

# DIGITAL PowerStorm 4D40T/4D50T/ 4D51T/4D60T Graphics Options

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## Owner's Guide

Order Number: EK-CEYES-OG. B01

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**Important:** If this module is to be used in a Class B environment, a label must be applied to the module before it is installed in a FCC Class B system. Use Figure 1-1 in Chapter 1, and the accompanying description, when applying the label to the module.

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# Preface

## Guide Overview

The *DIGITAL PowerStorm 4D40T/4D50T/4D51T/4D60T Graphics Options Owner's Guide* provides general information on the PowerStorm (PBXGI and SN-PBXGI) graphics modules. This information is independent of hardware platform. For specific information regarding your hardware platform, refer to your system documentation.

## Audience

This guide is for individuals who install and use the PowerStorm 4D40T/4D50T/4D51T/4D60T graphics options.

## Organization

The *DIGITAL PowerStorm 4D40T/4D50T/4D51T/4D60T Graphics Options Owner's Guide* is organized as follows:

- **Chapter 1, Introduction**, provides a description of the PowerStorm 4D40T module (PBXGI-AA/SN-PBXGI-AA), the PowerStorm 4D50T module (PBXGI-AB/SN-PBXGI-AB), the PowerStorm 4D51T module (PBXGI-AD/SN-PBXGI-AD), and the PowerStorm 4D60T module (PBXGI-AC/ SN-PBXGI-AC).
- **Chapter 2, Module Installation**, provides module-specific information to use in conjunction with your system hardware installation guide.
- **Chapter 3, Technical Description**, describes the features that accelerate the rasterization of computer graphics and enhance visual impact.
- **Appendix A, Monitor Resolutions**, lists resolutions for software supported multi-synch monitors.
- **Appendix B, Specifications**, lists the physical and environmental specifications, video output characteristics, and stereo output characteristics.

- **Appendix C, For DIGITAL Service Use**, provides a list of Field Replaceable Units (FRUs).
- **Glossary** lists and defines words used in this document.

## Conventions

The following conventions are used in this guide:

<b>CAUTION</b>	Cautions provide information to prevent damage to equipment or software. Read these carefully.
<b>Important</b>	Important notations provide information to allow your system to work properly.
<b>Note</b>	A note calls the reader's attention to important information.
<b>WARNING</b>	A warning contains information essential to the safety of personnel.  To reduce the risk of electrical shock, do not attempt to open the equipment unless instructed. Do not use a tool for purposes other than instructed.

## Reader's Comments

DIGITAL welcomes your comments on this or any other manual. You can send your comments to the following address:

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Shared Engineering Services  
129 Parker Street  
PKO3-2/21J  
Maynard, MA 01754-2199

If you have suggestions for improving particular sections, or if you find any errors, please indicate the manual title, order number, chapter and section.

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## Introduction

### Description

The PowerStorm graphics accelerator modules are PCI local bus options that generate high-resolution, 3-dimensional (3D) color graphics. Application programs can utilize these graphics to render mechanical and electrical CAD, molecular modeling, scientific visualization, simulation, animation, and other graphical information.

The PowerStorm modules offer the following features and functions:

- OpenGL support
- Gouraud shading and antialiasing vector support
- 16 MB—32 MB of frame buffer memory
- Up to 128 video planes
- Support for multi-sync monitors
- Texture processing support with optional 4MB, 16MB, or 32MB of texture memory for the PowerStorm 4D40T/4D50T/4D60T graphics options and a standard 4MB or optional 16MB texture memory for the PowerStorm 4D51T graphics option.
- Packaging in a dual-PCI module set for the PowerStorm 4D40T/4D50T /4D60T graphics options and a single-PCI module for the PowerStorm 4D51T graphics option

## Using A Module In A FCC Class B Environment

If a PowerStorm 4D40T/4D50T/4D60T module is to be used in a FCC Class B environment, a label must be added to the module before it is installed in the FCC Class B system. Use Figure 1-1 when you apply the label 1 to the module. The PowerStorm 4D51T option module already has a FCC Class B label attached.

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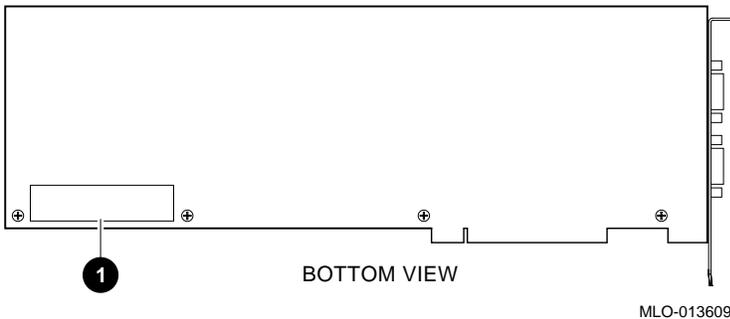
### Note

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Systems configured at the factory with a PowerStorm 4D40T/4D50T/4D60T module, are shipped with the label attached to the module. However, when a module is shipped as an option, the label must be attached by the customer. (The label is in an envelope packaged with the module).

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Figure 1-1 FCC Label for Class B Environment



## Version Information

Table 1–1 provides information about this version of the PowerStorm 4D40T/4D50T/4D51T/4D60T graphics options.

**Table 1–1 Module Versions**

Model Number	DIGITAL Order Number	Frame Buffer
4D60T	PBXGI-AC/SN-PBXGI-AC	2.0 Mpixels
4D51T	PBXGI-AD/SN-PBXGI-AD	1.3 Mpixels
4D50T	PBXGI-AB/SN-PBXGI-AB	1.3 Mpixels
4D40T	PBXGI-AA/SN-PBXGI-AA	1.3 Mpixels

## Contents of Your Order

Your order includes the following items:

- PowerStorm option module, order number PBXGI-xx or SN-PBXGI-xx
- *DIGITAL PowerStorm 4D40T/4D50T/4D51T/4D60T Graphics Options Owner's Guide*
- *Graphics Support Services Software for Microsoft Windows NT Installation and User Guide for Alpha Systems*
- *Graphics Support Services Software for Microsoft Windows NT Installation and User Guide for Intel Systems*
- Antistatic wriststrap

## Software

Table 1–2 lists the minimum software version levels that are compatible with the PowerStorm 4D40T/4D50T/4D51T/4D60T graphics modules.

**Table 1–2 Software Version Levels Compatible with PowerStorm Modules**

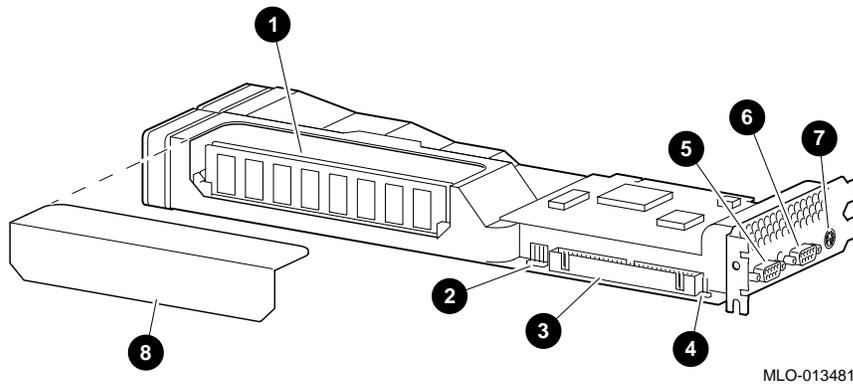
<b>DIGITAL Order Number</b>	<b>DIGITAL Open3D</b>	<b>DIGITAL UNIX</b>	<b>Microsoft Windows NT</b>	<b>Graphics Support Services Software</b>
PBXGI-AC/ SN-PBXGI-AC	Version 4.0a	Version 4.0a	Version 3.51	Version 3.5
PBXGI-AD/ SN-PBXGI-AD	Version 4.6	Version 4.0d	Version 4.0	Version 4.4
PBXGI-AB/ SN-PBXGI-AB	Version 4.0a	Version 4.0a	Version 3.51	Version 3.5
PBXGI-AA/ SN-PBXGI-AA	Version 4.0a	Version 4.0a	Version 3.51	Version 3.5

## Module Features

### PowerStorm 4D60T Modules

The PowerStorm 4D60T graphics module is shown in Figure 1–2. Table 1–3 describes the module features.

Figure 1–2 PowerStorm 4D60T Module



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Table 1–3 PowerStorm 4D60T Module Features

Reference Number	Description
1	Texture memory
2	Not currently used
3	Not currently used
4	VGA enable/disable jumper pins
5	VGA pass-through connector (black) for separate VGA module
6	Video cable connector (blue) to monitor
7	Stereo sync output connector
8	Texture memory access cover

## PowerStorm 4D40T and 4D50T Modules

The PowerStorm 4D40T and 4D50T graphics modules are similar in appearance. They are shown as one figure (Figure 1–3). Table 1–4 describes the module features.

Figure 1–3 PowerStorm 4D40T and 4D50T Modules

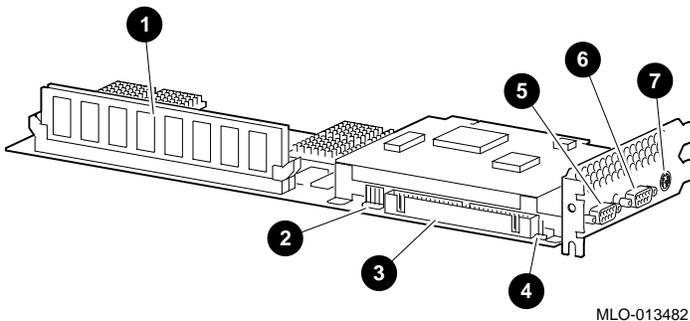


Table 1–4 PowerStorm 4D40T and 4D50T Module Features

Reference Number	Description
1	Texture memory
2	Not currently used
3	Not currently used
4	VGA enable/disable jumper pins
5	VGA pass-through connector (black) for separate VGA module
6	Video cable connector (blue) to monitor
7	Stereo sync output connector

## PowerStorm 4D51T Modules

The PowerStorm 4D51T graphics module is shown in Figure 1-4. Table 1-5 describes the module features.

Figure 1-4 PowerStorm 4D51T Module

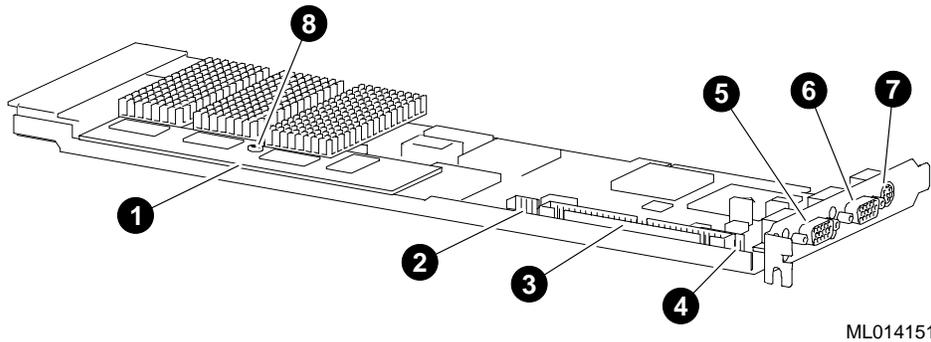


Table 1-5 PowerStorm 4D51T Module Features

Reference Number	Description
1	Texture memory
2	Not currently used
3	Not currently used
4	VGA enable/disable jumper pins
5	VGA pass-through connector (black) for separate VGA module
6	Video cable connector (blue) to monitor
7	Stereo sync output connector
8	Texture memory module retaining screw



# 2

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## Module Installation

### Procedure

The installation of a PowerStorm graphics module can be accomplished in a few easy-to-do steps. Each step presumes that you are familiar with your hardware platform. For specific information regarding your hardware platform, refer to your system documentation.

### Preparing for Installation

To install a module in your system, follow these steps:

1. Turn off the power to the system and any external devices. Disconnect any external devices and cables, and unplug the power cord from the wall outlet.
2. Remove the system unit cover, and unscrew and remove any metal filler plate that may be present for the PCI slots that you have selected. Remove adjacent filler plates for ease of installation. Save the screw(s) that secured the metal filler plate(s); you will need them later to secure the module to the enclosure.

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#### Caution

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To avoid damage to the module from static discharge, wear the antistatic wriststrap (part number 12-36175-01) when handling the module. Instructions for use are on the strap's envelope.

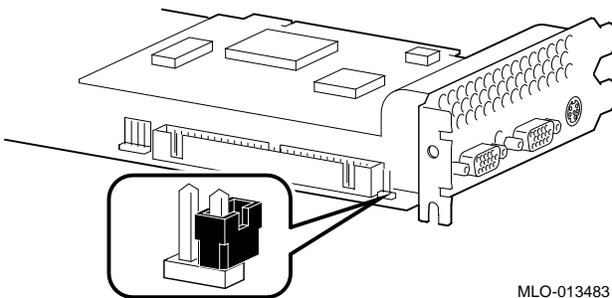
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3. Check to see that the VGA enable (make active)/disable jumper is in the correct position. See Figure 1–2, Figure 1–3, and Figure 1–4 for the location of the jumper on the module.

The modules are shipped from the factory with the VGA jumper enabled (no jumper in place). If you wish to add a jumper, you must locate a jumper (customer-supplied for the PowerStorm 4D40T/4D50T/4D60T; included with the PowerStorm 4D51T), and place it in one of the following positions:

- VGA disabled - jumper is on both jumper pins
- VGA enabled - jumper is in the park position (on one jumper pin as shown in Figure 2–1)

**Figure 2–1 VGA Enable/Disable Jumper Settings**



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**Note**

The PowerStorm 4D60T graphics module is shown in the above figure, however, the VGA enable/disable jumper is located in the same position on the PowerStorm 4D40T/4D50T/4D51T graphics modules.

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## Installing PowerStorm 4D40T/4D50T/4D60T Texture Memory

The PowerStorm 4D40T/4D50T/4D60T graphics options provide texture memory, with the addition of optional memory modules in the dual inline memory module (DIMM) sockets. Texture memory permits you to store several sets of MIP-mapped textures for subsequent texture mapping. Both DIMM sockets must be populated with the same density DIMM. A slide-out cover provides easy access to the texture memory sockets on the PowerStorm 4D60T module.

Figure 1–2 and Figure 1–3 show the location of texture memory. Figure 2–2 shows the texture memory sockets. You must remove the slide-out cover that is positioned over the memory in the PowerStorm 4D60T model. To install DIMM memory, follow these steps:

1. Attach the wriststrap if you have not already done so.
2. Remove the graphics module from the system.
3. Place the module on an antistatic surface.
4. Remove the DIMM slide-out cover (PowerStorm 4D60T model).
5. Remove the new DIMM from its antistatic protective bag.

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### Caution

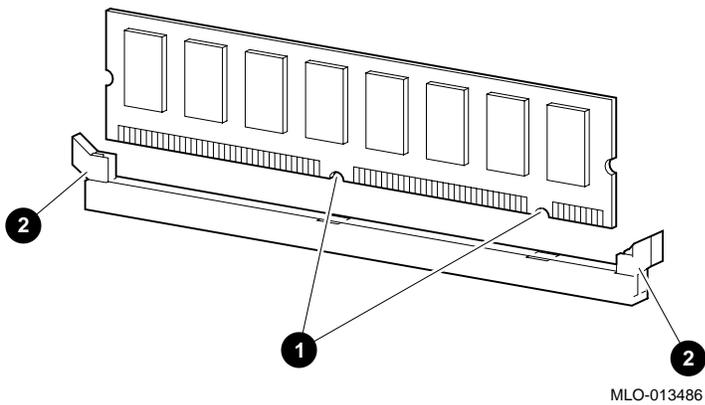
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Do not bend, twist or drop DIMMs as damage may occur.

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6. Align the DIMM keys 1 with the notches in one of the texture memory sockets. Insert the DIMM into the socket. See Figure 2-2.

**Figure 2-2 Installing PowerStorm 4D40T/4D50T/4D60T Texture Memory**



7. Push firmly down on the top corners of the DIMM until it is seated in the socket. The socket latches 2 fit into the side slots of the DIMM.
8. Repeat steps 5, 6 and 7 for the second DIMM.
9. Replace the DIMM cover (PowerStorm 4D60T only)
10. Insert the graphics module into the system.

## Upgrading the PowerStorm 4D51T Texture Memory

The PowerStorm 4D51T graphics option is shipped with 4 MB texture memory that permits you to store several sets of MIP-mapped textures for subsequent texture mapping. The PowerStorm 4D51T graphics option texture memory can be upgraded to 16 MB texture memory by removing the 4 MB texture memory module and replacing it with a 16 MB texture memory module.

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### Note

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The texture memory module for the PowerStorm 4D51T graphics option is not compatible with the texture memory DIMMs for the PowerStorm 4D40T/4D50T/4D60T graphics options.

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Figure 1–4 shows the location of texture memory on the PowerStorm 4D51T graphics option. Figure 2–3 shows the texture memory removal and replacement. To upgrade the PowerStorm texture memory, follow these steps:

1. Attach the wriststrap if you have not already done so.
2. Remove the graphics module from the system.
3. Place the module on an antistatic surface.
4. Remove the retaining screw 1 that secures the texture memory module to the PowerStorm 4D51T graphics accelerator module. See Figure 2–3.
5. Remove the 4 MB texture memory module 2 from its sockets 3 by lifting it straight up.

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### Caution

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Do not bend, twist or drop texture memory modules as damage may occur.

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### Note

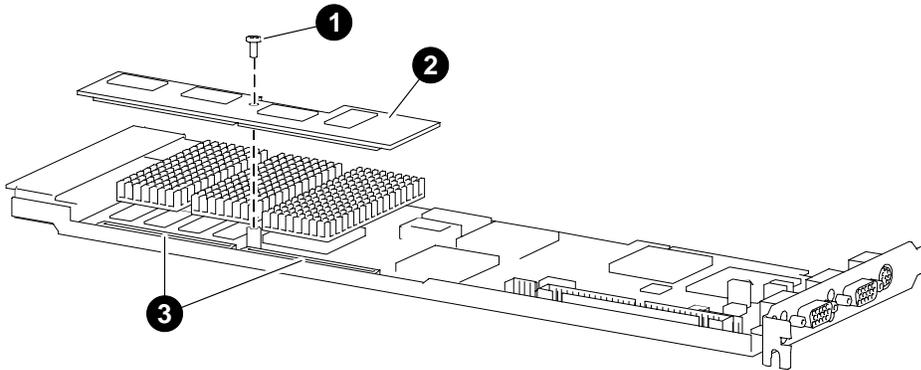
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A 16 MB texture memory module is identified by having memory devices mounted on both sides of the module while a 4 MB texture memory module has memory devices mounted on only one side of the module.

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6. Remove the 16 MB texture memory module from its antistatic protective bag.
7. Align the texture memory module with the texture memory sockets and the retaining screw hole. Insert the texture memory module into the sockets. See Figure 2-3.

**Figure 2-3 Upgrading the PowerStorm 4D51T Texture Memory**



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8. Push firmly down on the texture memory module until it is seated in the sockets.
9. Reinstall the retaining screw to secure the texture memory module to the PowerStorm 4D51T graphics accelerator module.
10. Insert the graphics module into the system.

## Completing the Installation

To complete the installation of the graphics module, follow these steps:

1. Insert the PowerStorm 4D40T/4D50T/4D60T graphics module into any PCI option slot pair (0.8 inch spacing). The PowerStorm 4D51T graphics module only requires a single PCI option slot. Refer to your system documentation for additional information.
2. Push the module firmly into the PCI socket(s).
3. Insert the screw(s) (removed from the filler plate(s) in an earlier step) and secure the module to the enclosure (see Figure 2–4).

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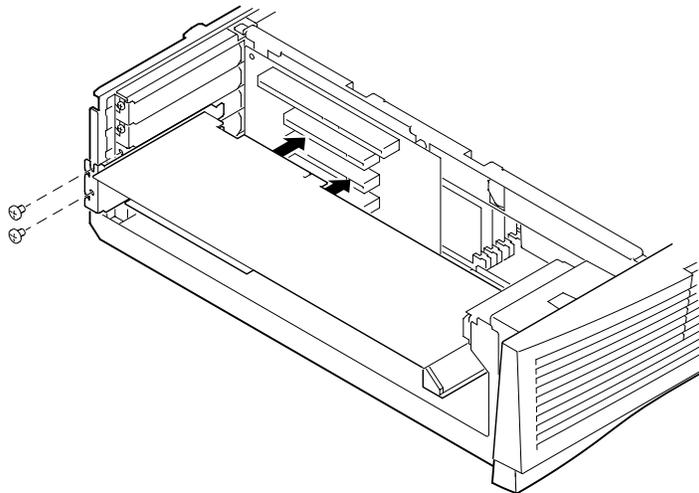
### Note

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The following figure shows a dual-slot PowerStorm 4D40T/4D50T /4D60T graphics option being installed. The PowerStorm 4D51T graphics option only requires a single PCI slot.

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**Figure 2–4** Completing the Installation



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4. Restart the system according to the instructions in your system documentation. If the texture memory is not sized correctly when you restart the system, then perform the following steps:
  - a. Ensure that the DIMM(s) or texture memory module are properly seated in their sockets
  - b. Ensure that both DIMMs are the same memory size (PowerStorm 4D40T/4D50T/4D60T only)
5. Replace and secure the cover to the system unit. Attach all external devices and cables that were previously removed.
6. Connect the video cable to the video cable port (blue bulkhead connector).
7. Connect your video monitor as described in your system documentation.
8. Plug the power cord into the wall outlet. Turn on the external devices and then turn on the system.

## Confirming Proper Installation

To confirm that the module is installed properly, perform the following steps:

1. Turn on the monitor and any other devices connected to the system unit.
2. Turn on the system unit.
3. Verify that the console display is available and legible on the monitor screen.

## Troubleshooting

If the console display does not appear on the monitor screen, perform the following steps:

1. Verify that the power cords for the system and video monitor, and all related devices, are plugged into a live wall outlet and that all devices are on.
2. Ensure that the video and any optional cable connections are secure.
3. Verify that the video cable is properly secured to the video cable port and video monitor.
4. Verify that the module is seated correctly in the PCI slot.
5. Verify that the monitor can handle the resolution and refresh rate. For Windows NT systems, refer to the *Graphics Support Services Software for Microsoft Windows NT Installation and User Guide for Alpha Systems* or the *Graphics Support Services Software for Microsoft Windows NT Installation and User Guide for Intel Systems* for information.
6. Verify that the video monitor brightness and contrast controls are properly set.
7. Verify that the VGA jumper is in the correct position, as shown in Figure 2-1.

If a problem persists, contact your DIGITAL service representative



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## Technical Description

### Rasterization Accelerator Features

The PowerStorm 4D40T/4D50T/4D51T/4D60T graphics accelerators are 32-bit PCI peripherals that include advanced features to accelerate the rasterization of computer graphics and enhance visual impact. An integrated rasterization accelerator is comprised of a Peripheral Component Interconnect (PCI) bus interface, a graphics engine, a texture processor and a frame buffer.

### PCI Bus Interface

The PCI bus interface features:

- **PCI-compatible bus interface**

The PCI direct memory access (PCIDMA) application-specific integrated circuit (ASIC) provides the PCI-compatible bus interface for the accelerators, including bus mastership capability.

- **High-speed direct memory access (DMA) engine**

The rasterization accelerator uses a high-speed DMA engine to accelerate PCI bus data transfers. The DMA engine transfers data in bursts without intervention from the host processor. These unattended transfers free the host processor from transferring massive amounts of graphics data over the PCI bus.

## Graphics Engine

The graphics engine is the core of the rasterization accelerator. It accelerates the translation of high-level graphics requests into pixel-oriented requests through derivative calculations and span iteration. It then coordinates the movement of pixels to the frame buffer.

The graphics engine uses four logic blocks (see Figure 3–2) to perform the pixel rasterization:

- **Request handler**

The request handler monitors the data output to the graphics FIFO. When data arrives, the request handler analyzes it and writes it to an appropriate processing block. The request handler routes vertex data for triangles and lines to the slope calculation block.

Drawing requests (other than vertex data for triangles and lines) such as blits, fills, and bit expands, bypass the slope calculation and span generation blocks. The request handler routes this data directly to the pixel interpolation block.

- **Slope calculation**

The slope calculation block performs the slope calculation part of the rasterization process for triangles and lines. Floating-point math ensures the accuracy of triangle edges.

The slope calculation block calculates color derivatives, depth derivatives, and edge slopes. It also adjusts the vertex data to a pixel center for the topmost vertex. The slope calculation block converts all data to a fixed-point format and routes it to the span generation block.

- **Span generation**

The span generation block performs the span calculation part of the rasterization process for triangles and lines. The span generation block determines the leftmost **x** and **y** coordinates for each scanline in a triangle. It also calculates the initial color and depth value for each scanline, and routes the data to the pixel interpolation block.

- **Pixel interpolation**

The pixel interpolation block is common for all graphics drawing requests. For triangle meshes, the pixel interpolation block expands the data from the span generation block to pixel data by successively adding the **x**-derivative value to the initial color and depth values (**z**) for each span.

The pixel interpolation block also sends the ( $x$ ,  $y$ ) address and pixel data to the frame buffer over the IZ bus. The IZ bus is a 64-bit bus with a pixel span protocol to facilitate high data throughput. This protocol allows burst transfers of pixel data to occur between the rasterization accelerator and the frame buffer.

The graphics engine supports the following features:

- **High-level vertex interface**

The rasterization accelerator allows the software to send vertex data for triangles and vectors in multiple formats. Supported formats include 8-bit packed integer, 16-bit packed integer, 32-bit integer, single-precision floating point, and double-precision floating point.

The host processor achieves higher performance because it does not convert data that is native to a particular application. To conserve bandwidth, the application optionally loads constant color and Z values to avoid sending them with each vertex.

- **Gouraud shading**

The graphics engine supports smooth shading of 3D triangle meshes with the Gouraud algorithm. High performance hardware accomplishes the shading of the entire triangle, including color and depth derivative calculations and pixel interpolation. The hardware also allows maximum update rates with minimum load on the host processor.

- **Symbolized vector**

The graphics engine supports the application of any user-supplied, two-color pattern onto vectors without performance degradation. Dotted or dashed lines are examples of symbolized vectors.

- **Antialiased vector**

Hardware support of antialiased vectors eliminates the jagged appearance of vectors on standard raster displays.

- **Sub-pixel accuracy**

The graphics engine uses sub-pixel accuracy for improving the quality of the graphics image. Sub-pixel accuracy ensures adjacent polygons and vectors join smoothly.

- **Window clipping**

While rendering triangles and vectors, the graphics engine discards pixels that would fall outside the region of the target window. Hardware clipping in this fashion alleviates the burden of checking objects in software before sending them to the graphics system.

## Texture Processor

The texture processor is contained in the graphics engine/texture processor ASIC. The texture processor receives instructions from the graphics engine by means of a high-speed bus and buffers the instructions in a FIFO to enhance performance. The texture processor reads the instructions from the FIFO, and then translates the instructions into reads and writes of texture memory. Its primary function is to retrieve a group of texels, interpolate among them, and generate a final color value. The final color value represents the textured color of a pixel. The texture processor places this value into its output FIFO. The graphics engine transfers the pixel's location and color value from the FIFO to the resolvers for placement into the frame buffer.

The texture processor supports the following features:

- **Advanced texture processor hardware**

The texture processor is integrated into the graphics engine/texture processor ASIC. It supports 32-bit textures, one byte for each of the color components: red, green, blue and alpha.

- **Texture memory (PowerStorm 4D40T/4D50T/4D60T)**

Texture memory ranges in size from 4 MB to 32 MB and provides a range of texture maps from 1 MTexels to 8 MTexels. See Table B-5 for additional information.

- **Texture memory (PowerStorm 4D51T)**

Texture memory ranges in size from 4 MB to 16 MB and provides a range of texture maps from 1 MTexels to 4 MTexels. See Table B-5 for additional information.

- **MIP-mapping support with trilinear interpolation**

The texture processor allows various sizes of texture maps to coexist in texture memory. Different MIP (multum in parvo—many things in a small place) maps allow the appropriate level of detail to be shown based on viewing distance. The texture processor chooses four (4) texels nearest the actual texel value from each of the nearest two (2) MIP maps (for a total of eight (8) texels). The texture processor blends the eight texels to produce the actual texel value by using trilinear interpolation.

## **Texturing**

Texturing is available on the PowerStorm 4D40T/4D50T/4D51T/4D60T graphics accelerators that have installed texture memory. Texturing is the process of applying a pattern, represented in memory as a two-dimensional array of image color values, to the surface of a 3D graphical object. For example, a wood grain pattern can be texture mapped to the surface of an object, such as a desk, to enhance the realism of the image or scene.

Another example of texture mapping is draping a land image from a satellite over a digital terrain model to create a 3D representation. The Texture Processor module of the graphics accelerators provides a dramatic performance increase for advanced texture processing when compared with software algorithms alone.

## **Frame Buffer**

The PowerStorm 4D40T/4D50T/4D51T/4D60T frame buffers are full-featured. Their deep pixel formats provide a flexible environment for applications with hardware acceleration. For example, double-buffered overlay planes provide the ability to annotate text and graphics over a 3D image in the image buffer. Both image buffers have access to one of four (4) video lookup tables (VLTs). The image VLT selection planes select the VLT to use. The mask planes allow for access control of the various drawing planes (for example, image or overlay). The image and overlay buffer selection control planes determine the buffer to display on a pixel-by-pixel basis. Other features include support of a wide variety of displays operating at high resolution.

The frame buffer supports the following features:

- **Video planes**

PowerStorm 4D40T/4D50T/4D51T/4D60T graphics options support two plane set configurations: 100 bits-per-pixel (bpp) and 128 bpp. The 128 bpp mode is supported at resolutions slightly less than the maximum. For example, the PowerStorm 4D50T/4D51T module supports 128 bpp up to a maximum resolution of 1 Mpixel (1152 x 864) and 100 bpp for resolutions up to 1280 x 1024.

Table 3–1 summarizes the video plane sets.

**Table 3–1 Video Plane Sets**

Video Plane Sets	100 Bits/Pixel	128 Bits/Pixel
Image (red, green, blue), front buffer	24	24
Image (red, green, blue), back buffer	24	24
Overlay, front buffer	4	8
Overlay, back buffer	4	8
Image, VLT selection, front buffer	4	4
Image, VLT selection, back buffer	4	4
Z buffer	24	32
Mask (pixel access control)	2	4
Image, buffer selection control	1	1
Overlay, buffer selection control	1	1
Alpha	0	8
Stencil	6	8
Fast Clear Front Buffer	1	1
Fast Clear Back Buffer	1	1

- **True-color image buffer**

The true-color image buffer is 24 bits and double-buffered. It contains the red, green and blue components of the image, with 8 bits per component to provide 16.7 million colors. There are two copies, or buffers, of image data: a front buffer and a back buffer. Two buffers enhance smooth animation, since applications may update the back buffer while displaying the front buffer.

- **High-resolution Z buffer**

The Z buffer holds up to 32 bits of depth information. Depth represents a distance from the observer’s eye to an object in a scene. A large Z buffer enables representation of a large number of unique depth values, which provides a more accurate rendering of scenes with large depth separation between objects.

- **Stencil buffer**  
The stencil buffer holds up to 8 bits of stencil information. It is a general-purpose resource for OpenGL applications. In a typical case, stenciling inhibits writes to portions of an application's window, but allows writes to other portions of an application window. The frame buffer accelerates building the values in the stencil buffer, and also accelerates the action of inhibiting or allowing writes on a per-pixel basis.
- **Alpha buffer**  
The alpha buffer holds up to 8-bits of alpha information. Alpha planes and alpha blending logic in the frame buffer assist the application in rendering scenes more realistically. Special effects that might result from alpha blending include transparency or tinting.
- **Multiple video lookup tables**  
The frame buffer includes up to four video lookup tables (VLTs). The VLTs provide multiple color palettes simultaneously for color remapping and advanced color refinement.
- **Window-mode double-buffering**  
Window-mode double-buffering allows multiple windows to display simultaneously from different buffers.
- **Gamma correction**  
10-bit gamma VLTs and 10-bit digital-to-analog converters (DACs) allow fine control of displayed colors without color degradation.
- **Hardware cursor**  
Hardware superimposes the cursor image over the video stream in real time, minimizing the cursor management tasks required by the host processor.
- **Stereoscopic viewing**  
The PowerStorm 4D40T/4D50T/4D51T/4D60T graphics accelerators may support the display of stereo images. Stereoscopic viewing requires a stereo-ready monitor and infrared shutter glasses with emitter module.

- **Multiple video resolutions**

The PowerStorm 4D40T/4D50T/4D51T/4D60T graphics accelerators include programmable pixel clock generation and video timing logic. This allows support of a wide variety of monitors with multiple video resolutions and refresh rates. Programmable video timing permits future monitor upgrades with only a software driver change. Supported resolutions range from 640 x 480 to 1920 x 1200. See Appendix A for a list of monitor resolutions supported on the DIGITAL UNIX and the Windows NT operating systems.

- **High-speed screen refresh**

High-speed screen refresh provides flicker-free displays up to 76 Hz for most screen resolutions.

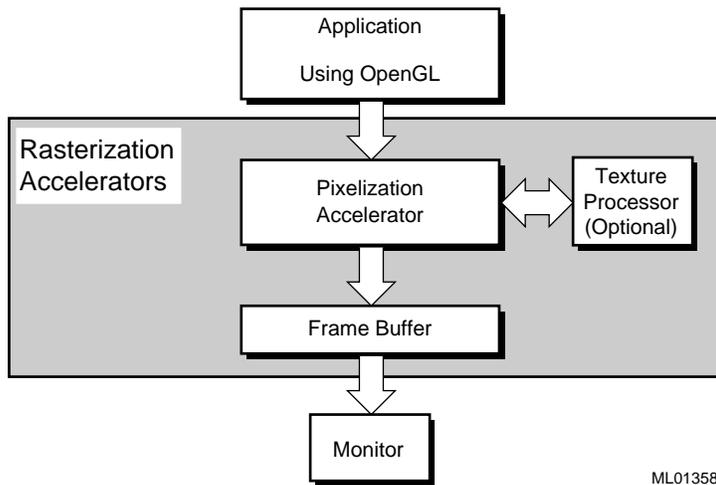
## **Rasterization Accelerator Functions**

The Graphics Device Interface (GDI) is the library of functions that the Windows NT operating system uses to create and manipulate 2D computer images. The PowerStorm 4D40T/4D50T/4D51T/4D60T rasterization hardware accelerates many GDI functions.

OpenGL is an industry standard library of functions used to create and manipulate 3D computer images. OpenGL functions, as a part of the Windows NT operating system and DIGITAL Open3D for DIGITAL UNIX, can be performed by the host processor. Hardware accelerators greatly improve OpenGL performance.

Figure 3-1 illustrates the rasterization accelerator, and the relationship between pixelization acceleration, texture processing, and the frame buffer. The accelerator processes OpenGL requests, thus freeing the host processor to perform application and database operations. This parallel processing results in unprecedented speed to generate and manipulate realistic images.

Figure 3-1 Rasterization Accelerator



- **Pixelization accelerator**

The pixelization accelerator consists of PCIDMA, graphics first-in, first-out (FIFO), and a graphics engine. The standard PCI bus provides high bandwidth support for the transfer of graphics data between the host processor and the rasterization accelerator.

The rasterization accelerator receives GDI or OpenGL element requests from the host processor through the PCIDMA and graphics FIFO. Element types include triangles, triangle meshes, lines, line strings and so on. The graphics engine ASIC converts the elements to pixels and routes them through the resolvers to video memory.

The rasterization accelerator also performs region fills, bit expands, and BIT BLock Transfer (BITBLT) operations. Optional processing of the pixels is performed by the texture processor prior to the graphics engine sending them to the resolvers.

- **Texture processor**

The texture processor is physically part of the graphics engine/texture processor ASIC. It supports 32-bit textures: 8-bits for each color component (red, green, blue and alpha).

The texture processor receives two types of setup parameters from the graphics engine: (1) for triangles, and (2) for pixel spans within a triangle. The triangle setup parameters consist of texturing control information and texture coordinate derivatives. The pixel span setup parameters consist of initial texture coordinates. These texturing setup parameters control the interpolation of the texture coordinate values. The texture processors correct for perspective during texture coordinate interpolation and thereby reduce image distortion.

The texture memory is capable of storing several sets of MIP-mapped textures for subsequent texture mapping. In MIP-mapping, multiple-sized versions of a texture are stored. Each version is filtered to account for distance from the viewer.

The texture processor chooses eight texels nearest the actual texel value from the nearest two MIP maps. The texture processor interpolates these eight texels to produce the actual texel value through the use of trilinear interpolation.

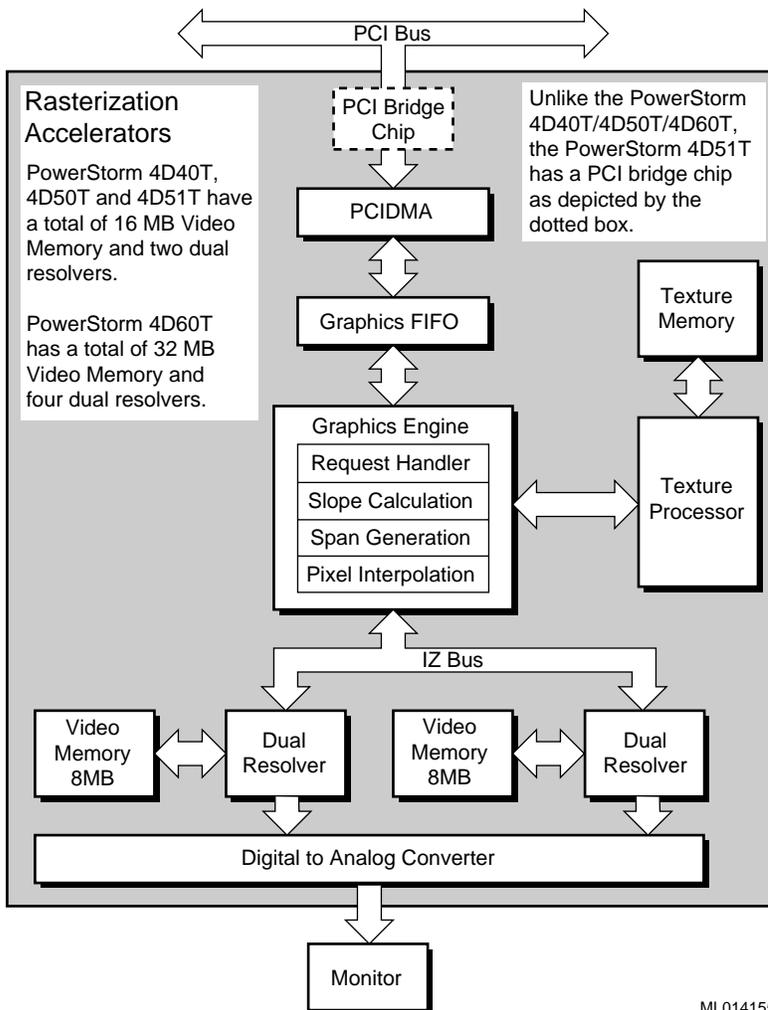
The actual texel value can either replace or blend with the Gouraud shaded pixel value generated by the graphics engine. Finally, the graphics engine routes the textured pixels from the texture processor to the resolvers, which write the textured pixels into video memory.

- **Frame buffer**

The frame buffer consists of the resolvers, video memory and a DAC. The resolvers retrieve digital pixel data from video memory, and send it to the DAC where it is converted to an analog voltage and presented to the monitor.

Figure 3-2 illustrates the rasterization process.

**Figure 3-2 Rasterization Process**



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# A

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## Monitor Resolutions

The PowerStorm 4D40T/4D50T/4D51T/4D60T graphics accelerators support standard multi-sync monitors. Refer to your monitor user documentation for monitor resolution information. Additionally, your software user guide and release notes contain helpful information.

## Monitor Resolutions for the DIGITAL UNIX Operating System

Table A-1 lists the software-supported monitor resolutions for the DIGITAL UNIX operating system.

**Table A-1 Monitor Resolutions for DIGITAL UNIX Systems**

Monitor Resolution	Vertical Refresh Rates FV (Hz)	4D40T	4D50T	4D51T	4D60T
640 x 480	60, 72, 75	Yes	Yes	Yes	Yes
720 x 400	70	Yes	Yes	Yes	Yes
800 x 600	60, 72, 75	Yes	Yes	Yes	Yes
1024 x 768	70, 75	Yes	Yes	Yes	Yes
1024 x 864	60	Yes	Yes	Yes	Yes
1152 x 900	76	Yes	Yes	Yes	Yes
1280 x 1024	60, 66, 72, 75	Yes	Yes	Yes	Yes
1600 x 1200	65, 75	No	No	No	Yes
1920 x 1080	60, 65, 75	No	No	No	Yes
1920 x 1200	60, 65	No	No	No	Yes

## Monitor Resolutions for the Windows NT Operating System

Table A-2 lists the software-supported monitor resolutions for the Windows NT operating system.

**Table A-2 Monitor Resolutions for Windows NT Systems**

Monitor Resolution	Vertical Refresh Rates FV (Hz)	4D40T	4D50T	4D51T	4D60T
640 x 480	60, 73, 75, 85	Yes	Yes	Yes	Yes
800 x 600	60, 72, 75, 85	Yes	Yes	Yes	Yes
1024 x 768	60, 70, 75, 85	Yes	Yes	Yes	Yes
1152 x 864	60, 70, 75, 85	Yes	Yes	Yes	Yes
1280 x 960	60, 75	Yes	Yes	Yes	Yes
1280 x 960	85	No	No	No	Yes
1280 x 1024	60, 75	Yes	Yes	Yes	Yes
1280 x 1024	85	No	No	No	Yes
1600 x 1200	60, 66, 75	No	No	No	Yes
1920 x 1080	60, 65, 75	No	No	No	Yes
1920 x 1200	60, 65	No	No	No	Yes



# B

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## Specifications

### Physical Specifications

The physical specifications of the modules are listed in Table B-1.

**Table B-1 Weight and Dimensions**

Module	Weight	Length	Width	Height
4D40T	415 gm (14.5 oz)	329 mm (13.42 in.)	98.5 mm (3.88 in.)	39.9 mm (1.57 in.)
4D50T	415 gm (14.5 oz)	329 mm (13.42 in.)	98.5 mm (3.88 in.)	39.9 mm (1.57 in.)
4D51T	385 gm (13.6 oz)	329 mm (13.42 in.)	98.5 mm (3.88 in.)	18.4 mm (0.725 in.)
4D60T	530 gm (18.5 oz)	329 mm (13.42 in.)	98.5 mm (3.88 in.)	39.9 mm (1.57 in.)

### Environmental Specifications

The environmental specifications for the PowerStorm 4D40T/4D50T/4D60T are listed in Table B-2.

**Table B-2 PowerStorm 4D40T/4D50T/4D60T Environmental Specifications**

Temperature range	10°C to 40°C (50°F to 104°F)
Temperature change rate	11°C/hr (20°F/hr) maximum
Relative humidity	5% to 95% noncondensing
Maximum wet bulb temperature	28°C (82°F)
Minimum dew point	2°C (36°F)
Maximum altitude	2400 m (8000 ft) at 36°C (96°F)

The environmental specifications for the PowerStorm 4D51T are listed in Table B-3.

**Table B-3 PowerStorm 4D51T Environmental Specifications**

Temperature range	10°C to 40°C (50°F to 104°F)
Temperature change rate	11°C/hr (20°F/hr) maximum
Relative humidity	20% to 80% noncondensing
Maximum wet bulb temperature	33°C (92°F)
Minimum dew point	2°C (36°F)
Maximum altitude	3000 m (10,000 ft) at 36°C (96°F)

## Power Consumption

Power consumption for the PowerStorm 4D40T/4D50T/4D51T/4D60T graphics options is shown in Table B-4. Note that 3V power is required in the PCI slot. Power figures relate to the entire assembly (without texture memory) which occupies two adjacent slots in the 4D40T/4D50T/4D60T modules. Texture memory values are listed separately in Table B-5, as the total additional power consumed by both DIMMs (*not* individual DIMMs) in the PowerStorm 4D40T/4D50T/4D60T modules.

**Table B-4 Power Consumption**

Option Number	Description	3.3V	5V	12V
PBXGI-AA/SN-PBXGI-AA	PowerStorm 4D40T	19.1 W	6.9 W	3.3 W
PBXGI-AB/SN-PBXGI-AB	PowerStorm 4D50T	23.3 W	6.9 W	3.3 W
PBXGI-AD/SN-PBXGI-AD	PowerStorm 4D51T w/4 MB texture memory	20.4 W	7.5 W	1.2 W
PBXGI-AC/SN-PBXGI-AC	PowerStorm 4D60T	34.9 W	6.9 W	3.3 W

**Table B–5 Texture Memory**

Option Number	Description	3.3V	5V	12V
PBXGI-GA/SN-PBXGI-GA (PowerStorm 4D40T/4D50T/4D60T)	4MB (1 MTexel)	2.2 W	N/A	N/A
PBXGI-GB/SN-PBXGI-GB (PowerStorm 4D40T/4D50T/4D60T)	16MB (4 MTexel)	2.6 W	N/A	N/A
PBXGI-GE/SN-PBXGI-GE (PowerStorm 4D51T)	16MB (4 MTexel)	2.6 W	NA	NA
PBXGI-GC/SN-PBXGI-GC (PowerStorm 4D40T/4D50T/4D60T)	32MB (8 MTexel)	4.0 W	N/A	N/A

## Cooling

The PowerStorm 4D60T module set includes components that require an active cooling solution. A duct cover is mounted on the board set and directs air over the components from two fans mounted at one end of the graphics module. Air from inside the assembly moves outside the system at the input/output (I/O) end of the graphics module set.

## Video Output/Input

Two output ports provide connection as follows:

- Blue connector is the video output to the monitor.
- Black connector is a pass through connector for VGA input from a separate VGA module.

## Video Output Port

Table B-6 provides the pin connections for the video output port.

**Table B-6 Video Output Pinout**

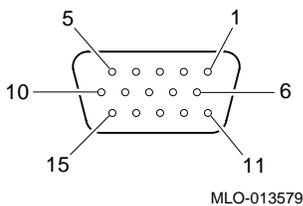
Signal Name	Pin	Signal Name	Pin
Red Analog Video	1	Supply +5V	9
Green Analog Video	2	Ground	10
Blue Analog Video	3	Monitor ID [0]	11
Monitor ID [2]	4	Monitor ID [1] <sup>1</sup>	12
Ground	5	Horizontal Sync	13
Ground	6	Vertical Sync	14
Ground	7	Monitor ID [3] <sup>2</sup>	15
Ground	8		

<sup>1</sup>Bi-directional Data (SDA) for DDC (PowerStorm 4D51T only)

<sup>2</sup>Data Clock (SCL) for DDC (PowerStorm 4D51T only)

The video output connector is a female, 15-pin, D-sub connector illustrated in Figure B-1.

**Figure B-1 Video Output Connector**



## VGA Input Port

The VGA input port allows connection of a separate VGA device for use by the system while in VGA mode.

Table B-7 provides the pin connections for the video (VGA) input port.

**Table B-7 Video (VGA) Input Pinout**

Signal Name	Pin	Signal Name	Pin
Red Analog Video	1	No Connection	9
Green Analog Video	2	Ground	10
Blue Analog Video	3	Monitor ID [0]	11
Monitor ID [2]	4	Monitor ID [1] <sup>1</sup>	12
Cable Sense	5	Horizontal Sync	13
Ground	6	Vertical Sync	14
Ground	7	Monitor ID [3] <sup>2</sup>	15
Ground	8		

<sup>1</sup>Bi-directional Data (SDA) for DDC (PowerStorm 4D51T only)

<sup>2</sup>Data Clock (SCL) for DDC (PowerStorm 4D51T only)

## Stereo Sync Output

The stereo sync output port provides connection to the LCD shutter glasses' emitter module.

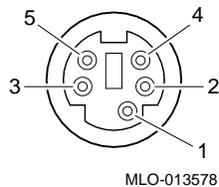
Table B-8 provides the pin connections for the stereo sync output port.

**Table B-8 Stereo Sync Output Pinout**

Signal Name	Pin	Signal	Pin
Ground	1	Stereo Sync	4
Ground	2	No Connect	5
+12V	3		

The stereo connector is a female, 5-pin, mini-DIN connector illustrated in Figure B-2.

**Figure B-2 Stereo Output Connector**



## Cable Options

Table B-9 lists the cables that you can use with the PowerStorm 4D40T/4D50T / 4D51T/4D60T graphics options.

**Table B-9 Cable Options**

Designation	DIGITAL Part Number	Length	Connector Type
BC13L-10	17-04340-01	3 meters (10 feet)	DSUB to 5-BNC
BC14J-10	17-04354-01	3 meters (10 feet)	DSUB to DSUB

# C

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## For DIGITAL Service Use

### FRU/Order Numbers

See Table C-1 to order field replaceable units (FRUs) for the customer.

**Table C-1 Module FRUs**

<b>FRU</b>	<b>Order Number</b>
PowerStorm 4D40T Module	30-46506-03
PowerStorm 4D50T Module	30-46506-01
PowerStorm 4D51T Module	30-46506-11
PowerStorm 4D60T Module	30-46506-02
4 MB Texture Memory (for PowerStorm 4D40T/4D50T/4D60T)	30-46506-04
4 MB Texture Memory (for PowerStorm 4D51T)	30-46506-12
16 MB Texture Memory (for PowerStorm 4D40T/4D50T/4D60T)	30-46506-05
16 MB Texture Memory (for PowerStorm 4D51T)	30-46506-13
32 MB Texture Memory (for PowerStorm 4D40T/4D50T/4D60T)	30-46506-06
Antistatic wriststrap	12-36175-01



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## Glossary

### **Alpha buffer**

The alpha buffer holds up to 8-bits of alpha information. Alpha planes and alpha blending logic in the frame buffer assist the application in rendering scenes realistically. Transparency and tinting are special effects that may result from alpha blending.

### **Digital-to-analog converter (DAC)**

The DAC converts pixel data into an analog voltage and sends it to the monitor for display. It also provides a 64 x 64 pixel hardware cursor.

### **Double buffering**

Double buffering in window-mode allows multiple windows to display simultaneously from different buffers.

### **Gamma correction**

Ten-bit gamma video lookup tables and 10-bit digital-to-analog converters (DACs) allow fine control of displayed colors without color degradation.

### **Hardware cursor**

Hardware superimposes the cursor image over the video stream in real-time, minimizing the cursor management tasks required by the host processor.

### **IZ bus**

The IZ bus is a 64-bit bus with a pixel span protocol to facilitate high data throughput.

### **PCIDMA**

The PCIDMA application-specific integrated circuit (ASIC) is a multichannel, direct memory access (DMA) engine capable of burst transfers.

### **Resolvers**

Resolvers perform the control function for reading and writing to video memory. The resolver examines pixel data from the input FIFO, and performs Z, mask, stencil, and alpha tests to determine if the data should be written to video memory.

The resolver performs Arithmetic and Logic Unit (ALU) operations between the source data (data from the graphics engine), and the destination data (data in video memory). The operations include logical operations and OpenGL-style, alpha-blend operations.

### **Screen refresh**

A high-speed screen refresh rate provides flicker-free displays for most screen resolutions.

### **Stencil buffer**

A general purpose resource for OpenGL applications that holds 8-bits of stencil information. Stenciling inhibits writes to portions of an applications window, but permits writes to other portions of the window. The frame buffer helps to build the values in the stencil buffer, and accelerates the action of inhibiting writes on a per-pixel basis.

### **Texture memory**

Texture memory stores several sets of MIP-mapped textures for subsequent texture mapping. Two DIMM sockets contain the texture memory modules. See Chapter 2 for additional information.

### **Texturing**

Texturing is the process of applying texture patterns such as wood grain, brick, or even a tree, and mapping it to the surface of a 3D graphics object to enhance the visual realism of the object.

### **True-color image buffer**

A double-buffered 24 bit buffer containing the red, green, and blue components of the image with 8 bits per component to provide 16.7 million colors.

### **Video lookup table**

The frame buffer includes up to four video lookup tables that provide multiple color palettes simultaneously for color remapping and advanced color refinement.

**Video memory**

The core of a frame buffer is video memory. Eight synchronous random access memory chips (SDRAMs) provide 16 MB of video memory for the PowerStorm 4D40T/4D50T/4D51T graphics modules. Sixteen SDRAMs provide 32 MB of video memory for the PowerStorm 4D60T module. Video memory stores each pixel with a maximum of 128 bits.

**Video resolutions**

The PowerStorm 4D40T, 4D50T, 4D51T, and 4D60T graphics modules include programmable pixel clock generation and video timing logic that supports monitors with multiple video resolutions and refresh rates. Supported resolutions are listed in Appendix A.

**Z-buffer**

The high resolution Z-buffer holds up to 32-bits of depth information. Depth represents a distance from the observer's eye to an object in a scene. The larger the Z-buffer, the larger the number of unique depth values which provide more accurate rendering of scenes with large depth separation between objects.



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