terminal Function Keys** — These keys produce codes used by a standard terminal. They are ESC, TAB, BACKSPACE, DEL, RETURN, LINE FEED, and the space bar.

- **Numeric Keypad Keys** — The function of these keys is determined by the host system and the mode in which they are used.

- **Device Control Keys** — These are system keys and are used to activate certain applications of the PS 390 in the various modes of the terminal emulator.

- **Function Keys** — These keys are interactive device keys that are set up by user network functions. They can be used for internal control or for communication back to the application program in the host.

5.2.1 Keyboard Modes Of Operation

The keyboard initiates actions that are defined by the mode of operation. These modes are entered by pressing one or more keys on the keyboard. The availability of various keyboard modes is in part determined by the host system. Table 3-1 describes the modes of operation for systems with a PS 300-style keyboard, and the key(s) used to access them. Table 3-2 describes the modes of operation for systems with a PS 390-style keyboard, and the keys used to access them.

Table 3-1. Keyboard Modes with PS 300-Style Keyboard

MODE	USE	KEY(S)TO ACCESS	KEYBOARD APPLICATION
Terminal Emulator	Access line to host	LINE_LOCAL	Keyboard input sent to host and characters displayed on PS 390 screen.
Command	Enter direct PS 390 commands	CTRL/LINE_ LOCAL	Text commands are displayed on the screen and executed by the command interpreter.
Local	Keyboard as graphics device	SHIFT/LINE_ LOCAL	Fkeys and Keyboard are activated as input devices for function networks. Text does not appear on screen.

Table 3-2. Keyboard Modes with PS 390-Style Keyboard

MODE	USE	KEY(S)TO ACCESS	KEYBOARD APPLICATION
TE	Access line to host	CTRL/HOST or ALT/HOST	Keyboard input sent to host and characters are displayed on screen
5080	Run 5080 applications	CTRL/5080 or ALT/5080	Applies to IBM 5080 Interface only
Command	Enter direct PS 390 commands	CTRL/CMND or ALT/CMND	Text commands are displayed on the screen and executed by the CI command interpreter
Local	Keyboard as graphics device	CTRL/LOCAL or ALT/LOCAL	Fkeys and keyboard are activated as devices for function networks

5.2.2 Key Sequences and Functions Of Interest

The following key sequences and their functions are active in all keyboard modes on all host systems.

- GRAPH and TERM - The text associated with either the terminal emulator or the command mode can be blanked by pressing the TERM key (PS 300 style) or CTRL/TERM (PS 390 style). Pressing the key sequence a second time will restore the text. Pressing the GRAPH key (PS 300 style) or CTRL/GRAPH (PS 390 style) blanks any graphics being displayed. Pressing the key sequence a second time will restore the graphics display. These keys may be used at any time, and allow the user to view both the text and the graphics display simultaneously, or to clear one or both from the screen.

- CLEAR HOME (PS 300-style keyboard only) - When used alone, this key erases the terminal emulator text from the screen and places the cursor in the top left corner of the screen. When used with the SHIFT key, the cursor is moved to home, but the screen is not cleared. When used with the CTRL key, the screen is cleared, but the cursor is not moved to home. This functionality is not supported with the PS 390-style keyboard.

5.3 Keyboard Modes for DEC Systems

The following section is directed to users with a DEC/VAX or PDP-11 host system or systems that are functionally similar to the DEC systems.

The PS 390 terminal emulator (TE) package provides the user with the ability to use the PS 390 display and keyboard as interactive graphics devices and allows for DEC VT100 emulation on the PS 390. Both the command mode and the local mode of the PS 390 require no host system interaction.

The following sections describe the three keyboard modes available for VT100 emulation on the PS 390 and how to access them.

5.3.1 VT100 Terminal Emulator Mode

In the terminal emulator (TE) mode, the PS 390 terminal functions as a standard terminal on the host. The user can log on to the host, access and edit host-resident files, and use the available host system utility commands.

Upon entering the TE mode, the RETURN key should be pressed at least once to generate a host prompt character on the screen. The cursor, a blinking square character, will appear on the active line in the active column. The PS 390 powers up in the TE mode.

5.3.2 VT100 Command Mode

In command mode, commands entered on the PS 390 keyboard are displayed as text on the screen. While in command mode, valid commands with the proper ";" terminator are immediately interpreted by the PS 390 and are not stored by the system or host in a file. Error messages received from the parser and the command interpreter are displayed on the screen.

The RETURN key should be pressed after entering the command mode to generate the PS 390 command prompt '@@' and the cursor.

5.3.3 VT100 Local Mode

In local mode, the function keys on the keyboard (and any other programmed keys) act as local input or selection devices for user-constructed PS 390 function networks. There is no cursor or screen prompt in the local mode, and the keyboard does not send any information to the host.

5.3.4 General Information

Keyboard activities are dependent on the mode used. The following list is an easy reference for keyboard use in various modes.

1. In the terminal emulator mode, movement of the text on the screen is host dependent.
2. In command mode, text appears on the first available line and moves down the screen. Text scrolls up when the last line is filled. By default, there is no automatic line wrap-around; text terminates at 80 columns. This can be changed, and is dependent on host system configuration.
3. The function keys generate certain escape sequences when used in modes other than local mode.

5.3.5 Terminal Emulator SETUP

The terminal emulator SETUP facility allows users to change some features of the display and keyboard. SETUP also gives the user access to a menu display of the current keyboard configuration. The SETUP facility is accessed by pressing the SETUP key (PS 300-style keyboard), or CTRL/ SETUP (PS 390-style keyboard). While in SETUP, the SETUP menu is displayed on the PS 390 screen. All keyboard input is sent to the SETUP facility, and the only active keys are the PS 390 device keys and the keys that the SETUP facility uses. SETUP may be entered from any of the three keyboard modes.

The status of features that have been changed using SETUP are in effect until changed by the user or until the system is rebooted. When the system is rebooted, the default values of SETUP are reinstated. The default values of the features in SETUP may be changed by entering the new values into the SITE.DAT file on the PS 390 graphics firmware. Refer to *Section TT2 Helpful Hints* for information on creating and using the SITE.DAT file.

5.3.6 SETUP Menu Display

The following menu is displayed when the SETUP key is pressed.

```
SETUP

F2=SRM:T   F3=AWRP:F   F4=ANSI:T   F5=VT52:F
F6=KPM:F   F7=CKM :F   F8:Cnum:T   F9=Knum:T

F10= Define break key :↑V
F11: Move TE viewport, lower left corner
F12= Move TE viewport, upper right corner
Mode: KB   Term: On    Graph : On
```

The status of the features (T or F) is displayed on the screen when the SETUP menu is displayed. With the exception of defining the BREAK key and setting the screen viewport for text, all the features are set or reset by pressing the indicated function key. The status of the feature changes (from T to F, or F to T) on the screen menu when the key is pressed. When

additional keystrokes are required, as in setting the viewport location and size, additional prompts are displayed after the function key that accesses that feature has been pressed. Table 3-3gives a breakdown of the function keys, their purpose, and the default values assigned to the features by the system.

Table 3-3. Terminal Emulator SETUP Features

FUNCTION KEY	FEATURE	DEFAULT VALUE
F2	SRM mode	TRUE
F3	Autowrap	FALSE
F4	ANSI mode	TRUE
F5	VT52 mode	FALSE
F6	Keypad mode	FALSE
F7	Cursor keys	FALSE
F8	Numeric keys in command mode	TRUE
F9	Numeric keys in keyboard mode	TRUE
F10	Define BREAK key	User defined
F11	Viewport lower left corner	User defined
F12	Viewport upper right corner	User defined

5.3.7 SETUP Feature Definitions

The following features may be set to ON or OFF by toggling the appropriate function key in the SETUP Mode. To exit SETUP, use the SETUP key (PS 300 style) or the CTRL/SETUP sequence (PS 390 style).

Function key F2 (SRM) sets or resets the send-receive mode of the PS 390 terminal. This mode determines whether the input to the screen from the keyboard is sent via the host or a PS 390 system function. (Refer to Section *RM10 Terminal Emulator* for more information on this feature.) The send-receive mode is set to TRUE by the system and may be changed by the user at any time.

Function key F3 (AWRP) lets you set or reset (on or off) automatic line wrap-around at 80 characters.

Function key F4 (ANSI) sets the ANSI (VT100) mode of the PS 390 terminal. When set (or TRUE) the PS 390 will generate and respond to VT100

(ANSI) control sequences. This mode defaults to TRUE and should only be changed when the user wants the PS 390 to respond like a teletype-style terminal and not respond to VT100 control sequences.

Function key F5 (VT52) allows the PS 390 to respond VT52 coded sequences. This defaults to FALSE.

Function key F6 (KPM) determines the function of the numeric keypad on the PS 390 keyboard. If set to TRUE, the numeric keypad will generate the control sequences used in the keypad application mode (i.e., host editing utilities such as DEC's EDT and KED). When set to FALSE, the numeric keypad generates its numeric keycap values.

Function key F7 (CKM) sets the cursor keys mode. When this mode is TRUE, the cursor keys are operational in all keyboard modes. The ANSI/ VT52 feature must be set to TRUE for this to be effective.

Function key F8 (Cnum) determines whether the numeric keyboard will generate keycap values or escape sequences in command mode. When set to TRUE, the keypad will generate the numeric keycap values in command mode.

Function key F9 (Knum) determines whether the numeric keyboard will generate keycap values or escape sequences in local mode. When set to TRUE, the keypad will generate the numeric keycap values in local mode.

Function key F10 (BREAK) is used to designate a key to send a break sequence to the host system. It is up to the user to decide which PS 390 key will be interpreted as a BREAK key by the host. To designate the BREAK key, first press function key F10, and then press the key that is to be used as the BREAK key. After pressing the designated BREAK key, press function key F1 to indicate the BREAK key has been selected and to return to SETUP Mode.

Any key may be used as a BREAK key, with the exception of those listed below.

- SETUP
- Function key F1
- GRAPH key
- TERM key

- LINE LOCAL key (PS 300 style)
- HOST (PS 390 style)
- CMND (PS 390 style)
- LOCAL (PS 390 style)

Any other function key, and any unspecified keys on the numeric keypad can be designated as the BREAK key. The BREAK key can be designated as a single key sequence, the shifted value of a key, or the control value of a key.

A break key time (duration) must also be defined in order to send a break sequence to the host. Defining this time is done by using a SETUP INTERFACE option. Normally, the following command would be used:

```
Setup Interface Port 10/Break_Time = 127;
```

Instead of a key, users may designate a CTRL/V (single character) escape sequence that will cause the terminal emulator to send a break to the host. A restriction on this sequence is that it must not be one that is generated by the E&S keyboard. Section *RM13 Interactive Devices* contains the escape sequences generated by the keyboard.

The BREAK key is only functional in the terminal emulator mode of operation.

Function keys F11 & F12 (Viewport). When the PS 390 System is booted, the display screen is initialized with a terminal emulator screen area that is 24 lines high and 80 columns wide. When the size and location of the viewport is changed, the viewport still contains the 24 horizontal lines and the 80 vertical columns, but the size of the rows and columns can be changed. For example, if the upper-right corner is moved from its original position to the top right-hand corner of the PS 390 screen, this does not add more available lines for text or display, but rather transforms the text appearing on the 24 lines. This text will appear to have twice the height.

The viewport can be made any size and any rectangular shape and can be placed anywhere on the PS 390 screen. To remove any previous text from the screen, use the TERM key (PS 300 style) or CTRL/TERM key sequence (PS 390 style). The SETUP menu is then visible.

There are two steps needed to change the viewport size and/or location:

1. To move the upper-right corner, first press function key F12, then the cursor key or keys that move the corner in the desired direction. As there is no cursor in SETUP, use the TERM key or CTRL/TERM key sequence again to get some text on the screen. As the cursor key is pressed, the text on the screen conforms to the corner position. When the appropriate position is reached, press function key F1.
2. To move the lower-left corner, first press function key F11, then the appropriate cursor key or keys. Again, have some text on the screen so that the movement of the corner is visible. When the lower-left corner reaches the desired position, press function key F1.

When the right corner of the text display area meets the left corner, or the bottom edge meets the top edge, the sizing action stops until cursor keys are pressed that move the corners in an appropriate direction. The movement of the corners also stops when they reach the edge of the display area of the screen.

5.4 Keyboard Modes For IBM 3278

The following section is directed to users with an IBM host system with the IBM 3278 emulator. The 3278 Interface option uses the PS 390 style keyboard only, and allows the keyboard to function in three modes: terminal emulator, command, and local mode.

5.4.1 Terminal Emulator Mode

In terminal emulator mode, the keyboard closely emulates the IBM 3278 Model 2 terminal.

In terminal emulator mode, the user can log on to the host, access and edit host resident files, and use the available host system utility commands. Files containing PS 390 commands can be built on the host and sent to the PS 390 using the GSRs.

Once exited, the terminal emulator mode is re-entered by pressing CTRL/HOST or ALT/HOST.

5.4.2 Command Mode

Command mode is used to enter PS 390 commands locally. To enter command mode, press the CTRL or ALT key, and while holding it down press

the HOST key. The RETURN key is pressed to generate the PS 390 command prompt '@@' and the cursor. In command mode, PS 390 commands are displayed as text on the screen. Valid commands with the proper terminator are immediately processed and are not stored by the system. Error messages received from the parser and the command interpreter will be displayed on the screen.

In the command mode, the delete key functions as a CRT type delete.

Pressing the delete key backspaces and deletes the previously entered text on the active or bottom line until the key is released. The backspace key is not operational in command mode.

5.4.3 Local Mode

Local mode allows the function keys and standard keyboard keys to act as inputs to any user-created function networks that are connected to them. There is no cursor or screen prompt in the local mode and the keyboard will only act as an input device to function networks. To enter the local mode, press the CTRL/LOCAL or ALT/LOCAL keys.

5.4.4 Terminal Emulator Displays

Additional indicator characters which give the status of the PS 390 are included in the IBM terminal emulator displays. They appear on the right side of the indicator line. They are defined as follows:

- H — Terminal emulator mode
- C — Command mode
- L — Local mode
- S — Setup mode
- G — Indicates that graphics display is enabled

5.4.5 SETUP For Terminal Emulator

The SETUP mode for the 3278 terminal emulator is accessed by pressing the <CRTL> SETUP. SETUP can be entered from any mode and is used to make the following adjustments.

Intensity – Function key #1 brightens the screen, Function key #2 dims the screen.

Contrast – Function key #3 raises the contrast, Function key #4 lowers the contrast.

The SETUP key sequence must be executed again after the appropriate adjustments are made to exit the SETUP mode.

5.4.6 General Information

The display and 3278 keyboard activities are dependent on the mode used. The following list of differences in mode operation for the keys and the display will provide an easy reference for keyboard and display use.

1. In the terminal emulator mode, movement of the text on the screen is host-dependent. Refer to the IBM 3278 operator's manuals for more information.
2. In command mode, text appears on the first available line and moves down the screen. Text scrolls up when the last line is filled. There is no automatic line wrap-around; text terminates at 80 columns and is typed over until a carriage return is performed. The Delete key is active for text editing. The ENTER key is not functional. The RETURN key should be used as the PS 390 line delimiter key, but a line is not sent to the command interpreter until the ";" command delimiter is entered.

5.5 Keyboard Modes for IBM 5080 Interface Option

The PS 390/IBM 5080 Capability Option allows the keyboard to operate in four modes. When a particular mode is in effect the system displays an indicator character to signal the operator.

5.5.1 5080 Mode

The 5080 mode is used to run 5080 application programs downloaded from the host. When this mode is entered, a 5 appears at the bottom right-hand corner of the screen.

5.5.2 Command Mode

Command mode is a PS 390 mode and is entered by pressing the CTRL or ALT key in conjunction with the CMND key. When this mode is entered, a C appears at the bottom right-hand corner of the screen.

5.5.3 Local Mode

Local mode is entered by pressing the CTRL/LOCAL or ALT/LOCAL keys. When this mode is entered, an L appears at the bottom right-hand corner of the screen.

5.5.4 Terminal Emulator Mode

Terminal emulator mode is used to communicate with the host system. Terminal emulator mode is entered by pressing the CTRL/HOST or ALT/HOST keys. The letter H appears at the bottom right-hand corner of the screen when terminal emulator mode is active.

6. Communication

The PS 390 does not rely on the host to perform any graphical manipulations, nor the mathematical calculations behind the manipulations. Also, the PS 390 is host independent in the sense that it can be interfaced to a variety of host systems. These interfaces use different communication protocols, and require varied means of access to the PS 390 system.

Even as a host-independent system, communication between the host and the PS 390 is very important. This section discusses what different options are available for communicating with the host, and when that communication is important.

These communication options include:

- Standard host/PS 390 data transfer. In this method of communication ASCII files are downloaded to the PS 390 just as they would be sent to any physical device. In this scheme, the PS 390 system functions perform the parsing of data, and then "package" that data in a format that is acceptable by the PS 390 command interpreter. "Standard" communication implies that the host can transmit data that is immediately acceptable by the PS 390 Chopper/parser, including routing bytes to multiplex graphics commands and terminal emulator information (ASCII escape and control sequences).

- Communication using the GSRs. In this method of communication the GSRs perform all prepackaging on the host. PS 390 commands are invoked by Pascal, FORTRAN or C routines and are sent directly

to the PS 390 command interpreter. The GSRs utilize the host CPU to prepackage data before downloading to the PS 390. This allows for substantially faster throughput, as the PS 390 command interpreter can immediately accept the data from the host and initiate the appropriate actions without having to parse the incoming commands. The GSRs also contain the routing bytes within the routines. This is the recommended communication scheme for finished user applications.

6.1 Using the Host System

The cable between the PS 390 and the host provides a way to utilize different components and facilities of each system. The host is used as a storage device by the PS 390 and, optionally, is used as a data processing device by the GSRs.

6.1.1 Using the Host as a Storage Device

The PS 390 has no local storage capability beyond what is loaded into memory during a graphics session. Once the system is powered down, or an initialization is performed, memory is cleared and the loaded data are lost. To retain information, the host system must be used as a storage device.

Initially, the best way to visualize this is to think of the PS 390 as a physical device attached to the host, like a line printer or a terminal. They both have local memory, but that memory is temporary. Therefore, the host system is used to store data that will be used repeatedly.

Conventionally, the storage is accomplished by building files, or loading files that will be used by the PS 390 into the host system. The host names the files and stores them in an appropriate manner. Files can be built on the host directly (using the PS 390 terminal emulator facility) and then downloaded to the PS 390, using the host system facilities. The content of these files depends on the method of communication that is going to be used. The first communication method that will be covered here is standard ASCII communication with the host, where the host recognizes the PS 390 to be a physical device attached to the host, and the PS 390 can be assigned a logical name.

6.1.2 Using the Host as a Processor

The GSRs use the host to package all data before it is sent to the PS 390. The GSRs provide an alternative method of invoking almost all the PS 390 standard commands as FORTRAN, Pascal or C routines. The prepackaging that is performed on the host gives a much faster throughput for any data being transferred.

The GSRs incorporate the appropriate routing bytes into each routine or, in the case with some of the utility routines, allow the user to select the routing byte in a parameter of the call.

6.2 PS 390 Local Communication

When entering the PS 390 command mode all commands sent after the "@@" prompt and terminated with the ";" command delimiter character are routed directly through the keyboard system function to the PS 390 parser, and then passed to the command interpreter after being processed. Local communication implies that nothing is sent down from the host, nor sent back to the host.

6.3 Direct Communication Using Host Facilities

Under DEC VAX/VMS and DEC PDP/RSX-11, files built on the host using the standard ASCII PS 390 command language can be routed through the command interpreter to the appropriate PS 390 system function network using standard host utilities such as the VMS WRITE, TYPE, and COPY commands and the RSX-11 PIP commands. These same methods are also available to other operating systems that have ways of building a file on the host, including the proper routing bytes, and then sending that file to the PS 390 using the logical or physical name given to the PS 390 by the host system.

6.3.1 Routing to the Appropriate Function

In building the host file, one of the first considerations is to determine what system network in the PS 390 the file should be sent to. For the ASCII commands or vector lists in a file to be sent to the PS 390 command interpreter to create displayable data structures or create function networks, the file must contain a field separator and a routing character as the first characters in a file.

The field separator character is the single <CTRL \> character (made by pressing the CTRL key and the \ (backslash) key simultaneously). The routing character is 0 (zero). The characters at the top of the file, then, would be:

↑\0

The file must terminate with an field separator character and another routing character that will send any following data to the terminal emulator, so that messages from the host will appear as text on the screen. The field separator character and the routing character for the terminal emulator are:

↑\>

A good illustration of how these bytes work is to send a file containing a small vector list and PS 390 commands from the host to the PS 390. With the ↑\> characters at the top and bottom of the file, the file will appear as text on the screen. By editing the file and replacing the top ↑\> characters with the ↑\0 characters, the file will be processed by the command interpreter and the graphics will be displayed on the screen.

6.4 Using Operating System Utilities for Downloading

The following example shows how DEC operating utilities can be used to download a file containing a vector list and/or other PS 390 commands to the PS 390.

This example uses the EDT editor on VAX/VMS systems or the EDT or KED editor on RSX-11M systems. Perform the following steps:

1. Log on to the host.
2. Go to the directory in which you wish to create and store your file.
3. Access the keypad editor. For VAX/VMS this is done as one of the following lines:

```
$ EDT filename.extension
$ EDIT/EDT filename.extension
```

4. The first characters in the file must be ↑\0 to route the file to the command interpreter of the PS 390.
5. Enter in the appropriate vector list and/or other PS 390 commands.
6. The final characters in the file must be ↑\> to route the next data received to the terminal emulator.

Under VMS, while in the editor, the file can be written to the physical or logical device name of the PS 390 terminal by using the appropriate system commands. The file must contain the routing characters described above to do this.

For example, where the PS 390 is **tta0**, do the following:

- Press function key F9 (emulating the "gold" key of the VT100 numeric keypad) and then the "7" key on the numeric keypad (emulating the "Command" key on a VT100).
- The editor will prompt with "Command:" at the bottom of the screen.
- To send a copy of the file you are editing to the PS 390 enter in:

```
WR tta0
```

- Or, the file can be "exited", leaving the editor utility and then copied to the physical or logical device name of the PS 390 by using the COPY command in VMS and the PIP command in RSX-11M.

For example where the filename is ROBOT.DAT and the physical device name of the PS 390 is tta0: for VMS and tt16: for RSX-11M, one of the following commands can be used:

```
$ COPY ROBOT.DAT tta0:

> PIP tt16:=ROBOT.DAT
```

The file can also be written directly to the PS 390 using the VMS TYPE command, if entered from the PS 390.

These commands will copy or write the file to the PS 390. The routing characters at the top of the file will send the data to the command interpreter of the PS 390, where the ASCII characters are processed into graphics data to be sent as a graphics display to the screen. If the routing characters are not compatible with the host system, or need to be changed, refer to Section *RM5 Host Communications*.

6.5 The Graphics Support Routines

The graphics support routines (GSRs) were developed to provide an alternative method of invoking the standard PS 390 command language to provide for faster through-put rates between the host system and the PS 390. The GSRs are distributed on magnetic tape as source code in FORTRAN, Pascal and C programming languages.

It is the responsibility of the user to load, compile, and link the routines with their application program. Installation instructions for the GSRs are provided in the Customer Installation and User Manuals for specific interfaces and operating system. Further documentation for the FORTRAN, Pascal, and C GSRs is provided in Section *RM4.*

The GSRs provide the following capabilities:

- Reduce local PS 390 processing time by bypassing the PS 390 parsing function. The GSRs allow the host to "prepackage" PS 390 graphics commands and send the packaged data directly to the PS 390 command interpreter.

- Allow PS 390 commands to be called by an application program. The PS 390 programmer is supplied with an alternative method of invoking the PS 390 command language. With the GSRs the programmer invokes the appropriate PS 390 command and defines the command parameters in FORTRAN, Pascal or C.
- Support most standard PS 390 commands. There is almost a one-to-one correlation between each PS 390 command and each GSR routine. Most of the commands that are not supported by the GSRs are commands that have to do with system configuration rather than graphics applications.

- Maintain PS 390 command language syntax and naming conventions. The GSRs maintain the naming conventions and command syntax established by the PS 390 command language as much as possible. Most commands have simply been prefixed with a 'P' and shortened to conform to FORTRAN, Pascal or C name limitations. Syntax follows command language syntax, when appropriate.

- Error-handling utilities. Each GSR routine has an error handling parameter that can be used by the programmer to call an error-handling subroutine or procedure.

- Support new products and options. The graphics support routines will continue to support new PS 390 commands as they are added to the PS 390 command list.

All software distributed by E&S are the latest released versions. As the GSRs would need to be relinked with user application programs at the time of a new or updated release, a strong attempt has been made to make the GSRs as "fixed" as possible. Modifications made to the low-level routines that set up the communication line between the host and the PS 390 that might be made should not affect the routines and/or parameters that are used by the programmer.

IS4. MAINTENANCE AND SERVICES

CONTENTS

Section IS4
Maintenance And Services

Complete hardware and software support of all E&S products is provided nationwide and in Europe. Field service operations and customer sites receive back-up support from the Software and Technical Support Groups based in Salt Lake City.

E&S provides the following services to provide high-response support:

- A customer service number
- Three standard maintenance service plans
- Negotiated special service contracts
- Maintenance support for OEM customers

The following sections discuss the support services available. For more information, contact the E&S Customer Engineering Department.

1. Customer Service Number

The Customer Service number is: (800) 582–4375.
(801) 582–9412 (Utah only)

This connects you to the dispatch office which will coordinate the support service you need. The customer service number is intended for logging problems; hardware or software. Office hours are 9:00 A.M. Eastern Time to 4:30 P.M. Pacific Time (7 A.M. to 5:30 P.M. Mountain Time). During non-business hours a call recorder will be operational. If you leave your name, area code, phone number, system serial number and a short description of the problem a call will be logged for you.

1.1 Hardware Support

Hardware support is provided based on your selected maintenance service. The dispatch office relays the problem and urgency to the appropriate E&S Customer Engineer. The Customer Engineer then schedules the time with the customer to visit the PS 390 site for any necessary repairs.

1.2 Software Support

Software support is provided to customers by the Customer Engineering Software Support Group at E&S corporate headquarters in Salt Lake City, Utah. Customer software problems will be logged into a problem tracking system which ensures that all software calls receive the fastest possible resolution.

Once you have logged your problem through dispatch, a Software Support Analyst will call back within one hour to get a detailed description of your problem. Within 48 hours, you will receive by telephone either a solution for your problem or a status report. There is no charge for this service, provided the following conditions are met:

- You have a Continuous Maintenance Service Contract, or selected the software support option of the Customer Participation plan.
- You are having a problem with an E&S supported product which fails to perform as specified.
- Your system is PS 390.
- Your system is being installed or is still under warranty.

Customers who do not hold a Continuous Maintenance Service Contract, and who request special help with software not covered under a Service Contract (and are not covered under installation or warranty) will be billed for the service at prevailing Customer Engineering hourly rates. If you will be billed, your consent will be obtained before the problem is investigated.

Before you call, please check the documentation to be sure your question cannot be answered there. Also, please have the following information at hand when you call:

- PS 390 graphics firmware version number. This is the E&S part number that appears on the distribution media of the PS 390 graphics firmware package (for example, 904015-001 A1).
- The host computer model, and operating system and its version number under which you are encountering difficulties (for example, DEC VAX 11/780, VMS V3.3).
- Complete error numbers and messages which were output.
- If possible, the commands issued that caused the problem in question.

1.3 Documentation Support

Additional support is provided to customers by the Interactive Systems Publications Group at corporate headquarters in Salt Lake City, Utah. During the hours of 8:30 a.m. to 4:30 p.m. Mountain Standard Time, technical writers are available for questions or comments regarding documentation. Your corrections and/or suggestions are encouraged regarding existing documentation or needed documentation.

This service is available free of charge to anyone using E&S equipment and its related documentation. No other requirements (such as a maintenance contract) are required. Documentation must be ordered through your E&S Marketing Representative.

2. Standard Maintenance Service Plans

E&S offers three standard maintenance plans. These are described in the following sections.

2.1 Continuous Maintenance Service

Continuous Maintenance Service is an on-call contract maintenance service. It is designed to supply you with complete and continuing maintenance of all hardware, software, and firmware supplied by E&S. It features 24-hour response for corrective maintenance, and periodic preventative maintenance. Standard service hours are eight hours per day, 8:00 a.m. to 5:00 p.m. five days per week, excluding holidays. Extended service hours are available under the Continuous Maintenance Service plan. The cost of all labor, parts, travel and living are covered by the monthly service fee for the Continuous Maintenance Service.

Software maintenance under the Continuous Maintenance Service plan covers identification and correction of errors in the software, and consultation on the programming of the graphics system. On-site assistance is supplied when necessary.

2.2 Requested Maintenance Service

Requested Maintenance Service is a time-and-material service supplied only upon customer request for E&S hardware, software and firmware. Response time is supplied on a basis of the availability of service personnel and resources.

Customers will be billed for all labor, replacement parts, travel, and per diem using the published Requested Maintenance Service rates in effect when the service request is received.

2.3 Customer Participation Service

Customer Participation Service is only offered to universities and other non-profit research organizations. E&S provides the appropriate diagnostic software and written procedures for isolating problems to the module, or assembly part level. The module can them be removed from the system and sent to E&S for repair or replacement. The turn-around time for repairs/replacements is 15 days. In addition, this service provides you with telephone consultation to aid in failure identification, and two on-site visits per year by an E&S Customer Engineer.

An optional software support service can be include with this plan.

3. Special Service Contracts

In addition to the standard maintenance services, E&S designs custom maintenance service plans to meet the needs of its customers. For example, a maintenance service can be designed for a Continuous Maintenance Service customer to guarantee a 30-minute average response time, 60-minute mean time to repair, and a 99.5% system availability over a 96-hour-per-week service period.

4. Maintenance Support for OEM Customers

Various service and support offerings are available for OEM customers. These include maintenance training, card and module repair, first level on-site support, maintenance plan design and an OEM Field Service Support Plan. In this latter plan, second and third level support is provided to the OEMs first-level field service personnel by the Technical Support and Software Support Groups of the E&S Customer Engineering Department.

PS 300 SITE PREPARATION AND CUSTOMER SUPPORT GUIDE

EVANS & SUTHERLAND

January 1986
E&S #901172-054 A1

PREFACE

This guide lists the steps that you, as the customer, must take prior to requesting the installation of an Evans & Sutherland PS 300 Graphics System. This guide also describes the installation process and lists the services that will be provided by Evans & Sutherland after the installation is complete. E&S hardware installation information given in this manual is for reference only and should not become the basis for unauthorized installation.

Please read this guide carefully. It supports all PS 300 Graphics Systems and will refer you to the appropriate customer installation manual for your host/PS 300 interface and any other options you might have purchased.

In this guide, a PS 300.0 system is any PS 300 system with a serial number below 2000. A PS 300.1 system is a PS 300 system with a Joint Control Processor card. A PS 300.2 system is a PS 300 with a serial number over 2000 and a low-profile cabinet. As of first quarter 1986, availablity of the PS 300.2 system has not been determined.

The first page of this guide is the Customer Installation Checklist. You must complete this checklist before requesting the hardware installation of your system. All the installation requirements for your interface and any options must be met before requesting the installation of your system. If you have any question regarding installation procedures or requirements, please call E&S Customer Service Center at (800) 582-4375.

Chapter 1 provides a comprehensive list of site preparation requirements. This chapter provides the site planning and preparation procedures that must be completed before your system can be installed.

Chapter 2 briefly describes the installation process that is concluded by completing the Performance Verification Test. This test must be run in the presence of an authorized customer representative. Information is provided on E&S 60-day warranty on new products that is initiated by the completion of the Performance Verification Form.

Chapter 3 describes the maintenance services that are available through the Customer Engineering Department.

Chapter 4 contains PS 300 system operating considerations and a brief troubleshooting guide.

Appendix A is a summary of PS 300 product specifications.

OTHER DOCUMENTS

This guide refers to other documentation provided with PS 300 systems. For site preparation purposes, all installation manuals for interfaces and options purchased with the PS 300 system are shipped with the system software and should arrive at your site approximately two to three weeks prior to the system hardware.

Please open the system software package and read the installation manuals as soon as they arrive.

This guide may also refer to sections in the **PS 300 Document Set.** This five-volume set is shipped with the system hardware in a separate box that may be opened. If you wish to order additional document sets, contact your E&S account executive.

CONTENTS

TABLES

CUSTOMER INSTALLATION CHECKLIST

PS 300 GRAPHICS SYSTEMS

Before requesting hardware installation and testing of the PS 300 Graphics System, you, as the customer, must meet the requirements for system installation. You have met the requirements when you can answer yes to the questions listed below. Do not request hardware installation until this list is complete.

1. Has the software package arrived at your site? This package contains floppy diskettes, magnetic tape, and important documentation that must be read before installation can take place.

2. Has the hardware arrived at your site? The PS 300 system is usually shipped in two large crates that should not be opened or unpacked and one smaller box containing documentation that should be opened.

3. Do you have a location readied for the system that meets all space, environmental, and ease-of-access considerations?

4. Does your site meet the power requirements of the PS 300 system?

5. Do you have a table or a suitable surface that the PS 300 display can be installed on? Is it within 20 feet of where the PS 300 control unit will be located?

6. Do you have a functional host system that is ready to communicate with the PS 300?

7. Have you read the appropriate **Customer Installation and User Manual** for your interface and met all the requirements listed on the Customer Installation Checklist for that interface, including loading the E&S host-resident software on your host and purchasing and running the appropriate interface cable from your host to the location of the PS 300?

8. Have you read the appropriate **Customer Installation and User Manual** for any other option you have purchased as part of your system and met all the requirements listed on the Customer Installation Checklist for that option?

9. Have you moved the shipping crates from your dock to the installation area?

10. Have you made sure that a system manager or someone with system privileges, as well as an authorized customer representative will be available during the hardware installation process?

If you have answered yes to all questions, call the E&S Customer Service Center at 1-800-582-4375 and request installation.

1. INSTALLATION REQUIREMENTS

This chapter should be read carefully before beginning any site preparation procedures. Your site must meet site requirements before the hardware installation of the system by an Evans & Sutherland Customer Engineer can take place. Please follow the procedures outlined in this guide before requesting installation of the hardware at your site.

If there are any questions regarding installation procedures or requirements, please call E&S Customer Service Center, 1-800-582-4375.

As it is impossible to predict the needs of each particular installation, the information presented here is general in nature and should be tailored to meet your own needs. The principles established are important, and adhering to the basic guidelines of site planning and preparation will promote:

- Timely system installation.
- Optimum equipment reliability.
- Efficient operation of the system.
- Ease of equipment maintenance.

The checklist on the previous page is provided to ensure that the important steps in site selection and planning are observed. The list is a simple cross-check to determine if the primary site requirements have been met before installation is requested.

You should pay specific attention to the site requirements that are your responsibility and that must be met before an E&S field representative can perform the actual system installation. The four most important requirements are:

1. Selection and preparation of your site, including choice of site for space and location, provisions for the environmental considerations of power, temperature, and air quality, and sufficient facilities preparation for the PS 300 system and interactive devices.

2. Verification that your host system can communicate with the PS 300 and is capable of supporting the protocol that will be used in host/PS 300 data transfer.

3. Installation of cabling to connect the PS 300 with the host system; this cabling must meet specified standards and have the proper connector.

4. Loading of the E&S host-resident software on your host system so that communication testing between the host and the PS 300 system can be performed as part of the installation procedure.

This guide provides the information that you will need to complete the requirements listed in step 1. It is up to you to make sure that your host is functional. The procedures for meeting the requirements in step 3 and 4 are provided in the installation manual that supports the interface you have purchased.

PREDELIVERY PLANNING

Predelivery planning is essential for smooth installation and acceptance of a computer graphics system. It is important that a detailed schedule of installation activity be prepared as soon as possible after the equipment has been ordered and the site selected and prepared.

Delivery Constraints

The route the equipment is to travel from the receiving area to the installation site should be studied in advance, and measurements should be taken to ensure problem-free delivery of the equipment.

Factors to be considered are height and width of doors or halls through which the equipment must pass, availability of elevators, and any restrictions such as bends or obstructions in the hallways. The largest shipping crate will fit through a standard 3 1/2 foot doorway.

Equipment Handling

It is your responsibility to transport the system from its unloading site to the actual installation site. This should be done prior to the system installation date. This section deals with equipment handling, transportation methods, and the packaging of the PS 300 computer graphics system.

For shipment, the various items of the PS 300 are packed in reinforced cardboard boxes or mounted on shipping skids. All E&S equipment, with the exception of boxes containing host software and documentation, are marked with the following warning:

WARNING

To be opened and unpacked only by Evans & Sutherland Field Service Representatives. Unpacking by unauthorized persons may void the warranty on this equipment.

This notice should be observed. If the crates must be opened to move the system from your receiving area to the installation site, please contact the E&S Customer Service Center and request authorization to open the boxes.

Should you unpack or inspect any of the equipment without an E&S representative present, or without authorization from E&S, you assume all responsibility for any damage or shortage claims with the carrier.

Skid-Mounted Equipment

For ease of handling and packaging, the PS 300 control unit is packaged in a skid mounted box. The skid can be lifted and moved by forklift trucks, if handled with care. Boxes should remain in a vertical position, as noted on the box surface, at all times. Where narrow passageways prevent the passage of a forklift, a mobile lifter can be used. Care should be taken with the use of dollies or hand pallets and jacks. The box should not be subjected to any hard bumps or shocks.

Boxed Equipment

The PS 300 display and interactive devices are shipped in reinforced cardboard boxes. Care should be taken in the transportation of these boxes to the system site. Boxes should not be dropped or handled in a hazardous manner and should remain in a vertical position, as noted on the box surface.

Once the installation has taken place, you are responsible for the disposal of the packing material. Preparations should be made in advance for the transportation of the empty packaging material from the installation site when the installation has been completed.

SITE PLANNING

Adequate site planning and preparation can ease the installation process and produce efficient system operation. For the best results, design work should be assigned to professional engineers and architects, and construction work should be performed by qualified electrical, mechanical, and structural contractors.

Site planning requirements will vary greatly from site to site. The available physical area often dictates the choice of site. The following sections deal with some of the aspects to be considered when evaluating potential site locations.

Choosing a Site

The location and environmental aspects of your system are as significant as the equipment itself. The system could prove to be unusable if it is placed in an awkward or inadequately supported location. Primary considerations for site selection are the basic requirements of space and location.

Space

The actual floor area required for the system will depend on the system itself, the length-to-width ratio of the area, the locations of walls, partitions, windows, and doors. The PS 300 system requires an area of approximately three feet by five feet. To determine the exact area your system will require, a layout should be prepared to scale, with all features of the site location included. The area allotted should provide for:

- Future expansion of the system.
- Storage of related materials.
- Convenient system operation.
- Easy access for service and maintenance.

The PS 300 should be at least 12 feet from all sources of heat, including sunlight and central heating vents.

There should be at least two feet of clearance around the PS 300 control unit to provide for air flow and cabling. The back of the display must have at least one foot of clearance for cabling.

The actual size of the system components are provided in Table 1-1.

Table 1-1. Physical Characteristics of PS 300 System Components

	Control Unit	Display	Keyboard	Dials	12x12 Tablet	Function Buttons
Height	30.1"	20.7"	3.5"	3.7"	3.0"	6.5"
Width	26.0"	20.7"	1.1"	12.0"	15.7"	6.5"
Depth	26.4"	23.5"	8.3"	8.3"	16.4"	7.85"
Weight	170 lbs	120 lbs	8.2 lbs	4.6 lbs	11 lbs	

Control unit weight includes 5 basic cards. The 25' cable from the control unit to the display weighs 6 lbs.

Table 1-2. Physical Characteristics of PS 300.2 System Components

	Control Unit	Display	Keyboard	Dials	12x12 Tablet	Function Buttons
Height	26.25"	20.7"	3.5"	3.7"	3.0"	6.5"
Width	21.0"	20.7"	1.1"	12.0"	15.7"	6.5"
Depth	28.25"	23.5"	8.3"	8.3"	16.4"	7.85"
Weight	120 lbs	120 lbs	8.2 lbs	4.6 lbs	11 lbs	

Control unit weight includes 5 basic cards. The 25' cable from the control unit to the display weighs 6 lbs.

Location

The site selected for the system should be located near work-related areas for efficient operation. The distance from the host to the PS 300 is determined by the type of interface used. Refer to the appropriate customer installation manual for your interface for information on distance limitations or restrictions.

The location of the site is also dependent on existing or planned facilities at the site. The location should be able to:

- Provide adequate power supply.
- Conform to environmental requirements.
- Provide adequate flooring.
- Conform to safety and fire regulations.
- Provide easy access for equipment delivery and installation.
- Provide for the flow of work in the most efficient manner possible with respect to such considerations as related areas, human factors, storage, and noise isolation.

ENVIRONMENTAL SUPPORT

Factors to be considered as part of environmental support include power requirements, adequate heating and/or cooling facilities, and adequate air quality.

Power Requirements

The available supply of power should be adequate to handle not only the power loads represented by the installation of the PS 300, but any anticipated future loads. The electrical system must conform to applicable national and local codes and ordinances.

The electrical service should be checked prior to system installation to ensure that power levels are within the specified limits. For 115V installations, separate 15A circuits are needed for each PS 300 control unit and each PS 300 display. The wall receptacles should be standard wall plugs, NEMA 5-15R 125V 15A or equivalent.

To ensure proper operation of the PS 300 system, the following limitations are placed on AC power disturbances:

- A maximum of ± 10% of nominal power for .1 seconds occurring no more than once every 10 seconds.

- Maximum harmonic content of 5% rms, no more than 3% rms for any single harmonic.
- Maximum impulse of 300V with rise time of .1 microseconds or slower, lasting no longer than 10 microseconds for total duration.

It is important to note that many unconditioned A/C service mains exceed these specifications, especially during periods of heavy use and/or electrical disturbances. Care should be taken to ensure that the input power supplied to PS 300 equipment has been adequately conditioned.

Table 1-3 provides the power requirements for the PS 300 control unit and displays. The control unit and displays run on a two-wire-plus-ground circuits. The displays must share a common ground with their supporting control units. Note: If a parallel interface is to be installed, a separate ground from the host must be provided.

Table 1-3. PS 300 Power Considerations

	Line Voltage	Phase Load	Line Frequency	Maximum Current	Power Consumption	Power Cord
Control Unit	115 VAC ±10%	Single	47-63 Hz	12 amps @115 VAC	1380 watts (4710 BTU) maximum	3-prong 6 foot (3/14 AWG)
AB19 Monochrome Display	115/230 VAC ±10%	Single	50-60 Hz	9 amps @115 VAC	1080 watts (3680 BTU) maximum	3-prong 6 foot (3/14 AWG)
19-inch SM19 CSM Display	115/230 VAC ±10%	Single	50-60 Hz	12 amps @115 VAC 6 amps @220 VAC	1400 watts (4780 BTU) maximum	3-prong 6 foot (3/14 AWG)
19-inch Raster Display	115/230 VAC ±10%	Single	50-60 Hz	1.2 amps @115 VAC .6 amp @220 VAC	130 watts (450 BTU) maximum	3-prong 6 foot (3/18 AWG)

Temperature and Air Quality

Evans & Sutherland computer equipment is designed to perform well in various environments. The following sections provide the temperature and air quality requirements to support your system.

Temperature

The air conditioning system should be able to provide sufficient heating and cooling to maintain the environment within the specified limits. Heating is normally required when all equipment is turned off during cool weather. Maximum cooling demands are reached on the warmest days with all equipment in operation. The best way to provide the proper air temperature is to provide a separate thermostatic control to compensate for the heat dispersed by the PS 300 and any other equipment and personnel in the area.

The following table provides the recommended temperatures and humidity ranges for the PS 300 system during operation and storage.

Table 1-4. Temperature and Humidity Ranges

	OPERATING	STORAGE	
		With System Software	Without System Software
Temperature	65°F to 80°F 18°C to 27°C	50°F to 117°F 10°C to 47°C	-08°F to 117°F -22°C to 47°C
Humidity	20% to 80% Noncondensing	1% to 95% Noncondensing	

Heat dissipation factors can be calculated by using the following table. These figures should be added to any other heat dispersal from equipment and personnel located in the same room.

Table 1-5. Heat Dissipation Ranges

PS 300 SYSTEM COMPONENT	HEAT DISPERSED
Control Unit	4710 BTU/hr
19" Monochrome Display	3680 BTU/hr
19" Color Display	4780 BTU/hr
26" Color Display	8533 BTU/hr
19" Raster Display	450 BTU/hr
one person	400 BTU/hr

Air Quality

The Evans & Sutherland computer graphics equipment has been designed to operate in an office-type environment, where air filtration is not always possible. However, the E&S control unit should be placed away from high traffic areas, as the build-up of floating particles is more concentrated in these areas. Airborne dust, dirt particles, and smoke can clog intake air filters and cause damage to the floppy disk drive.

Dust can usually be controlled by normal heating, ventilating, and cooling equipment if adequate filters are used. Keeping the system area clean and orderly will lessen the concentration of airborne particles and help maintain system reliability.

The PS 300 system should never be placed in an area containing even small concentrates of corrosive chemicals.

Where excess dust or airborne particles are present, an electrostatic filter should be installed to prevent damage to the system.

FACILITIES PREPARATION AND CONSIDERATIONS

Once the site has been selected and provisions have been made for environmental support, there are several other factors that should be considered. The following sections provide information on the work table, appropriate floor coverings, cabling, use of partitions, and safety considerations. Information on operating considerations such as acoustics, vibration, static electricity, and corrosive elements is also provided.

Work Table

The PS 300 displays and interactive devices will need a surface to be installed on. This should be a table or large desk of heavy construction. Check the specifications on the display and interactive devices to determine the exact size of the work surface needed, along with weight requirements. The work surface should be a comfortable height for an operator. The suggested height is 28 inches.

The surface of the table or desk should be durable, nonglare, and easy to maintain.

Floor Coverings

The most desirable flooring is a raised floor which includes tile-covered panels supported by a grid system of pedestals. These floors simplify installation and provide flexibility for subsequent layout changes or expansion. They also provide an area through which cables connecting various components of the system can be routed and kept out of the way.

Any floor surface may be adequate for the installation of the PS 300, with the following in mind:

- Carpeting - Any high-grade industrial carpeting, with short, closed-loop piles. Minimal or no padding should be used. The carpet should have good antistatic properties and/or a low surface resistivity.

CAUTION

Shag rug, deep pile and other such carpets are not recommended and may cause serious operational difficulties. These rugs have loose fibers and collect dust particles which can damage the floppy disk drive, clog cooling inlet filters, as well as generate unacceptable levels of static electricity (ESD).

- Tile - Most tiles provide a suitable surface. Specific attention should be given to underlay. There is a tendency for some tiles to build up static charge. This can be minimized by proper application of low-resistivity sealer and polish. This application will need to be repeated at appropriate intervals.
- Wax is not recommended as a protective coating for floors in a computer area as it tends to build up surface resistivity and increase static charge.
- Other surfaces should be evaluated for surface resistivity, ease of cleaning and resistance to decomposition, durability, cost, and appearance.

Cabling

Cable routing is an important consideration that should be taken into account during site planning. Conduits, cable ramps, and any necessary alterations should be implemented prior to the system delivery. Cables that need to be routed include the cabling from the host system to the PS 300 and cable from the PS 300 control unit to the display.

Partitions

Floor to ceiling partitions are an effective way of controlling noise and dust in the computer room area. Considerations in using partitions include equipment access and cabling restraints. Partitions must be positioned to avoid blocking an adequate airflow to the equipment.

Fire and Safety Precautions

The degree of protection from fire required for a computer installation is adequately met by building, fire, and safety codes. However, local experts should be consulted about fire prevention and extinguishing devices.

The computer installation should not be located near the use, storage, or manufacturing of flammable or explosive material.

For safety as well as operational reasons, a common earth ground should be provided for each interconnected piece of equipment.

All power circuits should be adequately protected with fuses or circuit breakers of a suitable size.

No metal should be exposed on the walking surface of floors.

Acoustics

The E&S graphics system is designed to operate with a minimum amount of noise. Cooling fans within the cabinets can be a possible source of audible sound, but in most environments ambient noise will be louder than the PS 300.

If several PS 300s are to be operated in close proximity, acoustical damping of the ceiling, floors, and walls might be considered.

Vibration

Vibration can cause slow degradation of mechanical parts and contacts. It should be avoided whenever possible. In cases where structure-borne vibration is negligible, no problems should arise. If there is any anticipation of unusual or prolonged vibration, an E&S Technical Support representative should be consulted.

Electromagnetic Interference (EMI)

The PS 300 product line has been tested and found to meet the Federal Communications Commission radiation limits for a Class A computing device pursuant to Subpart J of Part 15 of the FCC rules.

EMI sources close to computer systems can affect their operation. It is difficult to predict whether or not problems will arise at a particular site. Some common sources of EMI that have been known to cause failures are:

Thunderstorms	Broadcast stations	Fluorescent lights
Radar	Mobile communications	Static electricity
High voltage power lines	Power tools	Ultrasonic cleaners
Appliances	Relay contactors	Dielectric heaters
Office machines	Vehicle ignitions	Arc welders
Industrial machines	Magnetic devices	

An E&S Technical Support representative should be consulted if potential problems exist at a particular site.

Altitude

System operation at high altitudes may be affected by low air density. Heat dissipation problems may occur at altitudes greater than 7000 feet (2000 meters). If high altitude operation is anticipated, additional blowers may be required to cool the system.

Static Electricity (ESD)

Static electricity is the result of physical action. Vibration, friction, and separation of materials are common static generators. People and furniture are the most common static storage collectors. Static may be generated by walking, rising from chairs, moving objects, or pushing vehicles with nonconductive wheels. Voltages of 16KV have been measured on plastic-covered metal desk chairs, just as a result of a person standing up. This often occurs at low relative humidities (0 to 20%).

The PS 300 system should not be located in an area where potentially large charges of static electricity may gather. For information on floor conductivity, see IEEE Standard 142-1972.

Although the PS 300 system has been engineered to resist the harmful effects of ESD, every effort should be made to reduce the possibility of ESD discharges directly to the equipment.

Corrosive Environments

Operation of the PS 300 in corrosive environments will result in damage to electronic components and circuitry.

Some common corrosive substances are:

Sodium chloride (salt)	Nitrogen oxides
Hydrogen sulfide	Nitrates
Sulfur dioxide	Ammonia
Hydrocarbons	Ozone

If any of these contaminants are present in the intended environment, an E&S Technical Support representative should be consulted for recommendations.

INTERFACE AND OPTION INSTALLATION MANUALS

One of the steps that must be taken during site preparation is to prepare for the interface that will serve as the communication link between your host system and the PS 300. An interface was chosen when the PS 300 system was ordered. A Customer Installation and User Manual for that interface was shipped to you in your system software package. It is very important that you read that manual carefully and take all steps required to prepare your site for the installation of the interface. Requirements for system and interface installation must be met before hardware installation of the PS 300 is requested.

There may also be a Customer Installation and User Manual for any option that you ordered with you system in the system software package. Options include raster displays, hardcopy interface cards, and interactive devices. Not all options have installation manuals. If your options require any site preparation before they can be installed, a manual for that option will be in the system software package.

PS 300 Customer Installation and User Manuals are provided for the following interfaces and options:

- PS 300 Standard Asynchronous Interface
- PS 300 UNIBUS Parallel Interface (VAX/VMX)
- PS 300/UNIX Parallel Interface
- PS 300/UNIX Ethernet® Interface
- PS 300 Ethernet® Interface (VAX/VMS)
- PS 300/IBM 3278 Interface
- PS 300/IBM 3258 Interface
- PS 350/IBM 5088 Interface
- PS 300 Raster Option
- PS 300 Hardcopy Interface Option

2. INSTALLATION, PERFORMANCE VERIFICATION, AND WARRANTY

This chapter briefly describes the installation process that is finalized by completing the Performance Verification Form. Completion of this form initiates the 60-day warranty provided for Evans & Sutherland products.

INSTALLATION

After unpacking the system, the Customer Engineer will install the hardware components of the system. It is not necessary for any customer representative to be present during hardware installation. A customer representative must, however, be present during the next stage of installation.

PERFORMANCE VERIFICATION TESTING

After completing the hardware installation, the E&S Customer Engineer will run the standard Performance Verification Test (PVT) for the PS 300 Graphics System and any other system, interface, or option tests. These tests must be run in the presence of an authorized customer representative. The tests demonstrate the performance of the system according to published specifications.

It is important that you observe and participate in this testing procedure. The PS 300 PVT demonstrates the performance of the following features of the PS 300 Graphics System:

- High speed processing of data primitives and matrix transformations, including:
  - three axis translations
  - three axis rotations
  - three axis scaling
- Six plane clipping
- Depth cueing

- Picking
- Character and vector data primitives (polygons are covered in a separate PS 340 PVT)
- Polynomial and Bspline curve primitives
- Independent character scaling and orientation
- Perspective
- Viewports

The PS 300 PVT will make use of the following peripherals, if present at your site:

- Local Hardcopy
- Data Tablet
- Control Dials
- Function Buttons
- Keyboard including Function Keys
- Mouse

For optional CSM displays the following performance characteristics will be covered:

- 120 hue and 15 saturation values

For the PS 350, the PS 300 PVT can be configured to demonstrate the following additional performance features:

- Light pen picking
- 127 Texture values

The following section describes in a general way how the performance of these features is verified.

- High speed processing of data primitives and matrix transformations, including three-axis rotation, translation, and scaling is demonstrated by having you use the dials to perform matrix transformations and the function keys to control a clock-driven network for the same transformations.
- Clipping is demonstrated by having you manipulate a data structure in such a way that it is clipped. In addition, you can use controls to enable/disable depth clipping and to adjust the position of the back clipping plane.

- Depth cueing and intensity levels are demonstrated by providing data structures that have sufficient depth to demonstrate depth cueing.
- Picking capability is verified by having pickable structures in the PS 300 PVT. When these structures are picked, either the information from the pick is returned or a visible action will happen or both.
- Character, vector, and curve data types are verified by being present and visible on the PS 300 PVT screen display.
- Independent character scaling and orientation is verified by having characters be part of the structures being manipulated.
- Perspective is demonstrated by allowing you to select either perspective or orthographic viewing for the PS 300 PVT data structures. The data structures are defined in such a way that it is apparent that the data structure is being viewed in perspective.
- Viewports are demonstrated by having multiple viewports for the various PS 300 PVT data structures.
- Hardcopy is demonstrated by making hard copies of the PS 300 PVT screen.
- 120 hues and 15 saturation levels are demonstrated by providing a data structure with 15 different saturation levels and then allowing you to vary the hue.

PS 340 Performance Verification

If the system being installed is a PS 340, the PS 340 PVT will be run after the completion of the PS 300 PVT.

Performance Verification Features

The **PS 300 System Performance Verification Manual** contains a description of the features and operating instructions for the PS 300 Performance Verification Test, the PS 340 Performance Verification Test, and other tests for optional devices such as the raster display. The PS 300 command language code used to build this test is provided in this manual and can be used as a reference for proper programming practices and as an example of function networking.

You should request a copy of the **PS 300 System Performance Verification Manual** if you want to run the tests yourself, or for more information on the verification process. (This manual will be available in February of 1986.)

Completion of the Performance Verification Form

At the conclusion of all performance verification testing, you and the E&S Field Engineer will complete the Performance Verification Form. This form acknowledges that the E&S product has been installed and is performing according to published specifications. Both you and the field engineer must sign and date the bottom of the form. The testing procedures and the completion of the form initiate the 60-day warranty period that is supplied with E&S products.

Any performance deficiencies should be described on the Performance Verification Form. E&S is responsible for making sure that deficiencies are corrected and that the product is brought up to the proper level of performance during the warranty period. If a product or device must be replaced during the warranty period, a separate warranty extension will be provided for that product or device to ensure that it has full 60-day warranty coverage.

An example of a deficiency is a keyboard whose LEDs do not display characters during the performance testing, a color display that is not properly aligned, or a control dial that will not turn properly. The Performance Verification Form should be completed for systems with noted deficiencies. Deficiencies do not define a system as unusable.

An unusable system is defined as a system where the critical failure of a device or component incapacitates the system in such a way that it is totally unusable for your purposes. If, because of a component failure, a system is declared unusable by the field engineer during the testing phase, the Performance Verification Form should not be completed until the failure is corrected and the system useable.

For example, a system would be declared unusable if the only host-to-PS 300 interface fails to perform and host communication is necessary at your site for your application. A system would be declared unusable if the color display fails to generate any images.

The installation of your system will not be officially completed until a useable system has been installed at your site. There may be some cases where shipment of parts to repair failures cause a short delay.

Warranty Deferral

If a usable system is performing to published specifications and you choose not to complete the Performance Verification Form, you will be asked to sign a warranty deferral that releases Evans & Sutherland from any financial obligations to insure or support the E&S product on your site.

You will be asked not to use the equipment and to place it in a secured area. The equipment will remain at your site unless otherwise specified. You will be liable for any damage to the system or system components that occurs during the warranty deferral period. Should E&S be requested to perform any service on the equipment, you will be charged according to the current Requested Maintenance Service rates.

The 60-day warranty period on the product will not be provided until the Performance Verification Form is completed.

PS 300 GRAPHICS SYSTEM WARRANTY

This warranty provides your new system or device with 60-days of full service, as provided by a standard E&S Continuous Maintenance Service contract. This is the standard maintenance service offered to the customers of E&S graphics products. The service is described in the following chapter.

Service and support of the PS 300 during the warranty, and under a Continuous Maintenance Service contract, is supplied by a team of highly qualified and extensively trained specialists and engineers within the E&S Customer Engineering Department.

Your first line of support is through the local Customer Engineer assigned to your system site and by the Customer Service toll-free hotline in Salt Lake City.

The local Customer Engineer is supported by District and Regional technical specialists and managers. These field personnel are supported by the Technical Support and Software Support Groups in Salt Lake.

3. PS 300 MAINTENANCE SERVICE PLANS, OPTION REQUESTS, AND OTHER SERVICES

Evans & Sutherland Customer Engineering provides complete hardware and software support of all E&S products. Nationwide coverage of customer sites is currently provided out of 16 field service locations. Service in Europe is provided by Evans & Sutherland GMBH, operating out of two locations. Field service operations and customer sites receive back-up support from the software and technical support groups based in Salt Lake City.

In the United States, requests for hardware and software service are handled through the E&S Customer Service Center which provides you with a call-back by an E&S customer engineer or software analyst within one hour of the request. In addition to providing maintenance service for hardware and software, Evans & Sutherland offers training classes for programmers and maintenance training courses.

Evans & Sutherland offers two standard maintenance service plans, OEM support, and will contract to provide on-site customer service. Evans & Sutherland can also negotiate special service contracts for maintenance programs tailored to fit individual needs.

The following sections detail these services. For more information, contact the Evans & Sutherland Customer Engineering Department.

SERVICE PLANS

Evans & Sutherland offers two maintenance service plans, Continuous Maintenance Service and Requested Maintenance Service.

Continuous Maintenance Service is designed to supply the customer with complete and continuing maintenance of all hardware, software, firmware, and documentation supplied by Evans & Sutherland. Requested Maintenance Service is supplied only at the customer's request. The following chart compares the two plans. The chart shows the type of service and the charges to the customer, as well as customer responsibilities, for each service.

SERVICE	CONTINUOUS MAINTENANCE (Standard, contracted on-call service)	REQUEST MAINTENANCE (Non-contract, time & materials service)
CORRECTIVE MAINTENANCE	All travel, labor, and parts costs covered under the contract.	Customer billed at the in-effect Requested Maintenance Service rates for travel, labor, and parts. Exchange prices on parts range from 40% to 100% of the spares catalog list price.
	24-hour elapsed response guaranteed	No guaranteed response time. Lowest call priority.
	Customer request for service to Customer Service Center provides the customer with a return call by a customer engineer within one hour.	Hotline service is not provided.
PREVENTATIVE MAINTENANCE	A preventative maintenance schedule is set up for individual customers as a function of their operating needs and environment. Minimum 3 visits per year.	Available on request. Billed at the in-effect Requested Service rates. Typical visit $1000-$1500 plus needed parts.
SOFTWARE SUPPORT	A Customer Service Hotline is provided, as well as on-site support (as needed) at no charge.	Available on request. Billed at the in-effect Requested Service rates.
NEW FIRMWARE AND SOFTWARE	Supplied automatically to all contract holders at no charge.	Available for purchase at catalog prices.
INSTALLATION OF PURCHASED OPTIONS	When scheduled by E&S, no charge for installation of add-on options to contract holders.	Billed at the in-effect system reconfiguration fee.

SERVICE	CONTINUOUS MAINTENANCE (Standard, contracted on-call service)	REQUEST MAINTENANCE (Non-contract, time & materials service)
FIELD CHANGE ORDERS (FCOs) INSTALLATION	FCOs that are necessary to correct performance defects and/or to maintain the equipment at a serviceable level are automatically installed at no charge. The price for installing FCOs that modify the system to support new add-on options is quoted along with the add-on option price.	Available for purchase. Customers are encouraged to purchase all FCOs required to maintain the system at a serviceable level in order to minimize repair costs.
CONFIGURATION CONTROL	Complete hardware, software, and firmware configuration data is maintained in the C.E. Department data base for all systems under contract.	Customer must maintain own configuration data. Failure to do so could result in in additional repair costs and charges. Reconfiguration charge may be necessary before servicing equipment.
PRICES	Guaranteed for 12-month contract periods Prices will be changed on the anniversary date only if the customer has had 90 days prior notice.	The in-effect Requested Service rates are subject to change without notice.
PAYMENT	Monthly rate is predetermined by hardware, firmware, and software configuration.	Customer must issue a purchase order before service will be dispatched. To reduce response time, a preissued purchase order is suggested.
RESPONSIBILITY	Evans & Sutherland assumes responsibility for the maintenance and support of systems under contract.	Customer takes full responsibility for the maintenance and support of all systems.

MAINTENANCE SUPPORT FOR OEMs

Various services and supports are available for OEM customers. These include maintenance training, card and module repair, first level on-site support by E&S customer engineers, maintenance plan design, and an OEM Field Service Support Plan. In the last plan, second and third level support is provided by the technical support and software support groups of the E&S Customer Engineering Department.

OTHER MAINTENANCE SERVICE

In addition to standard on-call and time-and-material contracts, E&S designs custom maintenance service plans to meet the needs of its customers. A typical maintenance service designed for a high volume Continuous Maintenance customer may guarantee a 30 minute average response time, 60 minute mean time to repair, and a 99.5% system availability over a 96 hour per week service period.

OPTION REQUESTS

Options can be ordered for your PS 300 at any time. Options include various color and raster displays, additional interactive devices, host interfaces, and specialized software and firmware. You should request sales literature from your account executive for further descriptions of all E&S products. Options must be ordered through your local Evans & Sutherland account executive.

The current configuration of your system must be available to determine if your system can support the option. If you have been under a Continuous Maintenance Service contract, we will have your current system configuration or we will send a customer engineer to your site to verify the configuration at no charge.

If you are not under a Continuous Maintenance Service contract, you must either supply us with a current system configuration, or you will be charged for the on-site visit to determine the configuration of your system.

Request for Bid

When you order an option for your system, a "Request for Bid" form will be filled out by the account executive. This bid must be submitted to Evans & Sutherland Customer Engineering. They will determine any charges that will be billed to you, in addition to the price of the option, and any applicable installation fee.

Charges are based on your current system configuration and the option you are requesting. Your system may require modifications to existing components to support the new option. If you are under a Continuous Maintenance Service contract, you will only be charged for these modifications if they are required to support the option.

If you are not under contract, you will be billed for all expenses. You will be notified of the charge before a sales order is generated for your option. The account executive will not complete the sale of the option until you have agreed to the bid.

Installation Charges for Options

If you are under Continuous Maintenance, installations of new options are provided free of charge when the installation of the option is scheduled by Evans & Sutherland. If you are under Continuous Maintenance and your require that the option be installed during a specific timeframe, you will be charged for the installation of the option.

If you are not under a Continuous Maintenance contract, you will be charged for all expenses accrued during the installation of the option.

SOFTWARE AND DOCUMENTATION SUPPORT

Customer Service Hotline
1-800-582-4375

Software Support

Software support is provided to customers by the Customer Engineering Software Support Group at Evans & Sutherland corporate headquarters in Salt Lake City, Utah. During the hours 8:30 a.m. to 4:30 p.m. Mountain Standard Time, customer software problems will be logged into a problem-tracking system to ensure that all software calls receive the fastest possible resolution.

Once you have logged your problem through the hotline, a Software Support Analyst will call you back within one hour to get a detailed description of your problem. Within 48 hours, you will receive by telephone either a solution for your problem or a status report.

There is no charge for this service, provided the following conditions are met:

- Your system is PS2, MPS, or PS 300.
- You have a Continuous Maintenance contract or your system is being installed or is still under warranty.
- You are having a problem with an Evans & Sutherland-supported product which fails to perform as specified.

Customers without a Continuous Maintenance contract who request special help with unsupported software (and are not covered under installation or warranty) will be billed for the service at prevailing Customer Engineering hourly rates. If you are to be billed, your consent will be obtained before the problem is investigated.

The hotline number is intended only for logging problems; it should not be busy for extended periods. However, if the number is continually busy or nonoperational, the formal problem logging service can also be reached by calling (801) 582-5847 and asking for Customer Engineering Software Support. Before 8:30 a.m. and after 4:30 p.m., a call recorder will be operational on the hotline number. If you leave your name, phone number, and type of system (for example, PS 340) an analyst will call you before 10 a.m. MST on the next work day.

Before you call, please check the documentation to be sure your question cannot be answered there. Also, please have the following information at hand when you call.

- Your customer site number and the system tag number. These numbers are listed on labels attached to your PS 300 display and control unit.
- PS 300 graphics firmware version number. This is the E&S part number that appears on the distribution media of the PS 300 Graphics Firmware Package (for example, 904015-001 A1).
- The host computer model, and operating system and its version number under which you are encountering difficulties (for example, DEC VAX 11/780, VMS V3.3).
- Complete error numbers and messages which were output.
- If possible, the commands issued that caused the problem in question.

Documentation Support

Additional support is provided to customers by the Interactive Systems Publications Group at corporate headquarters in Salt Lake City, Utah. During the hours of 8:30 a.m. to 4:30 p.m. Mountain Standard Time, technical writers will be available for questions or comments regarding documentation. Your corrections and/or suggestions are encouraged regarding existing documentation or needed documentation.

This service is available free of charge to anyone using E&S equipment and its related documentation. No other requirements (such as a Maintenance Contract) are required.

Evans & Sutherland documentation must be ordered through your E&S account executive. The **PS 300 Document Set** is orderable as a complete set, by volume, and by section. Other E&S documentation is orderable by volume only.

TRAINING PROGRAM

Evans & Sutherland offers a comprehensive training course for the PS 300 programmer. The class is designed to train users involved in writing application software for the PS 300. It is recommended that students already have a basic understanding of computer graphics, computer programming, and the basic operating system and editing functions of the host computer that will be used. Upon completion, students should have the knowledge and experience to use the PS 300 in most computer graphics applications.

The PS 300 Programmer Training Class is given at the E&S corporate offices in Salt Lake City, Utah, or arranged classes can be taught at customer sites. Class instructors are experienced E&S product specialists and application engineers.

A limited class capacity of no more than six people assures that students are given specialized, individual attention during classroom instruction, as well as hands-on experience at the PS 300.

Training materials are included in the cost of the course. Contact your E&S account executive about current costs and scheduling.

4. OPERATING CONSIDERATIONS AND TROUBLESHOOTING

This chapter provides brief operation considerations and troubleshooting tips. The **PS 300 Document Set** contains a complete description of system operation.

OPERATING CONSIDERATIONS

Powering the System Up and Down

Frequent powering up and down of a computer system is detrimental to system long-term reliability. Leaving a system powered up in a safe environment greatly enhances equipment reliability and serviceability.

It is recommended that the PS 300 be left powered up during the work day. If adequate safety and environmental provisions are taken, the PS 300 can be left powered on indefinitely. To provide a safe and reliable atmosphere for the graphics system, the air-conditioning equipment and/or other computer-supportive equipment must be well monitored. The only precaution recommended, if the PS 300 is to remain powered up, is for the operator to either turn the PS 300 display intensity down or turn the display off at the end of each session. This will prevent burn-in of any pattern present; and also protect the CRT phosphor in the event of a hardware malfunction.

The main power switch on the logic box is used to supply power to the logic cabinet and peripherals with the exception of the display. Each display has its own power-on-off switch on the front bezel.

Lighting

The PS 300 is designed to operate in a normal lighting environment. The optimum lighting for a graphics CRT display should be subdued, indirect incandescent lighting. Avoiding lighting situations that produce glare on the face of the CRT will significantly reduce operator fatigue.

TROUBLESHOOTING

The following chart provides a brief troubleshooting guide that can be used as an aid in system operation. This chart covers only those operating considerations that can be checked and remedied by you. There are no user-replaceable components or fuses inside any of the PS 300 cabinets. If you are unable to operate your system after using this guide, please call E&S Customer Service Center, 1-800-582-4375.

SYMPTOM	REMEDY
The system will not power on.	Check the power cords, A/C input circuits (wall plugs).
The system will not boot.	Make sure the system power is on. Check to make sure the correct firmware is installed in the drives. Make sure the latches on the drive doors is closed.
Nothing is displayed on the screen when the system is booted.	Make sure the display is on. Make sure the intensity is up. Check the power cords to the display and the cabling between the control unit and the display.
An interactive device fails to operate.	Make sure the device cable is connected to the device and to the proper data concentrator port on the back of the display.
The keyboard fails to respond once the system has booted.	Make sure you are in the proper keyboard mode of operation.
The system fails to respond to the host system.	Make sure that your interface is functional and that you are in the proper keyboard mode of operation. Make sure you have established the connection between the PS 300 system and the host system properly. (Refer to your interface installation manual.)

APPENDIX A. PS 300 SPECIFICATIONS

This appendix contains six sections.

Section 1 contains specifications for the PS 300 control unit.

Section 2 contains specifications for the PS 300 data concentrator.

Section 3 contains specifications for four displays.

Section 4 contains specifications for the interactive devices.

Section 5 contains general performance specifications.

Section 6 contains specifications for the interfaces.

CONTENTS

FIGURES AND TABLES

SECTION 1. PS 300 CONTROL UNIT

Description

This section describes three PS 300 control unit configurations. The PS 300.0 control unit has a serial number below 2000, contains a maximum of 8 cards (10 cards with an expansion chassis), and has single-sided diskette drive(s). When the PS 300.0 is configured with a Joint Control Processor card and dual-sided diskette drive(s), it becomes a PS 300.1 system. The PS 300.2 system, when available, will have a smaller-sized cabinet, dual-sided diskette drive(s), and a Joint Control Processor card.

The standard card set includes;

- 1 Line Generator Subsystem
- 1 Pipeline Subsystem
- 1 Arithmetic Control Processor
- 1 Graphics Control Processor (PS 300.0 systems)
  OR
- 1 Joint Control Processor with 1 or 2 MB memory (PS 300.1 and PS 300.2 systems)

Options include:

- 1 Joint Control Processor with an IBM 3278 interface with 1 or 2 MB of memory (PS 300.1 and PS 300.2 systems only)
- 2 Additional mass memory cards
- 4 Optional cards including GPIO interface card, CSM card, Raster card, and Hardcopy Option card

Each PS 300 control unit supports one display with interactive devices and up to 3 slave displays, including 1 raster display.

Grounding

All PS 300 displays should share a common ground with their supporting control units.

Size and Weight

	PS 300.0 & PS 300.1	PS 300.2
Height:	30.1" (76.5 cm)	26.25" (66.7 cm)
Width:	26" (66 cm)	21.0" (55.3 cm)
Depth:	26.4" (67.1 cm)	28.25" (71.8 cm)
Weight:	170 lbs. (77.1 kg)	120 lbs. (54.4 kg)

Power Requirements

115V Single Phase: ±10% 47-63 Hz, 12 amp
220V Single Phase: 7 amps for the control unit

The following limitations are placed on AC power disturbances:

- A maximum of ±10% of nominal power for .1 seconds occurring no more than once every 10 seconds.
- Maximum harmonic content of 5% rms, no more than 3% rms for any single harmonic.
- Maximum impulse of 300V with rise time of .1 microseconds or slower, lasting no longer than 10 microseconds for total duration.

Power Consumption

1380 watts maximum

Heat Dissipation

4710 BTUs/hour

Operating Temperature

65° to 80°F (18° to 27°C)

Relative Humidity

20% to 80%

PS 300.0 Port Connectors

There are six communication ports on the communications connector panel at the back of the PS 300 control unit. Port designations are described below.

Port 0	Port 1	Port 2	Port 3	Port 4	Port 5
RS-232 or RS-449 **Synchronous**	RS-232 or RS-449 **HOST**	RS-232 or Modular	RS-232 **DEBUG**	RS-232 or Display 1 **DISPLAY**	RS-232 or Display 0 **DISPLAY**

Port 4 and Port 5 are reserved for the data concentrator. If you have a display connected to Display 0, you cannot use Port 5 for serial communications. If you have a display connected to Display 1, you cannot use Port 4 for serial communications.

PS 300.2 Port Connectors

There are six communication ports on the communications connector panel at the back of the PS 300.2 control unit. Port designations are described below.

Port 0	Port 1	Port 2	Port 3	Port 4	Port 5
RS-232 or RS-449 **UNUSED**	RS-232 or RS-449 **HOST**	RS-232 or Modular **UNUSED**	RS-232 **DEBUG**	RS-232 or Display 1 **DISPLAY**	RS-232 or Display 0 **DISPLAY**

Port 4 and Port 5 are reserved for the data concentrator. If you have a display connected to Display 0, you cannot use Port 5 for serial communications. If you have a display connected to Display 1, you cannot use Port 4 for serial communications.

SECTION 2. DATA CONCENTRATOR

Baud Rate

Communication with control unit is at 300 baud or 19.2K baud.

Communication rate with interactive devices is selectable from 300, 600, 1200, 1800, 2000, 2400, 4800, 7200, and 9600 baud.

The cumulative baud rate of host and all interactive devices can be no greater that 19.2K for one display station.

Port Connectors

Each of the ports A through F on the backpanel of the display is capable of supporting an interactive device. Each port has a 25-pin D-type connector that provides minimal RS-232 support. An 8-pin modular connector that provides E&S modified RS-449 support is located below the 25-pin receptacle. The keyboard and control dials use the modular connector. The data tablet uses the 25-pin plug for communication, and the 9-pin D-type connector to supply power to the tablet.

The standard configuration of the interactive devices is:

PORT A	PORT B	PORT C	PORT D	PORT E	PORT F
Keyboard	Control Dials	32-Function Buttons	Unused	Unused or Mouse	Data Tablet

SECTION 3. DISPLAYS

Cabling

The cable between PS 300 control unit and the display is 25 feet long. This limits separation of the display and the control unit to approximately 20 feet.

AB19 MONOCHROME DISPLAY

Size and Weight

Height: 20.7" (52.6 cm)
Width: 20.7" (52.6 cm)
Depth: 23.5" (59.7 cm)
Weight: 120 lbs. (54.4 kg)

Power

Voltage: 115/230 ±10% VAC, 50/60 Hz.

RFI/EMI: Radiated or conducted RFI/EMI will not exceed amount permitted by FCC rules for Class A computer equipment.

Power Consumption

- ≤ 700 watts at high line (126.5 VAC) and full X and Y deflection.
- ≤ 300 watts at nominal line (115 VAC) and zero X and Y deflection where X and Y offsets are adjusted to zero.

Heat Dissipation

3686 BTUs/hour

Operating Environment

Temperature range: from 65° to 80°F (18° to 27°C)

Relative humidity: from 20% to 80% over the operating temperature range.

Non-Operating Environment

Temperature range: from 50° to 117°F (10° to 47°C)

Relative humidity: from 1% to 95% (non-precipitating) over the non-operating temperature range.

Shock and Vibration: normal handling and shipping requirements.

CRT

19" rectangular, 70° deflection 33% bonded safety panel, magnetic deflection and electrostatic focus.

Usable Display Area

A 10.5" x 10.5" square centered on CRT face containing the following zones (see Figure A-1):

Zone A - a square with height = 7.5", width = 10.5" centered on the CRT
Zone B - a square with height = 14.25", width = 18.0" centered on the CRT
Zone C - the region of the usable display area excluding zones A and B.

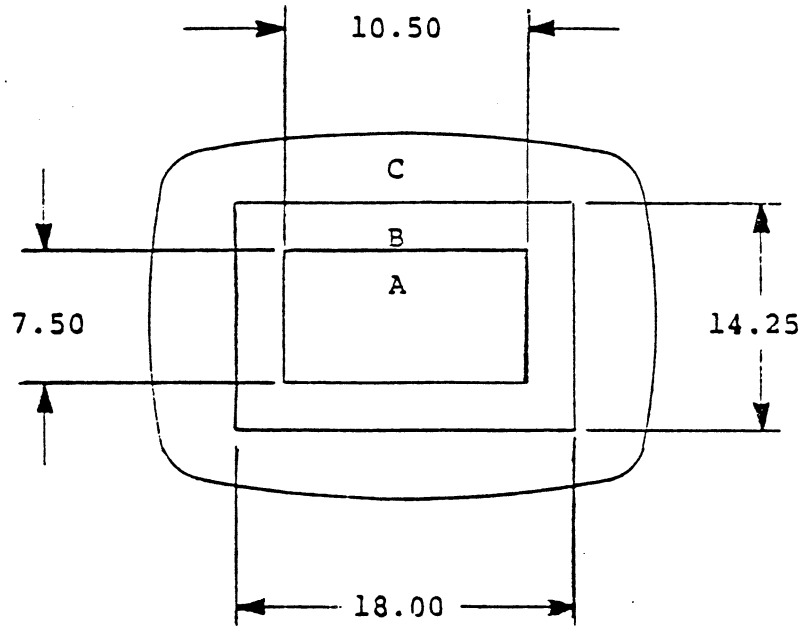


Figure A-1. CRT Zones

Brightness

Measured in zone A with a 420 line shrinking raster 8.4" high by 10.5" wide, line drawing rate of 729,000 inches/second, refreshed at 60 Hz.

Line Width at Specified Minimum Brightness

≤ .020" in Zone A
≤ .025" in Zone B
≤ .040" in Zone C

Endpoint Match

≤ .010" in Zone A
≤ .0125" in Zone B
≤ .020" in Zone C

Tolerances

Neck shadow shall not be evident within a 11.0" x 11.0" square centered on the display.

Retrace time $\leq$ 13.5 microsec for a 10.5 inch vertical or horizontal move and settle.

Slew rate $\geq$ 975,000 inches/second.

Small signal frequency response $\geq$ 1.3 MHz measured with a square wave input signal causing a 0.050 inch deflection on the screen.

Deflection tracking delay $\geq$ 130 nanosec and $\leq$ 200 nanosec when drawing at 729,000 inches/second.

Drift $\leq$ 0.10 inches in any direction during an 8 hour period. Determined after 15 minute warmup period.

Geometric distortion $\leq$ 1.25 percent of the total deflection possible in the usable display area.

Short line straightness $\leq$ the specified line width for a line (or segment of a line) less than 0.5 inches long.

On axis linearity (curvature) $\leq$ 0.050 inches over their 10.0 inch length. Segments must also meet the short line straightness specifications.

Orthogonality within 1° of 90°.

Spot motion and jitter $\leq$ 0.010 inches in the usable display area.

Repeatability $\leq$ 0.025 inches within a frame time (60 Hz maximum frame rate) and from frame to frame.

Control Range

Deflection gain adjustment from < ±4 inches to > ±6 inches from the center of the screen w/input ±5V.

Deflection centering adjustment ±0.625 inches.

Video gain adjustment provides maximum brightness fully clockwise w/maximum input video voltage of 3 to 5 volts. Video input of 0.0 volts provides 0.0 output intensity from the CRT when viewed in a dark room.

Phase error adjustment – no gap between lines should be detectable.

Video Circuitry

Video rise and fall times ≤ 65 nanosec.

Unblank rise and fall times ≤ 50 nanosec.

Video delay 65 nanosec maximum from input to CRT cathode.

Unblank delay 25 nanosec maximum.

Video delay compensation adjustable from 10 to 100 nanosec in increments of 10 nanosec.

Unblank input level will accept a TTL level where a TTL low signifies BLANK and a TTL high signifies UNBLANK.

Phosphor protect disables video drive ≤ 90 millisecs after loss of signal on either X or Y deflection inputs. Restores video drive < 10 millisecs of resumption of activity on both deflection inputs.

Crosstalk to deflection < 0.010 inches deflection.

AB19 Display Capabilities

PS 300 Vector Count at 30 Hz refresh rate

Table A-1. Vector Types

	Depth Cue Perspective	No Depth Cue Perspective	Depth Cue No Perspective	No Depth Cue No Perspective
2D	Type 3	Type 2	Type 2	Type 1
3D	Type 3	Type 2	Type 2	Type 2
2D Intrin Inten	Type 3	Type 2	Type 3	Type 2
3D Intrin Inten	Type 3	Type 3	Type 3	Type 3

Type 1 Vectors: 2D with no depth cueing and no perspective.
Type 2 Vectors: 3D with either depth cueing or perspective, but not both.
Type 3 Vectors: 3D with both depth cueing and perspective.

Vector Capacity

Table A-2. Type 1 Vectors

Size	Connected Draws Angle 6.0	18.0	30.0	42.0	54.0	66.0	78.0	Moves	M/D	Dots
0.05	95000	95000	95000	95000	63333	63333	63333	95000	47500	21111
0.10	95000	95000	95000	95000	63333	63333	63333	95000	47500	21111
0.15	63333	63333	63333	47500	47500	47500	47500	95000	38000	21111
0.20	47500	47500	47500	47500	47500	47500	47500	63333	38000	19000
0.25	47500	47500	47500	38000	38000	38000	38000	63333	31666	19000
0.30	38000	38000	38000	38000	38000	38000	38000	47500	31666	17272
0.50	31666	31666	31666	27142	27142	27142	27142	38000	23750	15833
1.00	19000	19000	17272	17272	17272	17272	15833	21111	15200	11875
2.00	10555	10555	10000	10000	10000	10000	9500	11875	9500	8260
5.00	4318	4318	4222	4222	4222	4222	4130	4871	4269	4130
10.00	2183	2183	2159	2159	2159	2159	2134	2435	2222	2235
14.85	1472	1472	1461	1461	1461	1461	1450	1653	1520	1557

Table A-3. Type 2 Vectors

Size	Connected Draws Angle 6.0	18.0	30.0	42.0	54.0	66.0	78.0	Moves	M/D	Dots
0.05	60000	60000	60000	60000	60000	60000	60000	60000	47500	21111
0.10	60000	60000	60000	60000	60000	60000	60000	60000	47500	21111
0.15	60000	60000	60000	47500	47500	47500	47500	60000	38000	21111
0.20	47500	47500	47500	47500	47500	47500	47500	60000	38000	19000
0.25	47500	47500	47500	38000	38000	38000	38000	60000	31666	19000
0.30	38000	38000	38000	38000	38000	38000	38000	47500	31666	17272
0.50	31666	31666	31666	27142	27142	27142	27142	38000	23750	15833
1.00	19000	19000	17272	17272	17272	17272	15833	21111	15200	11875
2.00	10555	10555	10000	10000	10000	10000	9500	11875	9500	8260
5.00	4318	4318	4222	4222	4222	4222	4130	4871	4269	4130
10.00	2183	2183	2159	2159	2159	2159	2134	2435	2222	2235
14.85	1472	1472	1461	1461	1461	1461	1450	1653	1520	1557

Table A-4. Type 3 Vectors

Size	Connected Draws Angle 6.0	18.0	30.0	42.0	54.0	66.0	78.0	Moves	M/D	Dots
0.05	45000	45000	45000	45000	45000	45000	45000	45000	45000	21111
0.10	45000	45000	45000	45000	45000	45000	45000	45000	45000	21111
0.15	45000	45000	45000	45000	45000	45000	45000	45000	38000	21111
0.20	45000	45000	45000	45000	45000	45000	45000	45000	38000	19000
0.25	45000	45000	45000	38000	38000	38000	38000	45000	31666	19000
0.30	38000	38000	38000	38000	38000	38000	38000	45000	31666	17272
0.50	31666	31666	31666	27142	27142	27142	27142	38000	23750	15833
1.00	19000	19000	17272	17272	17272	17272	15833	21111	15200	11875
2.00	10555	10555	10000	10000	10000	10000	9500	11875	9500	8260
5.00	4318	4318	4222	4222	4222	4222	4130	4871	4269	4130
10.00	2183	2183	2159	2159	2159	2159	2134	2435	2222	2235
14.85	1472	1472	1461	1461	1461	1461	1450	1653	1520	1557

Clipping

Trivial Rejection	0.00 nanosec
Clip against 1 plane	26.88 microsec
Clip against 2 planes	29.44 microsec
Clip against 3 planes	32.00 microsec
Clip against 4 planes	34.56 microsec
Clip against 5 planes	37.12 microsec
Clip against 6 planes	39.68 microsec

Add 2.56 microsec if vector has intrinsic intensity with endpoints at different intensity values.

Subtract 2.56 microsec if clipped vector is rejected.

Subtract 0.80 microsec if front - back clipping not used.

19-INCH CSM CALLIGRAPHIC DISPLAY

Size and Weight

Height: 20.7" (52.6 cm)
Width: 20.7" (52.6 cm)
Depth: 23.5" (59.7 cm)
Weight: 165 lbs. (75 kg)

Power

Standard 115/230 VAC circuit and a standard plug. ±10%, 12 amps maximum

Power Consumption

1300 watts maximum

Heat Dissipation

4100 BTUs/hr

Operating Environment

Temperature: 65° to 80° F (18° to 27°C)
Relative Humidity: 20% - 80% (noncondensing)

Non-Operating Environment

Temperature: -22° to 140°F (-30° to 60°C)
Relative Humidity: 0% to 90%, noncondensing

CRT

19" 90° rectangular magnetic deflection, high voltage focus, precision inline gun, 0.31 mm phosphor dot pitch, high contrast anti-reflective coated face plate, tension band implosion

Display Capacity

CSM ON mode only

Color

120 hues, 15 saturation values plus white
1,801 programmable colors which may be displayed simultaneously

Usable Display Area

10.5" x 10.5" square centered on the 19" CRT

Brightness

8.5 foot-lamberts at specified spot size of .025 inches, 60 Hz refresh rate, drawing at 364,500 inches/second

Tolerances

Geometric distortion ±1.0% of full deflection

Minimum linear writing speed: 550,000 inches/sec

Horizontal and vertical move/settle time: 20.0 microsec (10.5")

Small signal deflection BW: 630 KHz

On-axis linearity ±.75% of full deflection

Incremental on-axis linearity: adjacent intervals do not differ > 0.75% of full deflection

Short line straightness: no error > 0.020 inches

Orthogonality within ±1.0° @90°

Jitter and spot motion ±.010 inches maximum

Crosstalk to deflection (all sources): 0.010 inches

Phase error: no perceptible gap

Video rise and fall times: 65. nanosec maximum

Video delay adjustable, each color: adjustable to cover deflection tracking delay

Unblank (TTL) rise and fall times: 65. nanosec

Unblank delay: adjustable to cover deflection tracking delay

Repeatability $\leq$ .025 inches within the 10.5" x 10.5" usable display area

Convergence measured from line center to line center:

Within 3.5" radius	Within 5.25" radius	Within useable area
0.010"	0.015"	0.035"

Convergence stability: no drift over 100% of specified requirement over all conditions.

Spot size (line width) - for sharply defined spot. Display driven by PS 300 color card:

	Within 5.25" radius	Within display area
white	0.025"	0.035"
red, green, blue	0.030"	0.040"

Neck shadow: none visable within useable display area

Pincushion: adjust to obvious barrel distortion

Endpoint match: within .020" inside the 10.5" x 10.5" usable display area for each color.

Display Capabilities

All specifications listed below apply to the 19" Color Calligraphic display when it is driven at the slow speed CSM ON mode at 30 Hz refresh rate and after a suitable warm-up period for the display.

Table A-5. 19-Inch CSM Display Capabilities

Vector Length	Vector Type 1	2	3	Connected (20) 20	Draws	Moves	Move/Draw	Dots
0.10"	x			63333	31666	63333	23750	11176
0.10"		x		48850	31666	48850	23750	11176
0.10"			x	45000	31666	45000	23750	11176
0.25"	x	x	x	21111	19000	31666	15833	9500
0.50"	x	x	x	15833	14615	21111	12666	8260
1.00"	x	x	x	8636	7307	10555	7169	5937
10.00"	x	x	x	1085	1061	1165	1082	1073

Type 1 Vectors: 2D with no depth cueing and no perspective.
Type 2 Vectors: 3D with either depth cueing or perspective, but not both.
Type 3 Vectors: 3D with both depth cueing and perspective.

26-INCH CSM CALLIGRAPHIC DISPLAY

Size and Weight

Height: 51" (129.5 cm)
Width: 27" (68.6 cm)
Depth: 53" (134.6 cm)
Weight: 450 lbs. (204 kg)

Power

208 VAC or 220 VAC circuit. ±10%, 15 amps maximum

Power Consumption

2000 watts maximum

Heat Dissipation

6824 BTUs/hr

Operating Environment

Temperature: 65° to 80°F (18° to 27°C).
Relative Humidity: 20% - 80% (noncondensing)

Non-Operating Environment

Temperature: -22° to 140°F (-30° to 60°C).
Humidity: 0% - 90%, noncondensing

CRT

25 (26") black matrix rectangular magnetic deflection, high voltage focus, precision delta gun, .37 mm phosphor dot pitch, tension band implosion.

Display Capacity

CSM ON and CSM OFF modes.

Color

120 hues, 15 saturation values plus white
1,801 programmable colors which may be displayed simultaneously.

Useable Display Area

A 13" x 13" square centered on the 26" CRT

Brightness

8-foot lamberts minimum at specified line width, 60 Hz refresh rate, drawing at 451,000 inches per second.

Contrast ratio

60:1

Tolerances

Geometric distortion ±3.0% of full deflection

Axis linearity ±1.5% of full deflection

Orthogonality within ±1.0 degree

Jitter and spot motion ±.012" maximum

Repeatability $\leq$ .030 inches within a circle of 6-inch radius including hysteresis.

Convergence

Adjustable within ±.010 inches with a circle of 6-inch radius.
Adjustable within a ±.035 inches within the 13" x 13" display area.

Spot Size

(Line Width)

white	0.030"
red	0.040"
green	0.040"
blue	0.040"

Endpoint Match

Adjustable within .030" inside the 13" x 13" usable display area for each color.

Display Capabilities

All specifications listed below apply to the 26" Color Calligraphic display when it is driven at the slow speed CSM ON mode at 30 Hz refresh rate and after a suitable warm-up period for the display.

Table A-6. 26-Inch CSM Display Capabilities

Vector Length	Vector Type 1	2	3	Connected (20) 20	Draws	Moves	Move/Draw	Dots
0.10"	x			63333	31666	63333	23750	11176
0.10"		x	x	47500	31666	47500	23750	11176
0.25"	x	x	x	23750	21111	31666	16521	9500
0.50"	x	x	x	15833	14615	21111	12666	8260
1.00"	x	x	x	10000	8260	12666	8085	6551
10.00"	x	x	x	1319	1283	1417	1305	1283

Type 1 Vectors: 2D with no depth cueing and no perspective.
Type 2 Vectors: 3D with either depth cueing or perspective, but not both.
Type 3 Vectors: 3D with both depth cueing and perspective.

RASTER MONITOR

Size and Weight

Height: 20.7" (52.6 cm)
Width: 20.7" (52.6 cm)
Depth: 23.5" (59.7 cm)
Weight: 99 lbs (45 kg)

Power

100 to 120V or 220 to 240V ±10%, tap selectable, 50 or 60 Hz

Power Consumption

Less than 200VA (130W) maximum

Heat Dissipation

444 BTUs/hr

Operating Environment

Temperature: 23° to 104° F (-5° to 40°C) with cover
32° to 113° F (0° to 45°C) without cover
Relative Humidity: 20% to 80%

Non-Operating Environment

Temperature: -22° to 140° F (-30° to 60°C)
Humidity: 0% to 90%, noncondensing.

Scanning Frequency

Vertical frequency: 40 - 70 Hz
Horizontal frequency: 15.5 - 23.5 KHz

CRT

20" (19"V) self-convergence type dot-phosphor shadow mask tube and in-line electron gun. Phosphors are red, green and blue. Maximum effective screen size is 350(W) x 265(H) mm.

Input Signal

Termination: 75 ohm or high impedance are selected by the termination switch.

Connectors: BNC connectors for all inputs

R.G.B. Video: 0.5 to 2.0 Vp-p, positive white

Sync or HD: 1.0 to 5.0 Vp-p, signal of negative going sync

VD: 1.0 to 5.0 Vp-p, signal of negative going sync

Composite sync is superimposed on the green video signal.

Separate sync can be applied at the sync input for those cases where the video signal is without sync.

Loop through output connectors are provided for all inputs.

Timing requirements: refer to Figures A-2 and A-3.

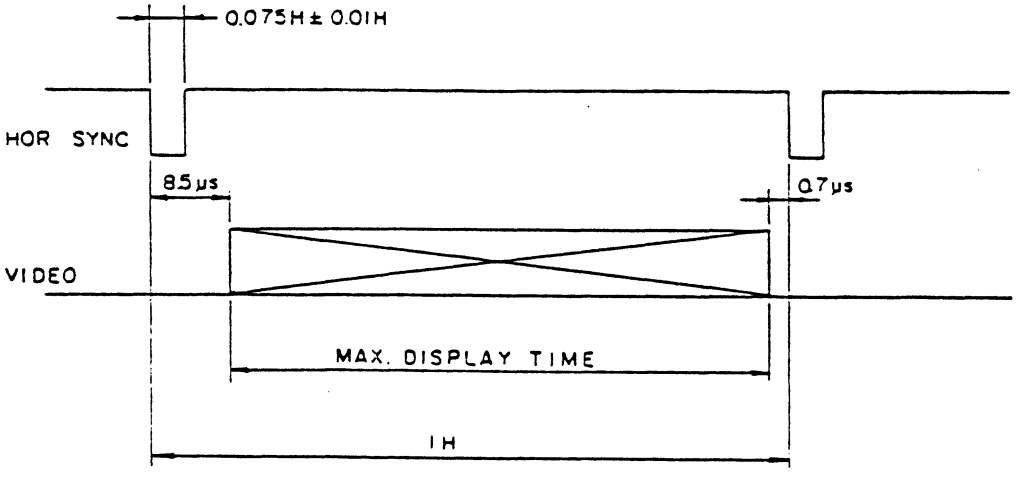


Figure A-2. Horizontal Timing

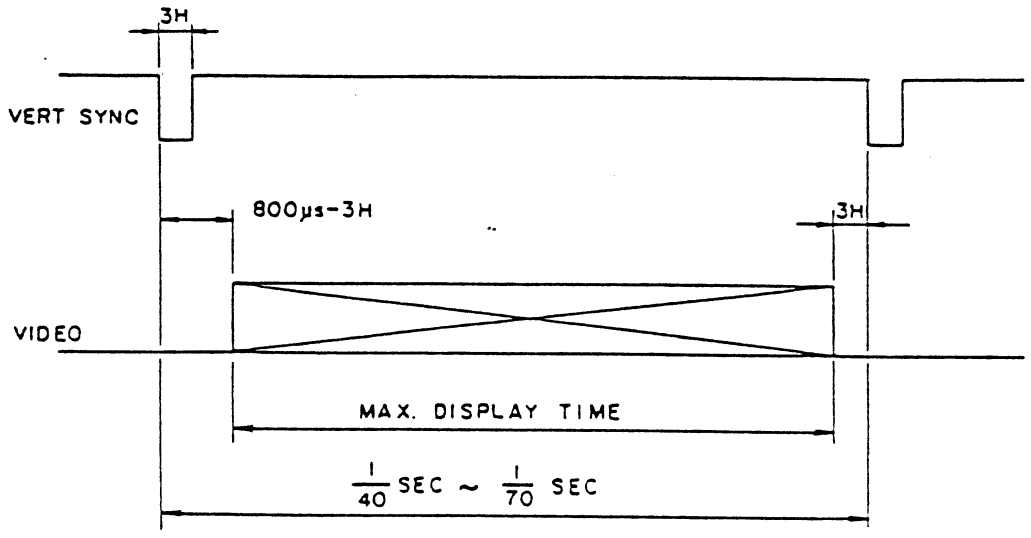


Figure A-3. Vertical Timing

The composite sync signal conforms generally with EIA-STD-RS170 and RS343.

Horizontal blanking time is less than 9.0 microseconds. Vertical blanking time is less than 800 microseconds.

Video Amplifier

The video amplifier is a linear amplifier which drives the cathode of the CRT. Video signals shall be compatible with the timing requirements of EIA-STD-RS170 and RS343. The peak-to-peak inputs signal amplitude will be between 0.5V and 2.0V.

The composite video signal shall be composed of approximately 70% video and approximately 30% sync amplitude.

a. Frequency Response: ±3 dB or less between 50 Hz to 25 Hz

b. Pulse Response: <20 ns

c. Differential Gain: <5%

d. Black Level Stability: Is maintained within 1% at any average picture level of 10% to 90%.

Convergence

< 0.75 mm in a centrally located area bounded by a circle w/diameter = picture height. Elsewhere the deviation <1.25 mm.

Raster Size Regulation

< 2mm with change of CRT beam current 0 to 200 microamperes.

Linearity and Geometry

Linearity measured and calculated by the following formula <7%:

$$\frac{MAX - MIN}{MEAN} \times 1/2 \times 100\ (\%)$$

Raster distortion < 2% of raster height.

SECTION 4. INTERACTIVE DEVICES

Each display station can support up to:

1 Keyboard
1 or more sets of Control Dials
1 or more Function Buttons Units
1 Data Tablet (6x6 or 12x12) with 4-button cursor or 1 Mouse
1 Light Pen (PS 350 only)

DATA TABLET (#204221-100) 6" x 6" (#204221-101) 12" x 12"

Size and Weight

	6" x 6"	12" x 12"
Length	12.02"	17.98"
Width	9.00"	15.57"
Front Thickness	.36"	.36"
Rear Thickness	.79"	.79"
Weight	1.7lbs.	4.4 lbs.

Power

12 Volts DC ± 1 volt	225 ma	275 ma

Operating Environment

Temperature: 20° to 104° F (10° to 40°C)
Humidity: 10% to 90% noncondensing
Altitude: 8000 ft. for 4 hours minimum

Non-Operating Environment

Temperature: -40° to 70°C
Humidity: 5% to 95% noncondensing
Altitude: 30,000 ft for one hour minimum

Communication

11-bit, asynchronous, serial format

Baud Rate

9600 baud standard, 1200 baud (selectable)

Interface

RS-232-C Standard, TTL (Selectable)

Cable

6 feet long, DTE/DCE - male/female with 9-pin D connector

Operational Modes

Diagnostic
Continuous
Point
Line
Suppressed
Remote
Binary
ASCII BCD

Word Structure

7/8 data bits, 1 start bit, 2 stop bits

KEYBOARD

Standard w/LEDs #204201-100, Standard w/o LEDs #204201-101
IBM w/LEDs #204201-102, IBM w/o LEDs #204201-103

Size and Weight

Length: 21.1 inches (53.6 cm)
Width: 8.25 inches (20.9 cm)
Height: 3.5 inches (8.9 cm)

Power

The +12V present on the modular jack is regulated to +5V dc by three LM340T 1-amp 5-volt regulators on the keyboard interface card.

Operating Environment

Temperature: 65° to 80°F (18° to 27°C)
Humidity: 20% to 80%

Baud Rate

2400 baud

Interface

On-card RS-449 differential line receiver and differential line driver.

Cable

An 8-conductor, flexible cable with locking modular plugs is used to connect the keyboard to the display console or to the control unit. The cable is similar in function and appearance to a standard telephone "flex" cord.

Operational Modes

Standard	IBM
Line	Self-Test Loopback
Label	ASCII
	IBM

LEDs

Optional 1 x 96-character array, in 12 8-character groups separated from each other by the space of one character. Each 4-character LED display is a separate 12-pin, clear plastic, encapsulated package. Provides low off-angle distortion to ± 50°.

CONTROL DIALS (#204211-100)

The control dials unit is a modular interactive device that is microprocessor controlled. Each dial is fully programmable.

Size and Weight

Height: 3.5" (8.9 cm)
Length: 12" (30.5 cm)
Width: 8.25" (20.9 cm)

Power

Regulated +5V DC

Operating Environment

Temperature: 65° to 80°F (18° to 27°C)
Humidity: 20% to 80%

Baud Rate

2400 baud

Interface

On-board, RS422 differential line receiver and a differential line driver.

Cable

Power, ground, and communication lines are routed through a modular phone cord from port B of the data concentrator to the control dials interface card.

Resolution

1024 counts per turn

Operational Modes

Local Loopback
Message
LED Segment Mode

LEDs

Optional separately programmable 8-character LED label for each dial. Displays static or dynamic information.

FUNCTION BUTTONS (#204230-100)

The function buttons unit provides 32 programmable functions.

Size and Weight

Height at front: 1.87"
Height at rear: 6.5"
Width: 6.5"
Depth: 7.75"

Power

+12V @ 2A

Operating Environment

Temperature: 65° to 80°F (18° to 27°C)
Humidity: 20% to 80%

Baud Rate

2400 baud

Interface

Communication between the function buttons unit and the data concentrator takes place through two pairs of differential duplex RS-449 lines that transmit and receive asynchronously through the cable connecting the two devices.

The function buttons microprocessor outputs a single TTL signal that is converted on the function button control card to an RS-449 signal pair. This signal pair is transmitted to the PS 300 data concentrator.

Cable

Power and communications are provided through a single modular phone cord that connects to the data concentrator.

Operational Modes

Test
Run

MOUSE (#801249-001 for 110V) (#801249-002 for 220V)

Power

110V AC

Operating Environment

Temperature: 65° to 80°F (18° to 27°C)
Humidity: 20% to 80%

Baud Rate

9600 baud

Interface

Cable terminates in an RS232 connector

Cable

6 feet long

Resolution

200 counts per inch

Port

The mouse can be plugged into any data concentrator port or into any unused port on the control unit, except port F. Port E is the default port

If a serial port is used, the configuration command should include NO_MASK and NO_HEAR.

Word Structure

The mouse sends a three-byte packed binary message that reports delta type movement. The first byte contains sign and button information.

Because it can send a three-byte message at 9600 baud, the mouse can generate as high as 320 messages per second, or 5.3 per possible update.

LIGHT PEN (#204225-200)

Size and Weight

Length: 6.5"
Diameter: 9/16"
Weight: 1.4 ounces
Aperture: 0.057 ± .003"

Power

+5V DC ±5% @ 50 milliamps maximum

Operating Environment

32° to 113° F (0° to 45°C)

Baud Rate

Not applicable

Interface

TTL compatible

Cable

9 foot long coiled cord or equivalent

Resolution

0.1 inch at maximum intensity setting (5 foot-lamberts for the standard Thomas tube #19M74P4M)

Spectral Response

4,200 to 11,000 angstroms

Luminous Sensitivity

2.0 foot-lamberts before raster of vectors spaced 0.020 inches apart.

Minimum Pickable Vector Length

0.050 inches at maximum intensity

Response Time

250 nanoseconds typical

Tip Switch Actuating Force

Four ounces typical

Tip Switch Travel

0.156 inches

SECTION 5. GENERAL PERFORMANCE SPECIFICATIONS

Character Display Processing Capability

- Standard 95 ASCII displayable character set.
- Fonts can have up to 128 characters.
- User definable fonts.
- Number of user-defined fonts is limited only by mass memory.
- Characters can be sized and oriented independent of modeling transforms.
- Characters are transformed by viewing transformations, allowing perspective and depth cueing to occur.
- Characters are clipped to window/viewport boundaries.
- Characters can be displayed in two dimensions by selecting the proper viewing transformations.

Each font consumes 1,282 bytes of memory plus 2 bytes for each stroke of each character. If there is an average of seven strokes per character then an average font requires 3,074 bytes of memory.

The PS 300 can display over 3,800 .10-inch high characters in 30 seconds.

Time Required for Data Structure Transversal

Instance of name1, name2...namen	6.24us + (n-1)*20.48us + 15.68us if n>1
IF	6.24us
SET BIT or SET LEVEL	5.60us
SET RATE	6.40us
VIEWport	16.64us
Viewport restoration	7.20us
4x4 Matrix (WINDOW, EYE, Field Of View)	16.80us
4x3 Matrix (LOOK AT, LOOK FROM)	33.60us
3x3 Matrix (Matrix_3x3, ROTate, SCALE)	20.80us
TRANslate by	18.88us
2x2 Matrix (CHARacter ROTate, CHARacter SCALE, CHARacter SIZE)	14.40us
SET DISPLAY, SET DEPTH, SET CONTrast	5.6 us
FONT - to load	49.92us
if already loaded	6.56us
character font restoration	43.52us

Mass Memory Requirements

General Overhead	71000 Bytes
Function Instance	128 Bytes
Function Input or Output Message (length depends on message)	16 to 300 Bytes
Structure Node (length depends on type of node)	64 to 128 Bytes

Font (n total strokes in font)	1282 + 2n Bytes
Block-normalized 2D Vector list	8 + 4n Bytes (n vectors, n# < 4095)
Block-normalized 3D Vector list (n vectors, n# < 4095)	8 + 6n Bytes
Vector-normalized 2D Vector list (n vectors, n# < 4095)	6 + 6n Bytes
Vector-normalized 3D Vector list (n vectors, n# < 4095)	6 + 8n Bytes

SECTION 6. INTERFACES

General Information

The standard data communication interface is asynchronous TTY RS-232-C and RS-449 at 300, 600, 1200, 1800, 2000, 2400, 4800, 7200, 9600, and 19200 baud.

The PS 300 system also supports parallel communication over the DEC UNIBUS® Parallel Interface, and synchronous serial communication over coaxial cable with the IBM 3278, IBM 3258, IBM 5088 Interface, or Ethernet® Interface.

The interface cable and connector enters the PS 300 through port 1 on the communication connector panel at the rear of the control unit. The port supports 25-pin RS-232-C connectors and 37-pin RS-449 connectors for asynchronous, serial communication. On PS 300.0 systems synchronous communication is supported on port 0. The following table provides port configurations and defaults.

Table A-7. Serial Communication Port Defaults

	PORT 0	PORT 1	PORT 2	PORT 3	PORT 4	PORT 5
Baud		9600	9600	9600	300	19,200
Bits Per Character		8	8	8	8	8
Stop Bits		1	1	1	1	1
Parity		None	None	None	None	None
Mode		Trans	Non-Trans	Non-Trans	Non-Trans	Non-Trans
Sends X_ON Characters		Yes	Yes	Yes	No	No
Receives X_ON Char.		No	Yes	Yes	Yes	No
Sends X_OFF Characters		Yes	Yes	Yes	No	No
Receives X_OFF Char.		No	Yes	Yes	Yes	No
Buffers		8 48-byte	8 48-byte	8 48-byte	8 48-byte	8 48-byte
STOP Buffer		Yes	1	0	0	0
GO Buffers		1	2	1	1	1
Debug Break		Disable	Disable	Enable	Disable	Disable

PS 300.1 and PS 300.2 do not support Port 0 or Port 2.

GENERAL PURPOSE INTERFACE OPTION (#204170-100)

The control section is based on an Am29116 microprocessor. It includes a 4K by 64 bit writable control store, a 2910 sequencer and a scratchpad memory.

GENERIC WIRE-WRAP INTERFACE (#204173-100)

Seventy percent of the card area is printed circuit and contains the standard GPIO hardware. The communications section is wire-wrapped.

To couple new devices with the GPIO bus, a standardized 72-pin connector has been created between the printed circuit and wirewrap areas on the card.

The connector carries the following signals:

SIGNAL NAME	PINS
The data bus internal to the GPIO (GPIOBUS[0..15])	16
The immediate field of the GPIO microword (IMMED[0..15])	16
Five available bus write signals Each one of these decoded lines can be used to write-enable a register on the GPIO bus. (*WREGDCD[3,4,5,12,15])	5
Ten available bus read signals (RREGDCD[11,12,24...31])	10
The encoded version of the GPIO bus read select field. (RDREG[0..4])	5
All four phases of the GPIO clock (9CK1D, *CK2D, CK90DEG, *CK90DEG) The first two are necessary to interface with GPIO bus.	4
Three condition code inputs to the 2910 sequencer (EXTCCIN[1..3])	3
Inputs to the dispatch register (DISPATCH[8.14])	7

SIGNAL NAME	PINS
A GPIO hardware reset signal (*RESETD)	1
A maintenance mode strobe (MAINTMODEC)	1
Four spare pins	4

UNIBUS PARALLEL INTERFACE (#204340-200)

Communication

Provides asynchronous communication with a UNIBUS interface card. It has 32 data lines--16 in and 16 out, 4 control lines out, and 8 control lines in. All lines use differential drivers/receivers and connect to the UNIBUS interface card via a parallel interface cable assembly. This provides a transmission capability for lengths of up to a thousand feet.

Transmission Rates

Allows data to be transferred at block-DMA burst speeds of over 500,000 bytes per second. Actual data rate will vary with block size, transfer frequency, length of interface cable, and interrupt service speed of the host.

Operation

The interface is provided by the E&S UNIBUS interface card (#195131-100), which plugs directly into the UNIBUS on the VAX host. This card uses four of the six available connectors in a standard UNIBUS SPC card slot.

In conjunction with the PS 300 run-time software and the E&S supplied host-resident drivers, the users' application will be able to take advantage of the DMA channel for high-speed transfer of commands and data to and from the PS 300.

It is intended only to provide data transfer between and host and the PS 300 run-time network. A serial line between the host and the PS 300 is still required to operate the PS 300 in terminal emulator (TE) mode.

Current Draw

3.5 amps at 5 volts

UNIBUS loading equals 1 UNIBUS load.

IBM 3250 INTERFACE (#204191-100)

Communication

Communication is serial, NRZI and SDLC encoded at a strap selectable bit rate of 1MHz for the 3258 or 2MHz for the 5088.

Provides a Western Digital WD1935 2MHz SDLC chip and clock extraction circuitry, a 2 MHz coaxial modem, and 32K bytes of high speed static RAM.

The 32K static RAM is organized in 8-bit bytes and has two purposes. In 3250 emulator mode, the RAM holds up to 32K of buffer program which the GPIO translates into PS 300 data structures. In PS 300 native mode, the RAM serves as a storage buffer for data sent to and from the host.

I/O Rates

18,000 bytes per second in local operation; 7,000 bytes per second in remote installations (typical rates). Actual rates depend upon the host application.

Operating Environment

This interface supports one connection to either an IBM 3258 controller or an IBM 5088 controller.

IBM 3278 INTERFACE (#204171-100)

Communication

Communication is serial, Manchester-encoded, and transformer-coupled to the coaxial cable. This interface uses only two of the four available coaxial I/O ports. It supports two connections, each one plug-compatible with an IBM 3278 terminal.

Central to the hardware interface are the DP8340 transmitter and two DP8341 receivers. These are basically parallel-to-serial and serial-to-parallel converters, respectively.

I/O Rates

Up to 18,000 bytes per second in local operation; up to 7,000 bytes per second in remote installations (typical rates). Actual rates depend upon the host application.

Operating Environments

The PS 300 can be supported either through a channel-attached IBM 3274 Control Unit or a remotely-attached IBM 3274 Control Unit with this interface. In either case, the PS 300 is supported as a 3278 Category A terminal only.

One of the following site configurations must be met:

Either the OS-VS1® or OS-VS2 (MVS)® operating system supporting the PS 300/3278 interface through a channel-attached IBM 3274 control unit. This requires ACF/VTAM® in the IBM host and a locally attached IBM 3274 with configuration support C, such as 1A, 1D, 31A, or 31D.

Either the OS-VS1 or OS-VS2 (MVS) operating system supporting the PS 300/3278 interface through a remote-attached IBM 3274 control unit. This requires ACF/VTAM in the IBM host and a remote-attached IBM 3274 with configuration support C, such as 1C, 31C, or 51C.

VM-CMS® operating system supporting the PS 300/3278 interface through a channel-attached IBM 3274 control unit. This requires MV-SP® running with CMS on the IBM host and an IBM 3274 model 1D or 31D, with configuration support C, in the non-SNA environment.

VM-CMS operating system supporting the PS 300/3278 interface through a remote-attached IBM 3274 control unit. This requires VM/SP® running with CMS on the IBM host and a 3274 model 1C, 31C, or 51C with configuration support C, when configured in BSC mode.

ETHERNET INTERFACE (#204179-100)

Communication

Communication is provided via the Data Link Controller (DCL®) which is an SEEQ DQ8003 chip. It performs parallel-to-serial and serial-to-parallel conversions with the serial link going to the Manchester Code Converter (MCC®) which is an SEEQ DQ8003 chip connected to a 20 MHz oscillator.

I/O Rates

10 M bits/sec = 100 nanosec bit cell ±0.01%.

Operating Environment

The interface runs under the UNIX© operating system (Version BSD 4.2) using Transmission Control Protocol/Internet Protocol (TCP/IP) network protocol on a DEC© VAX©.

Receive FIFO

4K by 10 bits

E&S CUSTOMER SERVICE TELEPHONE INFORMATION LIST

Evans & Sutherland Customer Engineering provides a central service number staffed by CE representatives who are available to take requests from 9:00 a.m. Eastern Time to 5:00 p.m. Pacific Time (7:00 a.m. to 6:00 Mountain Time). All calls concerning customer service should be made to one of the following numbers during these hours. Before you call, please have available your customer site number and system tag number. These numbers are on the label attached to your PS 300 display or control unit.

Customers in the continental United States should call toll-free:

1 + 800 + 582-4375

Customers within Utah or outside the continental United States should call:

(801) 582-5847, Extension 4848

If problems arise during product installation or you have a question that has not been answered adequately by the customer engineer or the customer service center, contact the regional manager at one of the following Customer Engineering offices:

Eastern Regional Manager
(for Eastern and Central Time Zones)
(518) 885-4639

Western Regional Manager
(for Mountain and Pacific Time Zones)
(916) 448-0355

If the regional office is unable to resolve the problem, you may want to call the appropriate department manager at corporate headquarters:

National Field Operations
(for field service issues)
(801) 582-5847, ext 4843

Software Support
(for sofware issues)
(801) 582-5847, ext 4810

Technical Support
(for hardware issues)
(801) 582-5847, ext 4868

Director of Customer Engineering
(for any unresolved problem)
(801) 582-5847, ext 4840

READER COMMENT FORM **Publication Number** _____

Title _____

Your comments will help us provide you with more accurate, complete, and useful documentation. After making your comments in the space below, cut and fold this form as indicated, and tape to secure (please do not staple). This form may be mailed free within the United States. Thank you for your help.

How did you use this publication?

- ☐ General information
- ☐ Guide to operating instructions
- ☐ As a reference manual
- ☐ Other _____

Please rate the quality of this publication in each of the following areas.

	EXCELLENT	GOOD	FAIR	POOR
Technical Accuracy Is the manual technically accurate?	☐	☐	☐	☐
Completeness Does the manual contain enough information?	☐	☐	☐	☐
Readability Is the manual easy to read and understand?	☐	☐	☐	☐
Clarity Are the instructions easy to follow?	☐	☐	☐	☐
Organization Is it easy to find needed information?	☐	☐	☐	☐
Illustrations and Examples Are they clear and useful?	☐	☐	☐	☐
Physical Attractiveness What do you think of the overall appearance?	☐	☐	☐	☐

What errors did you find in the manual? (Please include page numbers)_____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____ **Street** _____

Title _____ **City** _____

Department _____ **State** _____

Company _____ **Zip Code** _____

All comments and suggestions become the property of Evans & Sutherland.

Fold

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 4632 SALT LAKE CITY, UTAH

POSTAGE WILL BE PAID BY ADDRESSEE

EVANS & SUTHERLAND
580 Arapeen Drive
Salt Lake City, Utah 84108

ATTN: IAS TECHNICAL PUBLICATIONS

Fold

Cut along dotted line

CUSTOMER GUIDE

TO THE PS 390 RENDERING

PERFORMANCE VERIFICATION TEST

EVANS & SUTHERLAND

April 1987
E&S #901194-086 P1

1. PS 390 PVT DESCRIPTION

The PS 390 Rendering Performance Verification Test (PVT) demonstrates that the system meets specifications that have been published in E&S marketing literature. The test should be run after running the standard PS 300 PVT to verify the performance of the PS 390 firmware. The specifications demonstrated by the PS 390 PVT are as follows.

1.1 Performance Specifications

- Polygon edges may be defined as either "hard" or "soft." To verify this, the user can select from three display objects and see hard and soft edges.
- Polygons may be either convex or concave. This capability is verified by a display structure that will contain both types of polygons.
- Polygons may be defined with inner contours. This is demonstrated by a display structure that can be displayed and visually verified.
- Polygons may be considered single or double sided. This is demonstrated by two display structures that can be displayed and visually verified.
- A sectioning plane may be positioned. This capability is demonstrated by providing a sectioning plane that can be manipulated by the user on the current display structure.
- Sectioned objects may be saved for further sectioning. This is demonstrated by allowing the user to section an object and then save that new sectioned object in memory for future recall.
- Hidden-line removal may be performed on surfaces or solids. This is demonstrated by allowing the user to remove the hidden lines from the current display structure.
- Hidden-line rendering generates a vector list that can be saved. To demonstrate the ability to save the hidden-line vector list for future display, there is a key that performs the save to mass memory. The user is then able to recall that structure and verify that the vector list is indeed the hidden line rendering of the structure.
- Shaded image rendering may be performed on surfaces and solids. To demonstrate this, the user can select an image and choose the type of shading to be performed.
- The color raster scope may be used to present a rendered raster image of a PS 390 wireframe display structure. This is demonstrated by allowing the user to render the current image by pressing a rendering function key.

- There are multiple programmable light sources which are demonstrated by allowing the user to enter a mode where two light sources can be adjusted in any direction relative to the image.
- Multiple display windows are demonstrated by selecting combinations from one to four windows on the raster screen for rendering operations.
- Polygons may have a transparent attribute.
- Colors may be specified at the vertices of a polygon to provide color interpolation across the polygon.
- Objects may be overlaid on the raster screen.

Any performance attributes or specifications not included are specifically excluded.

1.2 Requirements

The following is required before the PS 390 PVT can be successfully executed.

- The minimum PS 390 board set, with at least 1 megabyte of mass memory and one floppy diskette drive.
- A PS 390 keyboard and dials; all other peripherals are optional.
- The diskette containing the PS 390 Rendering PVT.

1.3 PS 390 PVT Screen

The screen is divided into four viewports (as shown in Figure 1). The function key labels area appears on the far left of the screen only on systems using a non-LED keyboard. The large square viewport is where renderings appear. The rectangular viewport on the upper right of the screen contains pickable menu items. These menu items correspond to ten different dial modes which are described later in this document. The small square viewport is the default dynamic image viewport. To toggle the dynamic image to the large viewport, use Function Key F12 and select "LARGE W." This will cause the renderings to be displayed in the small viewing area. The rectangular viewport at the bottom of the screen is the status information box. It contains current value settings for the dials in most of the dial modes.

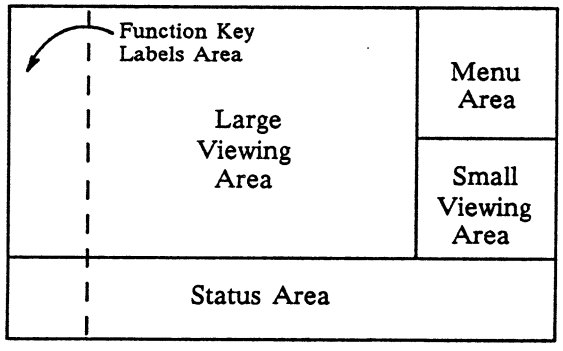


Figure 1. Screen Layout for the PS 390 PVT

The following is a list of the dial mode selections which are displayed in the menu area viewport:

Object Transformations
Sectioning Plane
Background/Ambient Light
Window/FOV
Sun Light
Moon Light
Poly 1 Att Front
Poly 1 Att Back
Poly 2 Att Front
Poly 2 Att Back

The following is a layout of the information given in the status area of the screen. Default values are given:

Table 1. Status Information Viewport Layout

Background Light		**Sun/Moon Light**		**Poly 1 Att**		**Poly 2 Att**	
				Front:		**Back:**	
Hue	0.0000	Hue	0.0000	Hue	0.0000	Hue	0.0000
Saturation	0.0000	Saturation	0.0000	Saturation	1.0000	Saturation	1.0000
Intensity	0.0000	Intensity	1.0000	Intensity	1.0000	Intensity	1.0000
Exposure	1.0000	Ambient	1.0000	Diffusion	1.0000	Diffusion	1.0000
				Specular	4	Specular	4
				Opaque	1.0000	Opaque	1.0000

Ambient Light

Hue	0.0000
Saturation	1.0000
Intensity	0.2000

101001

1.3.1 Notes on Status Area Display

The Sun and Moon Light labels have a common status line on the screen as do the Poly 1 Attribute and Poly 2 Attribute labels. The label that is highlighted is the one that is active. To make a label active, pick the label in the status area. The label will highlight, indicating that the label is active.

1.4 Data Structures

The data elements manipulated by the PS 390 PVT include three objects. The first object is a multicolored sphere. The second object is a hexafolium which is generated by performing transformations on the base sphere object. The transformations pull points on the sphere toward the center of the object. The third object is a rectangle. Data elements also include labels for function keys and dials, and the text area on the screen. The following is a description of each data element.

- The first object is the SPHERE. This object is defined as the default object.
- The second object is a HEXAFOLIUM. It is the result of transformations on the first object.
- The third object is a CUBE. This object has a hole through it.
- The two text areas. One displays the current output values of the following parameters: saturation, intensity, diffusion, specularity, and opacity. The second text area displays the pickable menu items corresponding to different dial modes.

2. KEYBOARD AND FUNCTION KEYS

The function keys serve as control keys. If an unused function key or any other keyboard key is pressed (with the exception of the LOCAL key), no error message or action occurs. Other control keys are described later in this in section.

Key/Button	Label	Control
1	"RENDER" "ABORT"	This key toggles between render and render abort. During a rendition, the key toggles to allow render abort. The key is reset to render upon completion of rendering.
2	"ORIG/REN"	Toggles the displayed object between the original object and the rendered object.
3	"C SECT" "SECTION" "BACK REM" "HIDDEN L" "WASH" "FLAT" "PHONG" "GOURAUD" "R HIDDEN" "SAVE REN"	The render mode select key. This key cycles through the following render modes: cross section, section, backface removal, hidden-line removal, wash shading, flat shading, Phong shading, and Gouraud shading, raster hidden line, and save rendering.
4	"SURFACE" "SOLID"	Toggles between solid and surface rendering.

Key/Button	Label	Control
5	"BIG PIC" "1 OF 2" "2 OF 2" "1 OF 4" "2 OF 4" "3 OF 4" "4 OF 4"	The rendering viewport select key. This key cycles through the following viewport selections: big pic, 1-of-2, 2-of-2, 1-of-4, 2-of-4, 3-of-4, 4-of-4, where: "big pic" is a large viewport the center of the rendering viewport. This is the default viewport. "1-of-2" is a viewport encompassing the left-hand half of the raster screen. "2-of-2" is a viewport encompassing the right-hand half of the raster screen. "1-of-4" is a viewport in the upper left quadrant. "2-of-4" is a viewport in the upper right quadrant. "3-of-4" is a viewport in the lower left quadrant. "4-of-4" is a viewport in the lower right quadrant. **Note:** These viewports are applied to the Large Viewing Area only
6	"ORIGINAL" "SAVED"	Toggles the displayed object between the original object and the saved object. The default is the original object.
7	"CLEAR"	Clears the raster screen.
8	"EDGE OFF" "EDGE ON"	Toggles the "Enhanced Edges" feature on the PS 390 Off and On.
9	"SECT ON" "SECT OFF"	Toggles display of the sectioning plane on and off. The default is sectioning plane OFF.
10	"FOV" "WINDOW"	Toggles between window and FOV displays of the object. The default is window display.
11	"OBJ 1" "OBJ 2" "OBJ 3" "OBJ 4" "OBJ 5" "OBJ 6" "OBJ 7"	The object select key. This key cycles through the following object selections: sphere (OBJ 1), hexafolium (OBJ 2), cube (OBJ 3). Objects 4 through 7 are undefined, so the user may download his own objects into the data structure.

12	"SMALL W" "LARGE W"	The dynamic object toggle key. SMALL W displays the object in the small viewing area. LARGE W displays the dynamic object in the large viewing area. This key also toggles the static raster display between the two viewing areas.

3. CONTROL DIALS

Dial modes are selectable by holding down the shift key and pressing one of the function keys. Dial modes may also be picked from the menu. The status window displays dial values for the selected mode; however, the status window does not show current dial values for rotates, translations, scales, and clipping plane adjustments.

The following are the ten dial modes and a description of their functions:

Dial Mode	Function
1	*Object Transformations* – these include XYZ rotations of the object, scaling, XYZ translations of the object, and back clipping.
2	*Sectioning Plane Transformations* – these include XYZ rotations, scaling, and XYZ translations of the sectioning plane.
3	*Background Light/Ambient Light* – This includes adjustments of hue, saturation, and intensity of both background light and ambient light. It also includes adjustments for exposure to the background light, and depth queuing.
4	Window/FOV – Includes adjusting the field of view angle and position, and the window size and position.

Dial Mode	Function
5	*Sun Light* – When this dial mode is selected the sun is displayed on the screen. It is attached by a vector to the center of the displayed object. XYZ rotations can be made on the sun, as well as changes in hue, saturation and intensity. When this light source is positioned and adjusted, it remains a functioning light source while other dial modes are accessed.
6	*Moon Light* – When this dial mode is selected the crescent moon is displayed on the screen. It is attached by a vector to the center of the displayed object. XYZ rotations can be made on the moon, as well as changes in hue, saturation and intensity. When this light source is positioned and adjusted, it remains a functioning light source while other dial modes are accessed.

7 *Polygon 1 Front Attribute* – Polygon 1 is the first of two designated faces of the displayed object. The front attributes concern the front side of the designated plane. Changes may be made to hue, saturation, intensity, diffusion, specularity and opacity.

8 *Polygon 1 Back Attribute* – The back attributes of polygon concern the back of the designated plane. Changes may be made to hue, saturation, intensity, diffusion, specularity and opacity.

9 *Polygon 2 Front Attribute* – Polygon 2 is the second of two designated faces of the displayed object. The front attributes concern the front side of the designated plane. Changes may be made to hue, saturation, intensity, diffusion, specularity and opacity.

10 *Polygon 2 Back Attribute* – The back attributes of polygon concern the back of the designated plane. Changes may be made to hue, saturation, intensity, diffusion, specularity and opacity.

The following is a description of the dial functions and labels in each of the ten dial modes.

For Dial Mode 1:

Dial	Function	Label
1	X rotation	"ROTATE X"
2	Y rotation	"ROTATE Y"
3	Z rotation	"ROTATE Z"
4	Scale	"SCALE"
5	X translation	"X TRANS"
6	Y translation	"Y TRANS"
7	Z translation	"Z TRANS"
8	Back clipping plane adjust	"BACKCLIP"

For Dial Mode 2:

Dial	Function	Label
1	X rotation	"ROTATE X"
2	Y rotation	"ROTATE Y"
3	Z rotation	"ROTATE Z"
4	Scale	"SCALE"
5	X translation	"X TRANS"
6	Y translation	"Y TRANS"
7	Z translation	"Z TRANS"
8	Unused	" "

For Dial Mode 3:

Dial	Function	Label
1	Hue	"BACK HUE"
2	Saturation of color	"BACK SAT"
3	Intensity of color	"BACK INT"
4	Exposure	"EXPOSURE"
5	Hue	"AMB HUE"
6	Saturation of color	"AMB SAT"
7	Intensity of color	"AMB INT"
8	Depth queuing	"DEPTHCUE"

For Dial Mode 4:

Dial	Function	Label
1	Intensity	"INTENS"
2	FOV angle	"FOV ANGL"
3	Window size	"WIN SIZE"
4	Field of view front angle	"FOV FRNT"
5	Field of view back position	"FOV BACK"
6	Window front position	"WIN FRNT"
7	Window back position	"WIN BACK"
8	Unused	" "

For Dial Modes 5 and 6:

Dial	Function	Label
1	X rotation	"ROTATE X"
2	Y rotation	"ROTATE Y"
3	Z rotation	"ROTATE Z"
4	Scale	"SCALE"
5	Hue	"HUE"
6	Saturation of color	"SATURATN"
7	Intensity of color	"INTENS"
8	Ambient portion	"AMB PRNT"

For Dial Modes 7, 8, 9, and 10:

Dial	Function	Label
1	Hue	"HUE"
2	Saturation	"SATURATN"
3	Intensity	"INTENS"
4	Diffusion	"DIFFUSN"
5	Specularity	"SPECULAR"
6	Opaque	"OPAQUE"
7	Unused	" "
8	Unused	" "

4. OTHER CONTROL KEYS

There are other combinations of keys that serve as control keys in the PS 390 PVT. The settings of the key combinations CTRL/F1 through F6 are represented in the status area of the screen by 6 toggle bits. When these settings are toggled on and off, the toggle bit on the screen also changes.

The following is a list of these key combinations and their functions.

Key(s)	Function
CTRL/F1	This combination of keys controls turning the specular lights on and off. The default is on.
CTRL/F2	This combination of keys controls the overlay of rendered images on the raster screen. The default is no overlay.
CTRL/F3	This combination of keys controls whether colors are specified as surface or vertex attributes. The default is color specified as a surface attribute.
CTRL/F4	This combination controls whether polygons are displayed as transparent or opaque. The default is opaque.
CTRL/F5	This combination controls whether contrast is set to zero. The default has contrast set to zero.
CTRL/F6	This combination toggles color blending on and off. The default is color blending on. To see the results of the clipping planes on the screen, color blending must be turned off.
CTRL/F7	This combination is the system reset. Using these keys reset the dial modes to their original values.

5. PROCEDURE FOR RUNNING THE TEST

Use the following instructions to run the test.

1. Boot your system firmware.
2. Install the floppy diskette containing the PS 390 PVT in drive 0.
3. Enter the command mode on your keyboard by pressing CTRL/LINE LOCAL on the VT100-style keyboards or ALT/LOCAL on IBM-style keyboards. Press RETURN. At the @@ prompt, enter one of the following sets of commands, depending on whether your keyboard has LED labels:

Keyboards with LEDs:	Keyboards without LEDs:
SEND 'PVT' TO <1>READBINARY;	SEND 'SLABEL' TO <1>READASCII; SEND 'PVTN' TO <1>READBINARY;

   The test should take approximately four minutes to load.

4. You must now load your object. To load the object supplied with the system, enter the following command:

   SEND 'OBJ' TO <1>READBINARY;

   For more specific notes on loading your object, refer to the User Notes in the next section.

5. Put your keyboard in interactive mode (to enable the function keys) by pressing SHIFT/LINE LOCAL on VT100-style keyboards or LOCAL on IBM-style keyboards. The PVT will come up in non-menu mode, in dial mode 1, with the sphere displayed in the small viewport.
6. Use Fkey 11 to cycle the display through the three objects in the data structure.
7. Using any object, turn the dials (dial mode 1) to perform matrix transformations on the object. You can use CTRL/F7 to reset the transformation values to their initial values.
8. Press SHIFT/FKEY2 to select dial mode 2, or if you have a data tablet, you may select dial mode 2 by picking it from the menu. Use Fkey 9 to turn sectioning on. The sectioning plane will be displayed on the screen. Use the dials to perform matrix transformations on the sectioning plane. The sectioned image can be rendered.

Note: At any time while running the test, the dynamic image displayed on the screen may be rendered in the static viewport by pressing function key F1. The type of shading in which the image is rendered is controlled by function key F3 and this function key must be set to one of the shading choices for the image to be rendered. The choice between surface or solid rendering is controlled by function key F4. The choice of rendering viewport is controlled by function key F5.

9. To select dial mode 3, press SHIFT/FKEY3 or pick the menu item Background/Ambient light on a data tablet. You can now make adjustments to the background and/or ambient light.

10. To select dial mode 4, press SHIFT/FKEY4 or pick the menu item Window/FOV. You can make adjustments to the field of view angle and position, and to the window size and position. The choice of window or field of view display is controlled by function key F10.

11. Select dial mode 5 by pressing SHIFT/FKEY5 or by picking "Sun Light" from the menu on the screen. In this mode, you may make adjustments to a light source which is represented on the screen as an image of the sun. Adjustments to the light source are shown in the status area of the screen. When adjustments to the light source have been made, they remain functioning while other dial modes are selected.

12. Select dial mode 6 by pressing SHIFT/FKEY6 or by picking "Moon light" from the menu on the screen. In this mode, you may make adjustments to a second light source which is represented on the screen as an image of the moon. Adjustments to this light source are shown in the status area of the screen. When adjustments to the light source have been made, they remain functioning while other dial modes are selected.

13. Select dial mode 7 in the same manner as you selected other modes. In this mode, the front attributes (hue, saturation, intensity, diffusion, specularity and opacity) of a designated plane on an object can be altered, and the object can be rendered.

14. Select dial mode 8 and the back attributes (hue, saturation, intensity, diffusion, specularity and opacity) of the same plane as was altered in mode 7 can now be changed, and the object can be rendered.

15. Select dial mode 9. In this mode, changes to the same attributes as were modified in mode 7 (front attributes) can be made to a second designated plane of an object.

16. Select dial mode 10. In this mode, changes to the same attributes as were modified in mode 8 (back attributes) can be made to the second designated plane of an object.

17. Perform rendering operations in the different viewports which are controlled by function key F5.

6. USER NOTES

6.1 Saving a Rendering

To save a rendering for future use, do the following:

1. Perform the rendering
2. Select the render mode 'Save Rendering' by pressing F3.
3. Press F1 (render key) to save the object.
4. To recall the saved object, press F6.

6.2 User-Defined Objects

To use the PS 390 PVT with your own object(s), load the PS 390 PVT as described in the previous section with the following exception. Instead of loading the objects supplied by E&S, download your own objects to the PS 390 and create an instance of those objects with the following type of name sequence:

OBJ/1 := Instance of User Object 1
OBJ/2 := Instance of User Object 2
.
.
.
OBJ/7 := Instance of User Object 7

6.3 Working with CTRL/F5, CTRL/F6, and CTRL/F7 Function Keys

CTRL/F5 is a set contrast toggle. This control key sequence toggles the contrast node of the display tree to allow for depth cueing. Refer to the SET CONTRAST command, documented in the Command Summary, Volume 3A, of the PS 300 Document Set for more information on setting contrast.

CTRL/F5 is a set color blend toggle. This control key sequence toggles the set contrast color blend node of the display tree to allow depth cueing of color blended vectors as well as clipping. To see what parts of your object are being clipped, toggle F6 until the object appears white. Refer to the SET COLOR BLENDING command, documented in the Command Summary, Volume 3A, of the *PS 300 Document Set* for more information on setting color blending.

CTRL/F6 is a reset key. This control key sequence resets the objects to their original orientation and the viewing parameters set by the dial modes to their original default values. This key is useful when you unintentionally set the viewing parameters such that the rendering of the object produces a undesirable rendition and you are not sure what parameter is causing the problems. This key does not reset the function keys.

READER COMMENT FORM **Publication Number** _____

Title _____

Your comments will help us provide you with more accurate, complete, and useful documentation. After making your comments in the space below, cut and fold this form as indicated, and tape to secure (please do not staple). This form may be mailed free within the United States. Thank you for your help.

How did you use this publication?

- ☐ General information
- ☐ Guide to operating instructions
- ☐ As a reference manual
- ☐ Other _____

Please rate the quality of this publication in each of the following areas.

	EXCELLENT	GOOD	FAIR	POOR
Technical Accuracy Is the manual technically accurate?	☐	☐	☐	☐
Completeness Does the manual contain enough information?	☐	☐	☐	☐
Readability Is the manual easy to read and understand?	☐	☐	☐	☐
Clarity Are the instructions easy to follow?	☐	☐	☐	☐
Organization Is it easy to find needed information?	☐	☐	☐	☐
Illustrations and Examples Are they clear and useful?	☐	☐	☐	☐
Physical Attractiveness What do you think of the overall appearance?	☐	☐	☐	☐

What errors did you find in the manual? (Please include page numbers) _____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____ **Street** _____

Title _____ **City** _____

Department _____ **State** _____

Company _____ **Zip Code** _____

All comments and suggestions become the property of Evans & Sutherland.

Fold

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 4632 SALT LAKE CITY, UTAH

POSTAGE WILL BE PAID BY ADDRESSEE

EVANS & SUTHERLAND
580 Arapeen Drive
Salt Lake City, Utah 84108

ATTN: IAS TECHNICAL PUBLICATIONS

Fold

Cut along dotted line

This in the 390 DVT

CUSTOMER GUIDE

TO

PS 300 SYSTEM PERFORMANCE VERIFICATION TEST

EVANS & SUTHERLAND

June 1986
E&S #901194-081 A1

PREFACE

This manual provides E&S customers with descriptions and operating procedures for the PS 300 System Performance Verification Test (PS 300 PVT). The test is designed to allow customers to become familiar with the PS 300 by using the keyboard and interactive devices to demonstrate the functionality of the system.

The test program is distributed on a floppy diskette.

Chapter 1 contains the a description of the PS 300 System Performance Verification Test including test requirements and test configurations. This chapter also includes descriptions of the data structures and descriptions of the uses for function buttons and dials in the test.

Chapter 2 describes the procedure for running the test.

Chapter 3 contains an example of how the data structure can be modified.

Chapter 4 contains a list of the source files for the PVT. These files are found on your distribution tape. This information is provided for your reference.

CONTENTS

1. PVT DESCRIPTION

The PS 300 PVT demonstrates the functionality of the system and the interactive devices and verifies the performance of all vector-refreshed displays. It will also test the local hardcopy interface card. In general, if a performance feature of your PS 300 is not verified in the PS 300 PVT it is due to one of the following reasons:

- The feature cannot be verified without special tools or instruments.
- An objective yes/no criteria is not possible.
- The feature is too time consuming to measure.

Some scope specifications are excluded because:

- Objective verification requires instruments for some specifications.
- Many specifications require a special environment for verification.
- Tuning procedures on the color scope serve as verification procedures, if necessary.
- PS 300 memory usage and data structure traversal times are excluded because they are too time consuming to measure, and because traversal time measurements require special instruments.
- PS 300 throughput measurements are not included because they are host and interface dependent.
- PS 300 vector capacity (45000 3D vectors at 30 Hz refresh) is excluded because it requires special instruments and because a minimal test would occupy over half a diskette. A diskette that can be used to demonstrate 45000 vectors is available on request.

REQUIREMENTS

- PS 300 system with at least one megabyte of mass memory and a PS 300 keyboard.
- The diskette containing the PS 300 PVT.
- The PS 300 firmware appropriate for your system model and interface.
- The mouse firmware, if the mouse is one of the devices to be tested at your site. The mouse firmware must be loaded prior to running the PS 300 PVT.

DESCRIPTION

The PS 300 PVT demonstrates that your system meets specifications published in E&S marketing literature, including:

- High-speed processing of data primitives and matrix transformations, including
  - 3D translations
  - 3D rotations
  - 3D scaling
  - Six-plane clipping
- Depth cueing
- Picking
- Character and vector data primitives (polygons are covered in a separate PS 340 PVT)
- Polynomial and B-spline curve primitives
- Independent character scaling and orientation
- Perspective
- Viewports

The PS 300 PVT tests the following peripherals, if present at your site:

- Monochrome vector-refreshed displays
- Color vector-refreshed displays (120 hue and 15 saturation values)
- Keyboard, including function keys
- Local hardcopy
- Data tablet
- Control dials
- Function buttons
- Mouse

If you have a PS 350, the PS 300 PVT can be configured to demonstrate the following additional performance features:

- Light pen picking
- 127 texture values

Configuring the PVT

The initial screen display allows you to configure the PVT for your system. The configurations available are:

Function Key	Label	Description and Default
1	PS350	Configures for PS 350. Default is no PS350.
2	LIGHTPEN	Configures for light pen. Default is no light pen. NOTE: Valid only when PS350 is selected.
3	CSM	Sets CSM on. Default is CSM off.
4	MOUSE	Configures for mouse. Default is no mouse.
5	RESET	Resets selections to defaults.
6	LOAD	Loads PS 300 PVT using the selected options.

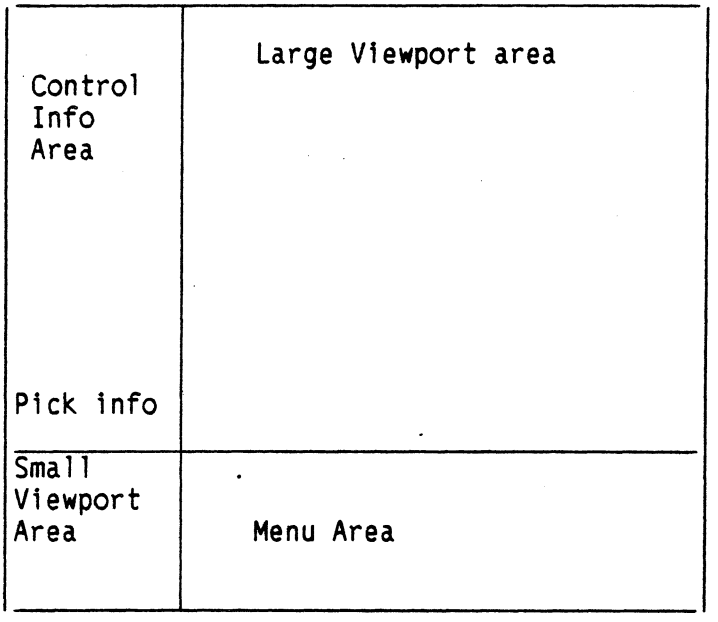
Note: you can configure the test for one method of picking at a time.

PVT Screen Layout

The screen display (Figure 1) is divided into four areas. The large, square interactive area in the upper right portion of your screen is a viewport where the rotate, scale, translate and back clipping plane controls are active. There is a small, square viewport in the lower left portion of the screen. Controls are provided to swap data structures displayed in these two viewports.

The rectangular area in the upper left contains the control values area and the picking information labels .

You can select items by either picking from the menu using the data tablet or by pressing the appropriate function key. The current state of the menu items is displayed in the menu area of the screen.



PS 300 PVT Screen Layout

Data Structures

The following basic data elements are manipulated by the PS 300 PVT. Each data structure is pickable. The description of the structures includes the color values that are provided for testing the optional vector-refreshed color display.

Bottlebrush

The "bottlebrush" is an ellipsoid data structure consisting of 15 substructures called platters. Each platter is a data structure consisting of a set color node applied to a scaled vector list. The initial hue for each platter is 0 (blue). A function network is connected to the hue input allowing the hue to vary from 0 to 360, step 3. Each platter has a unique saturation value following the sequence from 1 to 0, step .06666. The platters are circular arrays of radial lines spaced 3 degrees apart, which do not meet at the origin.

The structure can be scaled, rotated, or translated when in the large viewport. Pick information is displayed in the picking information area of the screen.

Cube

The cube is just that: a colored cube created by a single vector list. The hue of the cube is the same as the hue of the bottlebrush and can be altered in the same way . If you select the PS 350 option, the cube can be textured and the "around corners" option of texturing can be used.

This structure may be scaled, rotated, or translated when in the large viewport. Inside the cube, there are two semicircles; each semicircle is constructed as a polynomial curve.

Scaled Cube

A scaled instance of the cube is the "sprite". Initially the sprite is positioned at the center of the cube. When any edge of the cube is picked, the sprite is translated to the picked coordinates of the line.

Labels

The faces of the cube are labeled with world-oriented characters. The labels are front, back, left, right, bottom, top. Each label's orientation is such that the plane of the label is the same as the plane of the face of the cube.

The ends of the bottlebrush are labeled with "saturation=0" and "saturation= 1" on the appropriate end. These labels are screen oriented.

Text Areas

There are two text areas. One displays the labeled outputs of an instance of the PICKINFO function. The other displays the current output values of the following parameters: rotation angles, translate vector, scale factor, back-clipping plane position, and hue.

Keyboard and Function Buttons

The only keys on the keyboard that are used as controls during the test are the function keys. If an unused function key or any other keyboard key is pressed (with the exception of the LINE LOCAL on VT100-style keyboards and the LOCAL key on IBM-style keyboards), no error message or action occurs.

The function keys and buttons start and stop dynamic movement of the displayed objects. You may press a key or button to start a particular movement and then press it again to stop the movement. The keys and buttons are also used to switch between two options, such as orthographic and perspective viewing, and to enable depth clipping. They are also used to increment color values and change the control dial functions.

Key/Button	Control
1	XYZ rotation of the object in the large viewport. The rotation is clock driven and combined. The default is off. The label reads "ROT ON" when it is on and "ROT OFF" when it is off.
2	Z translation of the object in the large viewport. The translation is clock driven. **The translation factor goes from maximum to minimum and then resets to maximum and starts over. This is a world-space translation. The default is off. The label reads "TRAN ON" when it is on and "TRAN OFF" when it is off.
3	XYZ scaling of the object in the large viewport. The scaling is clock driven and combined. The scale factor oscillates between the minimum and maximum values. The default is off. The label will read "SCALE ON" when it is on and "SCALE OFF" when it is off.
4	Orthographic and perspective viewing of the object in the large viewport. The default is orthographic viewing. The label reads "ORTHO" when the viewing is orthographic and "PERSPEC" when when the viewing is perspective.
5	Enabling and disabling depth clipping of the object in the large viewport. The default is depth clipping enabled. The label reads "CLIP ON" when it is on and "CLIP OFF" when it is off.
6	Hue Control. Each time the function key or button is pressed the hue will increment by 3, modulo 360. The label reads "HUE nnn", where "nnn" is the current hue value. The default hue is 0, pure blue.
7	Swapping the cube and bottlebrush between the large and small viewports. Pressing the key or button swaps the objects between the two viewports. The default is the bottlebrush in the large viewport. The label reads "BRUSH/CUBE".
8	Switching the dials between two sets of dial functions. The label reads "DSET1" when dial set 1 is enabled and "DSET2" when dial set 2 is enabled. The default is dial set 1. (The next section provides a description of the two sets of dial functions.)

Key/Button	Control
9	Resetting the rotations, translations, and scale factor and controlling the clock driven networks. This key or button is a reset mechanism. If the clock driven networks are on, pressing this button or key turns them off. The label reads "RESET."
10	Texturing (PS 350 only). Each time the key or button is pressed, the texture value is incremented by 1, modulo 128. The label reads "TXTR nnn" where "nnn" is the current texture value. The default texture value is 127 (solid line).
11 & 12	The following four functions are only available when you have selected the PS 350 option from the configuration menu. If you have not selected the lightpen option from the configuration menu, function key F11 does not change (the tracking cross, the light pen and the screen blast functions are not enabled) and the label always reads "CORNERS". If you have selected the lightpen option, function key F11 cycles through the four functions. Function key F12 turns the selected function on and off. The LEDs and the menu display the state of the options. When the around corners function is the current selection, the label on F11 reads "CORNERS". If the "around corners" option is on, the F12 label reads "ON". If the function is off, the F12 label reads "OFF". The default value is off. If the lightpen option is enabled and is the current selection, the F11 label reads "LIGHTPEN". When the lightpen is on, the F12 label reads "ON". When the lightpen is off, the F12 label reads "OFF". The default value is on. If the light pen tracking cross is enabled and is the current selection, the F11 label reads "TRCKCROS". If the tracking cross is on, the F12 label reads "ON". If the tracking cross is off, the F12 label reads "OFF". The default is off. If the lightpen screen blast is enabled and is the current selection, the F11 label reads "SC BLAST". If screen blast is on the F12 label reads "ON". If the screen blast is off, the F12 label reads "OFF". The default value is off.

Control Dials

Because there are only eight dials, two sets of dial functions are available to support 16 dial functions. Function key or button 8 toggles between the two sets of functions.

In Dial Set 1, the functions performed by the control dials are:

Dial	Function and Label Heading
1	X rotation of the object. Label reads "X ROT."
2	Y rotation of the object. Label reads "Y ROT."
3	Z rotation of the object." Label reads "Z ROT."
4	Reset the rotations, translations, and scaling. 1/4 turn either direction will cause reset. Label reads "RESET." This reset is functionally equivalent to the function key reset.
5	X translation of the object. Label reads "X TRAN."
6	Y translation of the object. Label reads "Y TRAN."
7	Z translation of the object. Label reads "Z TRAN."
8	XYZ scaling of the object. Label reads "SCALE."

In Dial Set 2, the functions performed by the control dials are:

Dial	Function and Label Heading
1	X rotation of the object. Label reads "X ROT."
2	Y rotation of the object. Label reads "Y ROT."
3	Z rotation of the object. Label reads "Z ROT."
4	Reset the rotations, translations, and scaling. 1/4 turn either direction will cause reset. Label reads "RESET." This reset is functionally equivalent to the function key reset.
5	Back-clipping plane position. Label reads "BC POS."
6	Hue. Label reads "HUE."
7	When PS 350 enabled only: Controls texture value. Label reads "TEXTURE."
8	When PS 350 enabled only: Controls the "around corners" option. When the dial is turned the option is turned on and off. Label reads "CNRS ON" if on and "CNRS OFF" if off.

2. PROCEDURE FOR RUNNING THE TEST

When you run the PVT, you should use the reset button between demonstrations of the various features. The reset button resets the program to its initial values.

Use the following instructions to run the test.

1. Boot your system firmware.

2. Install the floppy diskette containing the PS 300 PVT in drive 0.

3. At the @@ prompt, enter the following command:

   SEND 'PVTCNFIG' TO <1>READASCII;

4. At the initial screen display, configure the test for your system. Select the appropriate options using the function keys. Load the configuration by pressing function key F6 (labeled LOAD).

5. When the configuration software has loaded and the screen layout shown in Figure 1 is displayed, use Dial Set 1, dials 1, 2, and 3, to perform matrix transformations on an object. Use function keys or buttons 1, 2, and 3 to control a clock driven network for the same transformations on the object. These functions demonstrate high-speed processing of data primitives and matrix transformations, including three-axis rotation, translation, and scaling. Use function key or button 9 to reset the transformation values or the clock driven network.

6. Use function key F5 or button 5 to enable depth clipping. Use dial 5 in Dial Set 2 to adjust the position of the back-clipping plane on an object. Both of these functions demonstrate clipping by manipulating a data structure in such a way that it is clipped.

7. Use the dials to manipulate the object in the large viewport to demonstrate depth cueing and intensity levels. The data structures used in the test have sufficient depth to demonstrate depth cueing.

8. Use the data tablet or mouse (or light pen on PS 350 systems) to pick the object in the large viewport. Pick information will be displayed on your screen.

9. Verify that character, vector, and curve data types are present and visible on the PS 300 PVT screen display. Refer to the section on the data structures for a description of what is present in each object. All three of these data types are used in the objects and in the screen text.

10. Verify that independent character scaling and orientation takes place when the labeled object is manipulated.

11. Use function key F4 or button 4 to demonstrate perspective and orthographic viewing. Either perspective or orthographic viewing can be applied to the object. The data structures are defined in such a way that it is apparent that the data structure is being viewed in perspective.

12. Verify multiple viewports by using function key F7 or button 7 to swap the objects between the large and the small viewports on the screen.

13. If you have a PS 330 or PS 340 system with the local hardcopy option, demonstrate the hardcopy option by pressing the hardcopy button on the keyboard to generate a plot of the present screen display. Do not use any of the interactive devices while the plot is generated.

14. If you have a color system, use function key F6 or button 6 to vary the hue. Each time you press the function key or button, the hue will increment by 3-modulo 360. The label reads "HUE nnn", where "nnn" is the current hue value. The default hue is 0, pure blue. 120 hues and 15 saturation levels are demonstrated by providing a data structure with 15 different saturation levels that allow variations of the hue.

15. If you have a PS 350 system, press function key F10 or button 10 to increment the texturing value. Each time you press the key or button, the texture value is incremented by 1, modulo 128. The label reads "TXTR nnn" where "nnn" is the current texture value. The default texture value is 127 (solid line).

16. Use dial 7 in Dial Set 2 to control texture value. Label reads "TEXTURE."

17. Use dial 8 in Dial Set 2 to control the "around corners" option. Turning the dial right or left switches the option on and off. Label reads "CNRS ON" if on and "CNRS OFF" if off.

18. Use function keys F11 and F12 to cycle through the PS 350 and light pen options. You must have configured PS 350 and light pen on the main menu to demonstrate these features. Use function key F11 to cycle between the four functions. Use function key F12 to turn the selected function on and off. The LEDs and the menu will display the state of the options. Lightpen must be ON to use both the tracking cross and the screen blast functions.

19. You may repeat any step or repeat the use of any device.

While you are using the various test controls, the following features of the PS 300 graphics system are demonstrated:

- There is no screen flicker with CSM on.
- All data structures exhibit good endpoint match.
- All dynamic controls operate smoothly. If you stop turning a dial, all visible effects of turning that dial stop. If you turn off a clock driven network, all visible effects of that network cease immediately.

3. MODIFYING THE DATA STRUCTURE

If you want to modify the data structure to display your own object, you can redefine the PVT's main or second object as your object. You will also have to load your object's vector list into the PS 300.

In the data structure the bottlebrush is defined as an object called "Main", so instead of the command:

Main := INSTANCE of Bottlebrush

you can redefine "main" in the following way

Main := INSTANCE of your_object

You may also redefine "second" (the name in the data structure for the cube) in the same way. You simply need to be sure that you use the same name for your vector list as you do in the new definition of main or second.

When choosing between redefining the main or the second object, remember that the main object will rotate in world space only, while the second object will rotate in object space only.

If after having redefined main or second you find that your object is too large to be displayed (you can see only a tiny part of it on the screen), you may scale it by entering the following into the data structure:

PREFIX Main WITH SCALE BY 0.01

where "0.01" is a scale value of your choosing.

If your object is too small to be displayed properly, you may scale it larger with the same command:

PREFIX Main WITH SCALE BY 10.00

again, where "10.00" is a value of your choice.

4. SOURCE FILES

The following is a list of the source files used in this test. For VAX users only the files are found in the directory: A2V01.PVT.300PVT.DIR.

The files are as follows:

CLOCK.MAC
CONFIG.DAT
FLIPFLOP.MAC
LTPEN.300
LTPEN.DAT.300
MENU.MAC
MOUSE.300
OBJECTROT.MAC
PROPSCALE.MAC
PS350.300
PS350.DAT.300
PVT.300
PVTCONFIG.300
PVT_CONFIG_DAT.300
PVT_CONFIG_INIT.300
PVT_DAT.300
RESET.300
ROTATE.MAC
TRANSLATE.MAC
WORLDROT.MAC

E&S CUSTOMER SERVICE TELEPHONE INFORMATION LIST

Evans & Sutherland Customer Engineering provides a central service number staffed by CE representatives who are available to take requests from 9:00 a.m. Eastern Time to 5:00 p.m. Pacific Time (7:00 a.m. to 6:00 p.m. Mountain Time). All calls concerning customer service should be made to one of the following numbers during these hours. Before you call, please have available your customer site number and system tag number. These numbers are on the label attached to your PS 300 display or control unit.

Customers in the continental United States should call toll-free:

1 + 800 + 582-4375

Customers within Utah or outside the continental United States should call:

(801) 582-5847, Extension 4848

If problems arise during product installation or you have a question that has not been answered adequately by the customer engineer or the customer service center, contact the regional manager at one of the following Customer Engineering offices:

Eastern Regional Manager
(for Eastern and Central Time Zones)
(518) 885-4639

Western Regional Manager
(for Mountain and Pacific Time Zones)
(916) 448-0355

If the regional office is unable to resolve the problem, you may want to call the appropriate department manager at corporate headquarters:

National Field Operations
(for field service issues)
(801) 582-5847, ext 4843

Software Support
(for sofware issues)
(801) 582-5847, ext 4810

Technical Support
(for hardware issues)
(801) 582-5847, ext 4868

Director of Customer Engineering
(for any unresolved problem)
(801) 582-5847, ext 4840