# GLZ1

## Hardware User's Guide

November 1995

INTERGRAPH
COMPUTER SYSTEMS

# *Getting Started*

The GLZ1 board is a 3D graphics accelerator for Intergraph's desktop and deskside graphics workstations.  It offers many features and functions including the following:

♦   Hardware support of Windows NT graphics (both GDI and OpenGL graphics operations)

♦   Gouraud shading support and antialiased vector support

♦   12 MB of frame buffer memory

♦   Industry-standard Peripheral Component Interconnect (PCI) bus interface with high speed Direct Memory Access (DMA) engine

♦   92 video planes

♦   Support of industry standard multi-sync monitors

Refer to Chapter 4, "Technical Description," for a full description of GLZ1 features and functions.

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**CAUTION**

Verify that your 3D graphics workstation is properly set up and ready for use. Follow the instructions to connect the VGA Loopback cable as printed in Chapter 2 or in the quick setup guide for your system. Do not connect the monitor cable to the VGA Out or VGA In ports. If you connect the monitor to the VGA Out port, the system will boot to a blue screen and stop. If you connect the monitor to the VGA In port, the video will not display.

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# *Starting Windows NT*

After setting up the equipment, you can power on the system and start the Windows NT operating system. To accommodate a specific monitor type, the system operates in non-VGA mode when the GL display driver is installed and running. You must select the non-VGA mode to configure the video display.

➤ To start Windows NT:

1.   Turn on the power to the monitor.

2.   Turn on the power to the workstation.

3.   At the initial OS Loader V3.51 boot screen, select the following option:

     ```
     Windows NT Workstation Version 3.51
     ```

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**Note:**   Do not select the `Windows NT Workstation Version 3.51 [VGA mode]` option.

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4.    When instructed, press CTRL+ALT+DEL.

5.    Log on to Windows NT.  Refer to the appropriate Windows NT user's guide for instructions, if necessary.

6.    Configure the video display as described in the following section.

# Configuring the Video Display

The Video Configuration application allows a user to select video attribute settings for the Intergraph GL display driver.  The user can modify desktop area (screen resolution), refresh frequency, gamma correction, dual screen orientation and display style.  Help screens are available to explain the attributes by using the Help command button.  In addition, context-sensitive help is available by pressing F1 and clicking on the option.

Video Configuration is available from the Control Panel and activates when installing the GL display driver.  When the GL display driver is running, Video Configuration determines the system configuration and the installed options.

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**Note:**   Any change made within Video Configuration, except for changes to gamma correction, requires a system reboot to become active.

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➤ To activate Video Configuration:

1.    Open Control Panel in the Main group of Program Manager.

2.    Open Video Config in the Control Panel window.  The Video
      Configuration dialog displays.

3.    Select the desired options.  Refer to the following table for
      information about each option.

Table 1-1.  GLZ1 Video Configuration Options

| Option | Description |
| --- | --- |
| Desktop Area | Allows you to select a screen resolution using the arrow buttons. |
| Color Palette | Allows you to select the maximum number of colors available on the palette. |
| Refresh Frequency | Allows you to change the refresh rate for standard multi-sync monitors at the selected resolution. |
| Monitor Type | This option not available with GLZ1. |

Table 1-1.  GLZ1 Video Configuration Options (Continued)

| Option | Description |
|---|---|
| Screen Display | Allows you to select dual screen mode and stereo mode.<br><br>Select Dual when a dual screen option is installed.<br><br>Select Stereo when using a monitor that supports a resolution with stereo support. |
| Orientation | Allows you to choose between two dual-monitor configurations:  monitors placed side-by-side (horizontal), or monitors stacked (vertical).  This option is active only when dual screen mode is active. |
| Style | Provides a choice of Primary Left/Top or Full Canvas.  Refer to "Dual-Screen Behavior" for more information about this option. |
| Graphics Info | Displays graphics information such as adapter type, driver information, and adapter information. |
| List All Modes | Displays a list of the valid resolutions and refresh frequencies. |
| Calibration | Displays the Color Calibration dialog for gamma correction used to refine the range of color intensity. |
| Preferences | Synchronizes buffer swapping to the monitor refresh rate. |

## *Dual-Screen Behavior*

Windows NT Workstation version 3.51 allows you to select one of two dual display behaviors.  You can display in Windows NT version 3.1 style or in the default 3.51 style, as described below:

♦ In version 3.1, the GL display driver treats the combined display area of the dual screens as a single canvas covering both screens. Windows and dialog boxes are centered and split between the two monitor screens. To use the version 3.1 behavior, select the Full Canvas option in the Style box in the Video Configuration dialog.

♦ In version 3.51, the GL display driver treats the left or top monitor as the primary canvas. When opened, application windows will maximize to the primary screen. To use the version 3.51 behavior, select the Primary Left/Top option in the Style box in the Video Configuration dialog.

**Note:** With some applications in version 3.51, if you extend the application window beyond one screen, unexpected results may occur. If so, reduce the size of the application window to less than a single-screen size, or try moving the application onto only the primary screen.

## *Gamma Correction*

The Color Calibration dialog allows you to select a gamma correction to refine the video red, green, and blue intensities.

➤ To select gamma correction:

1.  In the Video Configuration dialog, select Calibration. The Color Calibration dialog displays.

2.  Open the gamma correction option and choose the value or file, as applicable. Refer to the following table for information about each gamma correction option.

Table 1-2.  Gamma Correction Options

| Option | Description |
| --- | --- |
| Default Gamma Value | Activates the default gamma value of 1 immediately upon selection. |
| Gamma Value | Allows you to specify a gamma value which takes effect immediately upon selection. |
| Gamma File | Activates the Browse command button. Further |

| | explanation is available by selecting Help.  Click on the underlined text "Gamma Correction" and select the underlined text "gamma file." Browse allows you to scan a file entry dialog showing the files with a .GC (gamma correction) extension. Test allows you to verify the effect of the selected Gamma File.  The screen displays a color reference graphic for five seconds. |
| --- | --- |

3. If Gamma File is selected, click on Test.

4. Select OK to close the Color Calibration dialog.

Selecting OK returns you to the Video Configuration dialog with the modified gamma correction in effect. Selecting Cancel returns you to the Video Configuration dialog without updating the gamma correction.

### *Ending the Video Configuration Session*

Perform these steps after making changes in the Video Configuration dialog.

➤ To end the Video Configuration session:

1. Select OK on the Video Configuration dialog to apply the selected video attributes and return to Control Panel, or select Cancel to return to Control Panel without applying the video attributes.

2. If you have modified video attribute settings other than gamma correction, restart the workstation for the changes to take effect.

3. Change the default display driver as described next so that the GL display driver activates each time the workstation restarts.

## *Changing the Default Display Driver*

Once the Video Configuration settings are configured to your preferences, change the default display driver so that the GL display driver runs automatically.

➤ To change the default display driver:

1. Open Control Panel in the Main group of Program Manager.

2. Open System in the Control Panel window.  The System dialog displays.

3. Select Startup from the menu bar to display the operating system list. Select the Windows NT Workstation version 3.51 option.

**Note:** Do not select the `Windows NT Workstation Version 3.51 [VGA mode]` option.

4. Change the Show list for option to zero seconds.

5. Select OK; then, close Control Panel.  The workstation will now use the GL display driver by default each time the workstation is restarted.

# *Turning Off Full Drag*

When using 3D applications with the GL display driver, the screen may update slowly when dragging objects.  Use the following instructions to turn off the Full Drag option before using 3D applications.

➤ To turn off Full Drag:

1. Open Control Panel in the Main group of Program Manager.

2. Open Desktop in Control Panel.  The Desktop dialog displays.

3. Make sure the check box for Full Drag in the Applications option is not selected.

4.	Close Desktop; then, close Control Panel.

# Using Software Cursor with OpenGL Applications

Windows NT Workstation lets you use software cursors, such as decorated or animated cursors, in place of the standard cursor. If you use a software cursor while running an OpenGL application, the performance of that application will drop sharply whenever you position the software cursor in that application's window. For optimum performance of OpenGL applications, Intergraph recommends that you use only the standard cursor.

# Maintenance and Installation

This chapter describes opening Intergraph's desktop and deskside 3D graphics workstations to replace a GLZ1 board. It also describes installing a dual screen option in the desktop and deskside workstations.

## Static Precautions

Observe the following precautions when working with the internal components of the system.

♦ Avoid servicing the system in areas with electrostatic problems. Rugs and carpets, for example, cause static build-up.

♦ Handle all printed circuit boards as little as possible and by the edges only. Leave the boards in their protective packaging until you install them.

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**CAUTION**

Discharge personal static charge by touching a bare metal surface on the workstation before handling printed circuit boards.

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# *Opening the Desktop Workstation*

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**WARNING**

Before opening the workstation, turn off the system power.  Leave the
power cord connected to maintain ground.  Use caution when removing
the cover to avoid injury.

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➤ To open the desktop workstation:

1.    Pull out the spring-lock plunger on the back panel and turn it
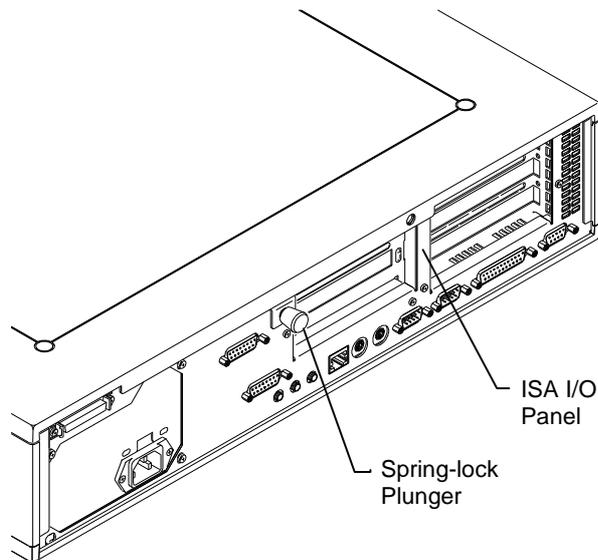      clockwise until it locks in the open position.

Figure 2-1.  Desktop Top Cover Removal

2.   Lift up the top cover above the ISA I/O panel and pull up and back to remove the top cover.

3.   Attach an antistatic wrist strap to a non-painted, metallic surface on the workstation or to the ground loop (formed in the metal) above the ISA I/O panel.  Ensure that the elastic loop in the strap snugly contacts your bare wrist.

# *Replacing GLZ1 Board in the Desktop*

This section describes replacing a graphics board in a desktop workstation.  For single monitor workstations, a GLZ1 board should reside in PCI slot 2.  Refer to Figure 2-2 for board and PCI slot locations.

➤ To replace a GLZ1 board in the desktop workstation:

1.   Disconnect the cables from the Video and VGA ports on the back panel of the base unit.

2.   Using a quarter-inch nutdriver, remove the screw from the currently installed GLZ1 board.  Retain the screw.

3.   Remove the GLZ1 board from the workstation.

4.   Align the card guides on the new GLZ1 board and install it into PCI slot 2.

5.   Install the screw previously removed to secure the GLZ1 board to the workstation.

# *Installing a Dual Screen Option in the Desktop*

For dual monitors, two GLZ1 boards should reside in PCI Slots 1 and 2.  The Intergraph GLZ1 dual screen option kit provides the following components to upgrade from a single screen to a dual screen configuration.  Verify that you have the following items.

♦ GLZ1 board
♦ Diskette containing the Intergraph GL display driver software
♦ *GLZ1 Hardware User's Guide*
♦ Clock sync cable
♦ FIFO status cable  (only used if Geometry Accelerator option board is present)
♦ Antistatic wrist strap

If an item is missing or damaged, notify Intergraph Customer Response Center at 1-800-633-7248 immediately.

➤ To install the second GLZ1 board for dual monitors:

1.    Using a quarter-inch nutdriver, remove the blanking plate from slot 1.
      Retain the screw.

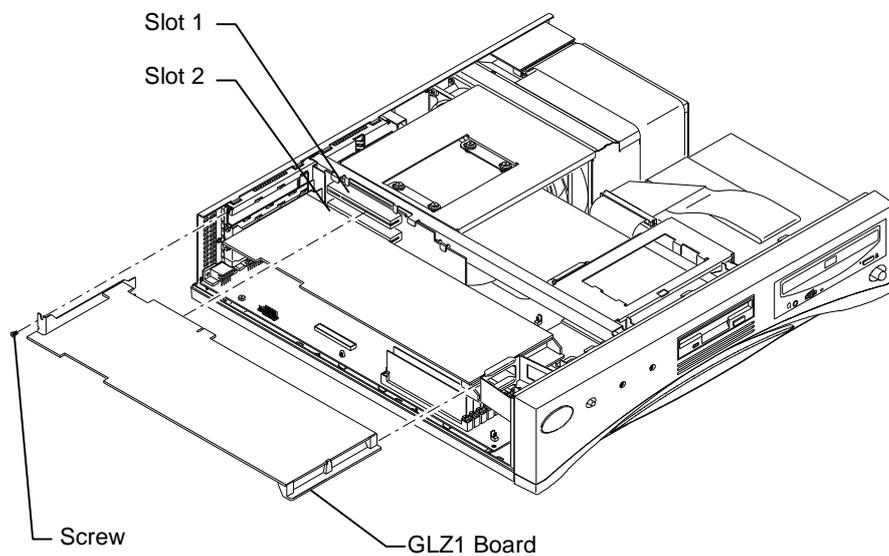2.    Install the second GLZ1 board into PCI slot 1.



Figure 2-2.  GLZ1 Board for Desktop, Dual Monitors

3.    Install the screws to secure the GLZ1 boards to the workstation.

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**CAUTION**

The clock sync cable installs only one way.  Do not force the keyed
connector.  Ensure pin 1 of both cable connectors engages pin 1 on both
board connectors.  The black wire connects to pin 1.

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4.      Install the clock sync cable between the two GLZ1 boards as shown in the following figure.



Clock Sync
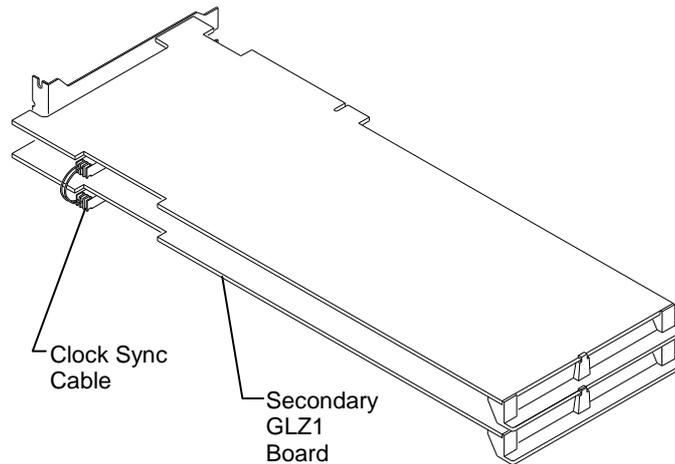Cable

Secondary
GLZ1
Board

Figure 2-3.  Clock Sync Cable Installation

# *Completing the Installation for the Desktop*

Follow these steps to reassemble the workstation and reconnect the monitor.

➤ To complete the installation:

1.      Replace the top cover on the workstation by aligning the tabs on the front of the top cover with the notches behind the faceplate.

2.      Lower the back of the top cover and slide it into place.

3.      Turn the spring-lock plunger to lock the top cover to the base unit.

4.   Connect the VGA Loopback cable and monitor cable for single
     monitor configurations as follows:

**VGA Loopback:**  Connect the VGA Loopback cable from the VGA Out port to the VGA In port as shown in Figure 2-4.

**Single monitor:**  Connect the monitor cable to the Video Out port in PCI slot 2.
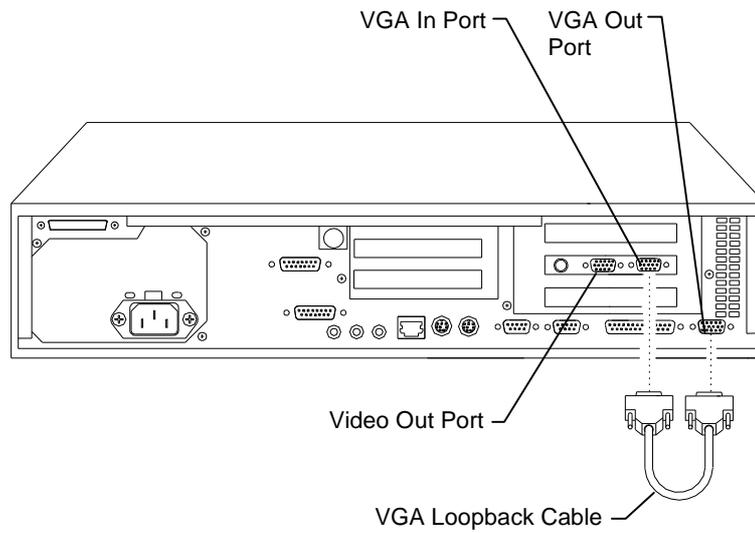


Figure 2-4.  Single Monitor Cable Connections

5.    Connect the VGA Loopback cable and monitor cables for dual monitor configurations as follows:

**VGA Loopback:**  Connect the VGA Loopback cable from the VGA Out port to the VGA In port as shown in Figure 2-5.

**Primary monitor:**  Connect the monitor cable to the Video Out port in PCI slot 1.

**Secondary monitor:**  Connect the monitor cable to the Video Out port in PCI slot 2.

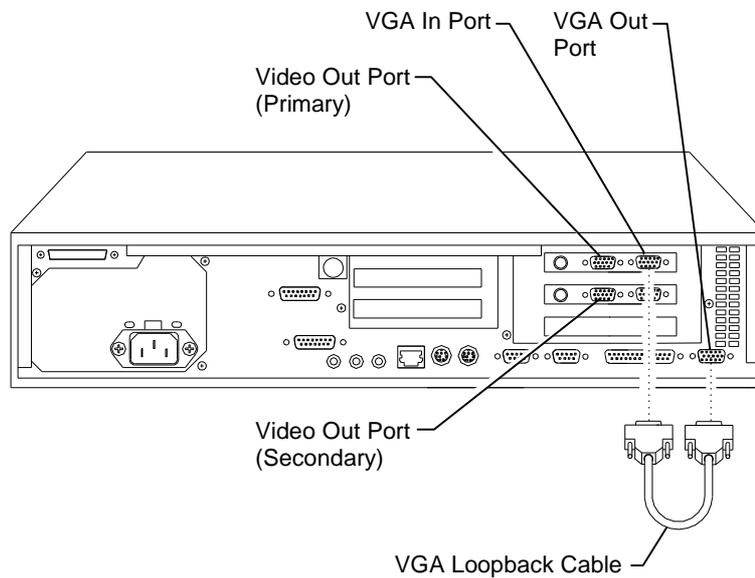Figure 2-5.  Dual Monitor Cable Connections

6.    If you need to configure the GL display driver, refer to "Configuring the Video Display" in Chapter 1.

# *Opening the Deskside Workstation*

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**WARNING**

Before opening the workstation, turn off the system power.  Leave the power cord connected to maintain ground.  Use caution when removing the cover to avoid injury.

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➤ To open the deskside workstation:

1. Using a quarter-inch nutdriver, remove the screw from the top cover. Retain the screw.
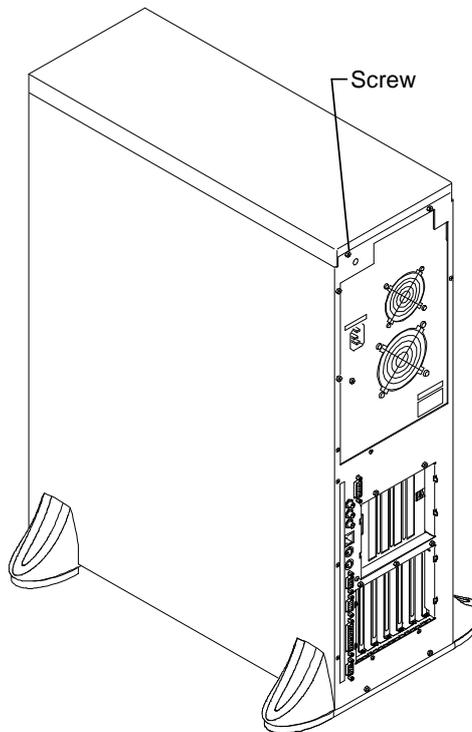
Figure 2-6.  Deskside Top Cover Removal

2.    Remove the top cover by sliding it toward the back of the workstation.

3.    Remove the footstands.

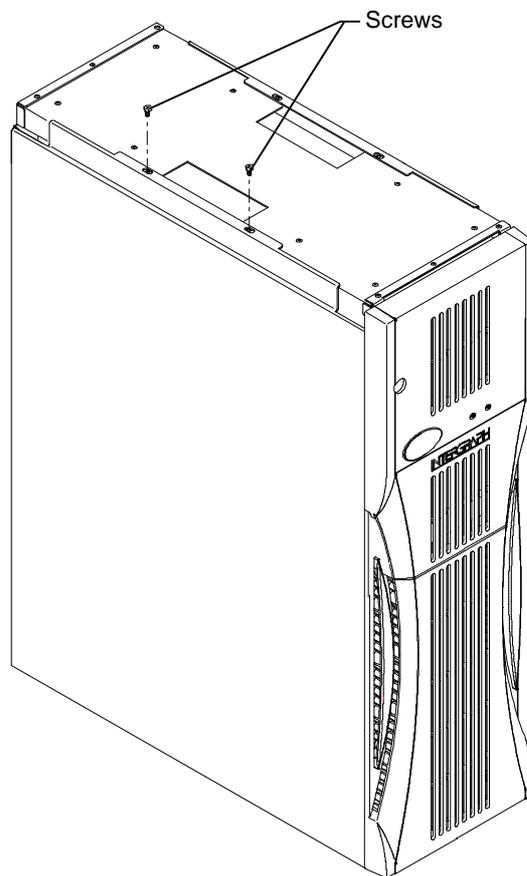4.    Remove the two screws from the top of the left side panel.

Figure 2-7.  Deskside Left Side Panel Removal

5.    Remove the left side panel by grasping the tab between the screw
      holes.  Then, slide the panel up and out from the workstation.

6.    Lay the workstation on its right side.

7. Remove the three screws from the PCI access panel on the bottom of the workstation.
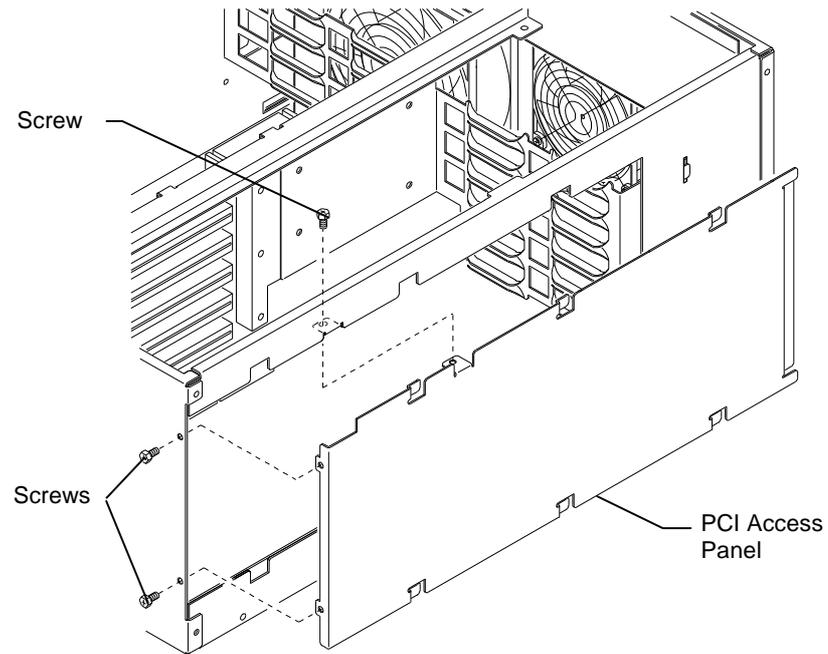


Figure 2-8. Deskside PCI Access Panel Removal

8. Remove the PCI access panel by sliding it toward the back of the workstation.

9. Attach an antistatic wrist strap to a non-painted, metallic surface on the workstation. Ensure that the elastic loop in the strap snugly contacts your bare wrist.

# *Replacing GLZ1 Board in the Deskside*

This section describes replacing a GLZ1 board in a deskside workstation.  For single monitor workstations, a GLZ1 board should reside in PCI slot 2.

➤ To replace a GLZ1 board in the deskside workstation:

1. Disconnect the cable(s) from the Video and VGA ports on the back panel of the base unit.

2. If replacing a secondary GLZ1 board in a dual screen configuration, disconnect the clock sync cable.

Clock Sync
Cable

Secondary
GLZ1
Board
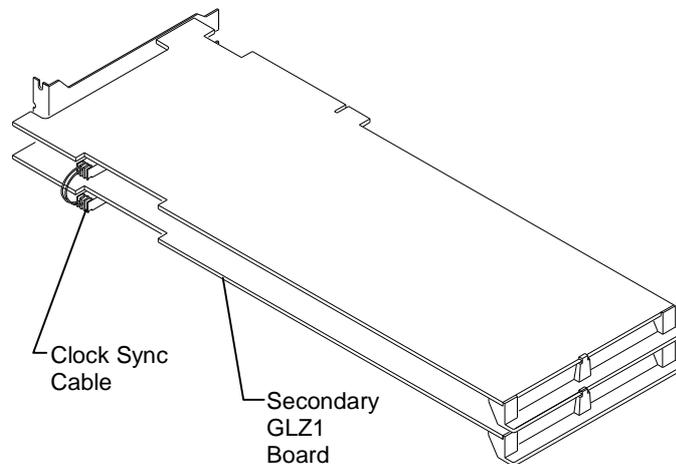
Figure 2-9.  Clock Sync Cable Removal

3. Using a quarter-inch nutdriver, remove the screw from the GLZ1 board.  Retain the screw.

4. Remove the GLZ1 board from the workstation.

5. Install the new GLZ1 board into the slot from which the previously installed board was removed.

**Note:**   In a dual screen configuration, the primary GLZ1 board resides in PCI slot 2 and the secondary GLZ1 board in PCI slot 3. Refer to Figure 2-10 for board and PCI slot location.

6.  Secure the board to the base unit using the screw removed previously.

7.  If you replaced a GLZ1 board in a dual screen configuration, install the clock sync cable.

---

**CAUTION**

The clock sync cable installs only one way.  Do not force the keyed connector.  Ensure pin 1 of both cable connectors engages pin 1 on both board connectors.  The black wire connects to pin 1.

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# *Installing a Dual Screen Option in the Deskside*

The Intergraph GLZ1 dual screen option kit provides the following components to upgrade from a single screen to a dual screen configuration.  Verify that you have the following items.

♦  GLZ1 board
♦  Diskette containing the Intergraph GL display driver software
♦  *GLZ1 Hardware User's Guide*
♦  Clock sync cable
♦  FIFO status cable (only used if Geometry Accelerator option board is present)
♦  Antistatic wrist strap

If an item is missing or damaged, notify Intergraph Customer Response Center at 1-800-633-7248 immediately.

➤ To install a dual screen option in the deskside:

1. Using a quarter-inch nutdriver, remove the blanking plate from PCI slot 3.  Retain the screws.  Refer to Figure 2-10 for board and PCI slot locations.

2.    Install the second GLZ1 board into PCI slot 3.



SIDE I

PCI Slot 1
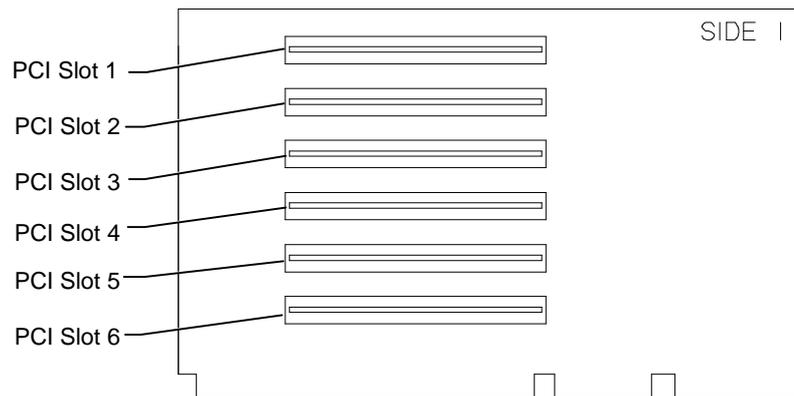PCI Slot 2
PCI Slot 3
PCI Slot 4
PCI Slot 5
PCI Slot 6

Figure 2-10.  Deskside PCI Slots

3.    Install the screw to secure the GLZ1 board to the workstation.

4.    Install the clock sync cable between the two GLZ1 boards.  Refer to Figure 2-11.

```
┌─────────────────────────────────────────────────────┐
│                      CAUTION                          │
│                                                       │
│  The clock sync cable installs only one way.  Do not force the  │
│  connector.  Ensure pin 1 of both cable connectors engages pin 1 on both  │
│  board connectors.  The black wire connects to pin 1.  │
│                                                       │
└─────────────────────────────────────────────────────┘
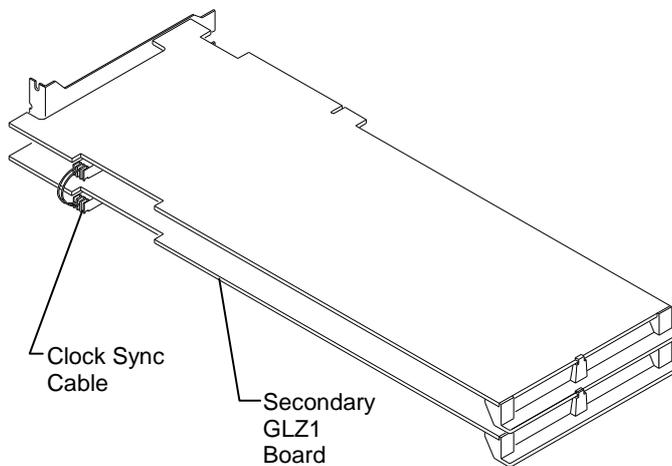```

Figure 2-11.  Clock Sync Cable Installation

# *Completing the Installation for the Deskside*

Follow these steps to reassemble the workstation and reconnect the monitor.

➤ To complete the installation:

1.    Install the PCI access panel on the workstation.

2. Raise the workstation to its normal standing position.

3. Install the side panel of the workstation.

4. Install the footstands.

```
                        CAUTION

   To avoid injury or damage to the equipment, replace the stabilizing
   footstands before operating the unit.
```

5.    Install the top cover of the workstation.

6.    Connect the VGA Loopback cable and monitor cable for single
      monitor configurations as follows:

      **VGA Loopback:**  Connect the VGA Loopback cable from the VGA
      Out port to the VGA In port as shown in Figure 2-12.

      **Single monitor:**  Connect the monitor cable to the Video Out port in
      PCI slot 2.

Figure 2-12.  Single Monitor Cable Connections

7. Connect the VGA Loopback cable and monitor cables for dual monitor configurations as follows:

**VGA Loopback:**  Connect the VGA Loopback cable from the VGA Out port to the VGA In port as shown in Figure 2-13.

**Primary monitor:**  Connect the monitor cable to the Video Out port in PCI slot 2.
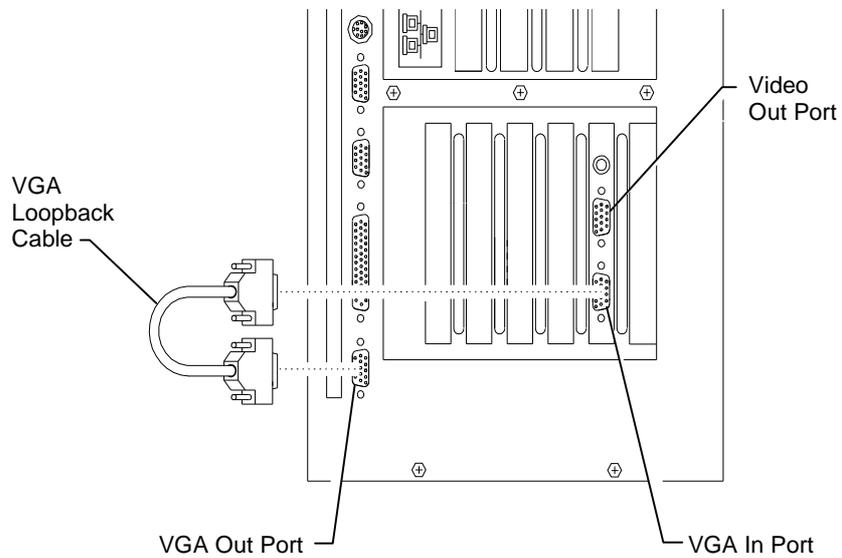
**Secondary monitor:**  Connect the monitor cable to the Video Out port in PCI slot 3.
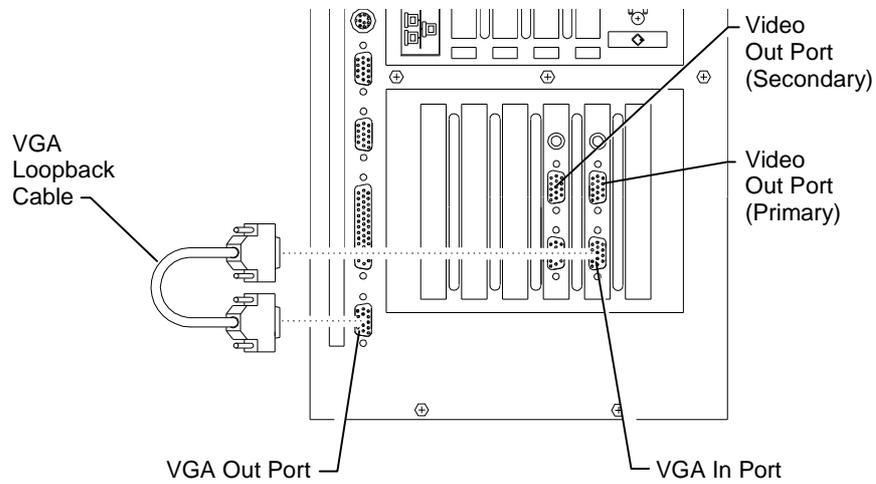


Figure 2-13.  Dual Monitor Cable Connections

8.    If you need to configure the GL display driver, refer to "Configuring the Video Display" in Chapter 1.

# *Driver Installation and Troubleshooting*

This chapter describes installing the GL display driver when it becomes necessary to upgrade to the latest driver or when upgrading the workstation hardware configuration.  It also contains troubleshooting procedures to determine which hardware assembly to return for repair.

## *GL Display Driver Installation*

First, power on the system and log on to Windows NT.  Then, install the GL driver as described in the following procedure.

➤ To install the GL display driver:

1.      Open Control Panel in the Main group of Program Manager.

2.      Open Display in the Control Panel window.  The Display Settings dialog displays.

3.      Select Change Display Type.  The Display Type dialog displays.

4.      Select Change.  The Select Device dialog displays.

5.      Confirm that the Disable current driver check box is marked.

6.      Select Other.  The Install from Disk dialog displays.

7.    Insert the diskette containing the Intergraph GL display driver into the floppy disk drive.

8.    Select OK.  After a few seconds, the GL Display Driver highlights.

9.    Select Install.  When prompted, confirm you want to change your system configuration.

---

**Note:**   If the GL display driver is already installed, the Windows NT Setup dialog displays, allowing you to choose the currently installed driver or a new driver.  Select New to install the GL display driver.

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10.   When prompted, confirm the directory path for the driver.  The Video Configuration dialog displays.

11.   Select and change the option settings according to system configuration and your preferences.  Refer to Chapter 1 or use Help for information about each option.

12.   Select OK to apply the attributes.

13.   Remove the diskette from the floppy disk drive.

14.   Shut down and restart the workstation for the driver to take effect.

# *Troubleshooting*

If you suspect a hardware problem, use this section to verify the graphics hardware, and to determine which hardware assembly to return for repair.

If you must reinstall the GL display driver, refer to the previous section,

"GL Display Driver Installation." If problems persist, contact the Customer Response Center at 1-800-633-7248.

## *Diagnostics*

Diagnostic utilities for checking the graphics boards and instructions for using them are available on the Intergraph Bulletin Board Service (IBBS). Refer to the TDZ hardware user's guide for instructions to access the IBBS and obtain files.

## *Video Display*

Table 3-1 lists some common video configuration problems.

Table 3-1.  Video Configuration Problems

| Problem | Action |
|---|---|
| Display is black, not synchronized, or distorted. | Restart Windows NT in VGA mode. |
| Monitor does not support a selected resolution or refresh rate. | Select a supported resolution and refresh rate. |
| Two GLZ1 graphics boards are installed, but you are not allowed to select the Dual Screen option (only one board detected). | Verify proper installation of both board sets. |
| A dim line, rolling vertically, is visible on the screen. | Verify proper installation of the clock sync cable. Refer to Chapter 2. |
| No VGA bootup screen. | Check the VGA loopback cable. Disconnect monitor cable from the Video Out port and connect it to the VGA port.  If no display, check the system board, monitor, monitor cable, and power to the monitor. |

## *Obtaining a Usable Video Resolution*

The system operates in VGA mode when the GL graphics driver is not running in order to accommodate all monitor types.  VGA mode is used during initial installation of the GL display driver and when experiencing video problems.

There are two methods for obtaining a usable display: using the Last Known Good configuration in Windows NT, or restarting the system in VGA mode.

If you select a resolution that causes the monitor to display incorrectly, do not press CTRL+ALT+DEL to log on to the Windows NT operating system; this will overwrite your Last Known Good configuration. Instead, use the Last Known Good option to correct the display problem.

➤ To use the Last Known Good configuration option:

1.    Restart the workstation.

2.    Select the Last Known Good configuration in Windows NT by pressing the space bar at the following prompt:

      ```
      Press space bar NOW to invoke the Last Known Good Menu
      ```

      If the above procedure fails to correct the display, complete the following instructions.

➤ To use the VGA mode option:

1.    Restart the workstation.

2.    At the initial OS Loader V3.51 boot screen of Windows NT, select the following option:

      ```
      Windows NT Workstation Version 3.51 [VGA mode]
      ```

3.    Open Video Config in Control Panel.

4.    Configure the video display attributes to correct the problem. Select the Help button or use context sensitive help for information about each option.

5. To reset the default display driver, refer to "Changing the Default Display Driver" in Chapter 1.

## *Determining a Defective Unit*

To determine if you have defective hardware, follow these steps.

➤ To determine a defective unit:

1.    Save and exit from all files, if possible.

2.    Shut down Windows NT, if possible.

3.    Turn off the power to the monitor and to the workstation.

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**CAUTION**

Always turn off the power to the workstation before connecting or disconnecting the cables.

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4.    Check and reseat all board and cable connections as needed.

5.    Turn on the power to the monitor.  If the monitor Power On LED does not illuminate, return the monitor.

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**Note:**    After a period of inactivity, the monitor enters a power saving mode.  On Intergraph Multi-sync monitors, the Power On LED on the front of the monitor will change from green to yellow to indicate the power saving mode is active.

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6.    Turn on the power to the workstation.  If the Power On LED on the workstation does not illuminate or if the BIOS beep codes indicate a failure, return the workstation.

7.    If the monitor display is distorted, ensure the software setup is correct for the monitor type.

If the software setup is correct, use a similar type monitor (if available and functioning properly) to determine if the workstation is defective.

# *Technical Description*

The GLZ1 board supports many features and functions previously found only in high end workstation graphics. This chapter provides a technical description of the GLZ1 Rasterization Accelerator/Frame Buffer by discussing its features and functions.

## *Features*

GLZ1 provides full hardware acceleration of graphics tasks. The features listed for the Rasterization Accelerator and Frame Buffer sections enhance both the performance and the image quality of the GLZ1.

Rasterization Accelerator Section:
♦ Industry standard PCI bus
♦ High-speed graphics DMA engine
♦ Multiple vertex data formats
♦ Gouraud shading support
♦ Symbolized vector support
♦ Antialiased vector support
♦ Sub-pixel accuracy

Frame Buffer Section:
♦ 92 video planes
♦ True color frame buffer
♦ Z buffer
♦ Video lookup tables
♦ Window mode double buffering
♦ Gamma correction
♦ Hardware cursor

- Stereoscopic viewing
- Multiple video resolutions
- High speed screen refresh
- Genlock support for dual monitors

## *Rasterization Accelerator*

The Rasterization Accelerator has many features that accelerate the rasterization requirements of GLZ1 graphics.

*Industry Standard PCI Bus* -- The Rasterization Accelerator uses the PCI bus to transfer data to and from the host processor. The PCI bus is a high performance bus capable of operating up to 33 MHz. The Rasterization Accelerator is a 32-bit PCI bus peripheral with bus mastership capability.

*High Speed Graphics DMA Engine* -- The Rasterization Accelerator uses a high speed DMA engine to accelerate PCI bus data transfers. The DMA engine transfers data in sixteen, 32-bit word bursts. The DMA frees the host processor from transferring massive amounts of graphics data over the PCI bus.

*Multiple Vertex Data Formats* -- The Rasterization Accelerator allows the software to send vertex data for triangles and vectors in multiple formats. The 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 Support* -- The Rasterization Accelerator supports Gouraud shading of 3D graphics triangle meshes. High performance

hardware accomplishes the shading of the entire triangle including color and depth derivative calculations and pixel interpolation. The hardware supports Gouraud shaded vectors and allows maximum update rates with minimum load on the host processor.

*Symbolized Vector Support* -- The rasterization hardware supports symbolized vectors that allow the application of any user-supplied, 32-bit, two-color pattern without performance degradation. Dotted or dashed lines are examples of symbolized vectors.

*Antialiased Vector Support* -- Hardware support of antialiased vectors eliminates the jagged appearance of vectors on standard raster displays.

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

# Frame Buffer

The Frame Buffer has many features that greatly enhance the visual impact of GLZ1 graphics.

*92 Video Planes* -- The following summarizes the 92 video plane set for the GLZ1 configurations.

| | |
|---|---|
| Image (red, green, blue), front buffer | 24 bits |
| Image (red, green, blue), back buffer | 24 bits |
| Overlay, front buffer | 1 bit |
| Overlay, back buffer | 1 bit |
| Image, VLT selection, front buffer | 3 bits |
| Image, VLT selection, back buffer | 3 bits |
| Z buffer | 24 bits |
| Mask (pixel access control) | 4 bits |
| Image, window control | 4 bits |

Overlay, window control                    4 bit

The image planes consist of 8 bits each of red, green, and blue to provide 16.7 million possible colors.  There are two copies, or buffers, of image data, front and back.  This allows smooth animation by updating one buffer while displaying from the other buffer.

Both image buffers have access to one of eight Video Lookup Tables (VLTs).  The image VLT selection planes select the VLT to use.  A double buffered overlay plane provides the ability to annotate text and graphics with a 3D image in the image buffer.

The Z buffer provides 24 bits of depth information.  The mask planes allow for access control of the various drawing planes (for example, image or overlay).  Finally, the image and overlay window control planes determine the buffer to display on a pixel-by-pixel basis.

*True Color Frame Buffer* -- A 24-bit, double buffered, true color frame buffer provides 8 bits of information for each red, green, and blue primary color.  The frame buffer provides two separate buffers, so that one updates while the other displays.
*Z Buffer* -- A 24-bit, Z buffer provides accurate display of scenes with large depth separation between objects.

*Video Lookup Tables* -- The Frame Buffer includes eight 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* -- State of the art 10-bit gamma VLTs, and 10-bit Digital to Analog Converters (DACs) allow user control of gamma values without color degradation.

*Hardware Cursor* -- A hardware cursor minimizes cursor tracking tasks of the host processor.

*Stereoscopic Viewing* -- GLZ1 supports the display of stereo images. Stereoscopic viewing requires a stereo-ready monitor and infrared shutter glasses with emitter module.

*Multiple Video Resolutions* -- GLZ1 includes 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 also allows future monitor upgrades with only a software driver change.  Supported resolutions range from 640 x 480 up to 1152 x 864.  Refer to Chapter 6 for additional information on supported monitor resolutions.

*High Speed Screen Refresh* -- High speed screen refresh provides flicker-free displays at 76 Hz and above for all screen resolutions.

*Genlock Support for Dual Monitors* -- Genlock eliminates the visual beat frequency effect that may occur when placing two monitors close to each other.  GLZ1 supports Genlock for dual monitors by using a clock sync cable installed between the two GLZ1 boards.

# *Functions*

GDI is the library of functions that Microsoft Windows NT uses to create and manipulate 2D computer images. The GLZ1 rasterization hardware accelerates many of the GDI functions. OpenGL is an industry standard library of functions used to create and manipulate 3D computer images. OpenGL functions, as built in to the Microsoft Windows NT operating system, can be performed by the host processor. However, the GLZ1 hardware accelerators greatly improve OpenGL performance.
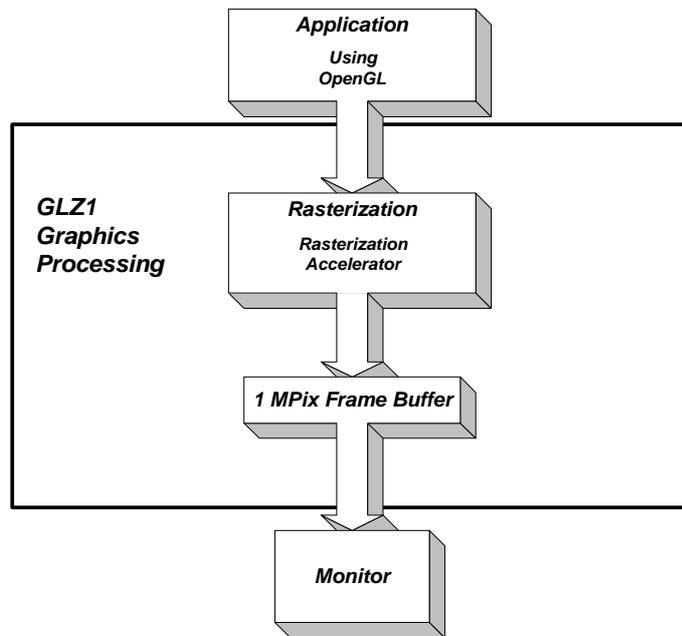
Figure 4-1.  GLZ1 OpenGL Processing Block Diagram

As shown in Figure 4-1, the GLZ1 provides OpenGL acceleration using the Rasterization Accelerator and Frame Buffer. This allows the host processor to perform application and database operations while the accelerator

performs OpenGL processing.  This parallel processing results in unprecedented speed to generate and manipulate realistic images.

## *Rasterization Accelerator/Frame Buffer*

The Rasterization Accelerator consists of the PCIDMA, Graphics FIFO, and Graphics Engine.  The Frame Buffer consists of the resolvers, video memory, Video Selector and Mappers (VSMs), and Digital to Analog Converter (DAC).  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 others.  The graphics engine ASIC converts the elements to pixels and routes them through the Resolvers to the Video Memory.  The Rasterization Accelerator also performs region fills, bit expands, and BIT BLock Transfer (BITBLT) operations.  The VSMs accept digital pixel data from the Video Memory, and send it to the DAC where it is converted to an analog voltage and presented to the monitor.
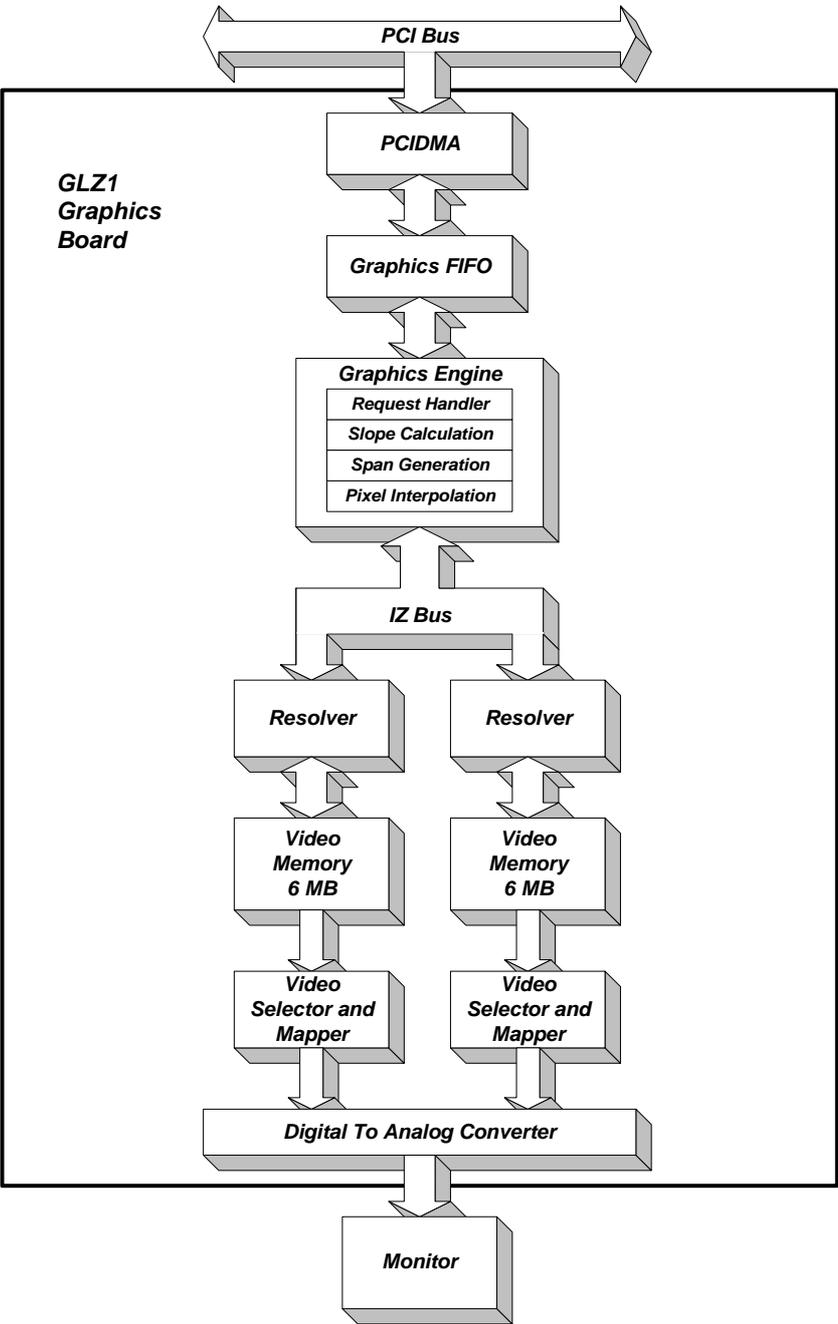
```
                         PCI Bus

GLZ1
Graphics                 PCIDMA
Board

                      Graphics FIFO

                      Graphics Engine
                     Request Handler
                     Slope Calculation
                     Span Generation
                     Pixel Interpolation

                         IZ Bus

          Resolver              Resolver

           Video                 Video
          Memory                Memory
           6 MB                  6 MB

           Video                 Video
       Selector and          Selector and
          Mapper                Mapper

              Digital To Analog Converter

                         Monitor
```

Figure 4-2.  Rasterization Accelerator/Frame Buffer Block Diagram

# *Hardware Description*

This chapter describes the GLZ1 board (Rasterization Accelerator/Frame Buffer) and discusses the architecture and hardware implementation.  The following describes the major components of the Rasterization Accelerator/Frame Buffer board.
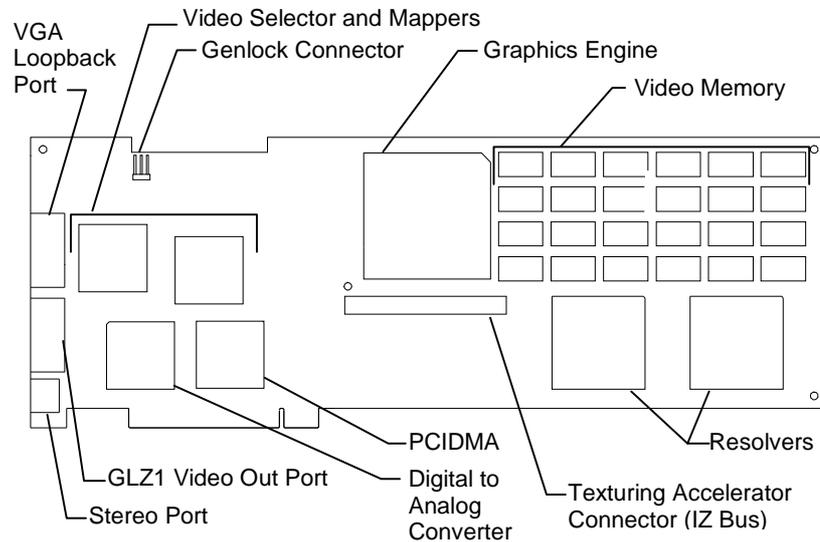


Figure 5-1.  GLZ1 Rasterization Accelerator/Frame Buffer Board

# *PCIDMA*

The PCIDMA ASIC is a multichannel, DMA engine capable of burst transfers of sixteen, 32-bit words.  The DMA transfer can be up to 4 MB.  For OpenGL requests, the Rasterization Accelerator uses a DMA to send vertex data through the PCIDMA to the graphics engine FIFO.

# Graphics Engine

The graphics engine ASIC is the main graphics processor for the board and the core of the Rasterization Accelerator. It takes vertex data from the graphics FIFO and produces spans of pixel data. The graphics engine ASIC sends the data to the frame buffer over a high speed pixel path called the Image/Z (IZ) bus.

The graphics engine uses four major logic blocks to perform the pixel rasterization. They are: (1) request handler, (2) slope calculation, (3) span generation, and (4) pixel interpolation.

## Request Handler

The request handler monitors the data output of 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 maps the (x, y) address to a linear address before sending the address and pixel data to the frame buffer over the IZ bus. The IZ bus is a 64-bit, 256 MB per second 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 maximum burst size is 4096 pixels.

# Resolver

Two resolver ASICs perform the memory control function for reading and writing data to the Video Memory. This includes coordinating the movement of data from the Video Memory to the Video Selector and Mapper (VSM) ASIC and DAC.

The graphics engine ASIC sends pixel data over the IZ bus to the resolver ASIC's IZ input FIFO. The resolver IZ input FIFO is 128 words deep so that the resolver can accommodate bursts of pixel data

without slowing overall system performance.  The pixel data consists of color (Red, Green, Blue, and Alpha - RGBA) and depth (Z) data.

The resolver examines pixel data from the input FIFO and determines if it should write the pixel data to the Video Memory.  The resolver performs Z, mask, and alpha tests to determine if data should be written.

The resolver can perform an Arithmetic and Logic Unit (ALU) operation in combination with the source data (data from the graphics engine) and the destination data (data in Video Memory). The operations include logical operations, Porter and Duff style alpha blend operations, and OpenGL style alpha blend operations.

The resolver performs several different types of VRAM write cycles including reads, writes, or read-modify-writes. It maximizes memory bandwidth by choosing an appropriate type. The resolver performs block write cycles to maximize performance for window clear and fill requests.

# Video Memory

The core of the frame buffer is 12 MB of Video Memory. The two resolver ASICs control the flow of data to and from the Video Memory. These resolvers provide a 128-bit, Video Memory interface. This wide interface allows GLZ1 to achieve a very high Video Memory access rate. The Video Memory comprises a total of 48 VRAMs, each VRAM consisting of 2 megabits of memory. Each Video memory pixel consists of 92 bits of memory.

# Video Selector and Mapper

The display subsystem consists of the Video Selector and Mapper (VSM) ASIC and the DAC. The VSM ASIC receives pixel data from the Video Memory. It selects the buffer (front or back), and the data (image or overlay) to display. The video selection planes select one of the VSM's eight Video Lookup Tables (VLTs) to map the image data. The VSM sends the mapped result to the DAC.

## Digital to Analog Converter

The Digital to Analog Converter (DAC) converts pixel data from the VSM into an analog voltage and sends it to the monitor for display. The integrated DAC contains a Video Lookup Table (VLT) consisting of 256 locations x 3 colors (RGB) x 10 bits per color used for gamma correction. The DAC also provides a user-definable 64 x 64 pixel hardware cursor.

# Specifications

Standard specifications for the GLZ1 board are subject to change without notice. The following specifications apply to the GLZ1 board.

**VRAM**:  12 MB

**I/O ports**:  One video output, one stereo sync output, and one VGA input

**GLZ1 power consumption**:  25 watts maximum

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**Note:**   Refer to the appropriate TDZ workstation hardware user's guide for environmental specifications.

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## Drawing Performance

The following summarizes the GLZ1 hardware performance for some commonly used graphics operations.  Actual system performance depends on the host processor speed and the software application.

### *3D Performance*

The performance values of the 3D drawing requests are obtained from randomly oriented data with Z-buffering enabled.

Table 6-1.  3D Graphics Performance

| 3D Requests | Performance |
|---|---|
| Triangle--50 pixel, Gouraud shaded | 235  K Triangles/sec |
| Triangle--25 pixel, Gouraud shaded | 440  K Triangles/sec |
| Vector--10 pixel, solid color | 900  K Vectors/sec |
| Vector--10 pixel, Gouraud shaded | 900  K Vectors/sec |
| Vector--10 pixel, antialiased | 425  K Vectors/sec |

### *2D Performance*

The performance values of the 2D drawing requests for the Graphical User Interface (GUI) are obtained with randomly oriented data.

Table 6-2.  2D Graphics Performance

| 2D Requests | Performance |
|---|---|
| Vector--10 pixel, solid color | 1.2  M Vectors/sec |
| Vector--10 pixel, antialiased | 450  K Vectors/sec |
| Blit--64 Bit | 13   M Pixels/sec |
| Fill--1280 x 1024 | 200 M Pixels/sec |
| Text--9 x 13 | 195  K Chars/sec |

# *Monitor Resolutions*

GLZ1 supports standard multi-sync monitors, including the Intergraph

17-inch and 21-inch monitors, at the following resolutions and refresh rates.

Table 6-3.  Monitor Resolution and Refresh Rate

| Resolution | Supported Refresh Rate (Hz) |
|---|---|
| 640   x   480 | 60, 72, 75, 85 |
| 800   x   600 | 60, 72, 75, 85 |
| 1024 x   768 | 60, 70, 75, 85 |
| 1152 x   864 | 60, 70, 75, 76 |

**Note:**   For more information on supported resolutions, refer to the README.TXT file included on the diskette containing the Intergraph GL display driver software.

# *Interfaces*

GLZ1 has three interface connections:  video port, VGA loopback port, and stereo port.

# *Video Port*

The video port provides connection to the monitor.  The following table provides the pin connections for the video port.

Table 6-4.  Video Port Pinouts

| Signal Name | Pin |
|---|---|
| Red Analog Video | 1 |
| Green Analog Video | 2 |
| Blue Analog Video | 3 |
| Ground | 4 |
| Ground | 5 |
| Ground | 6 |
| Ground | 7 |
| Ground | 8 |
| No Connect | 9 |
| Ground | 10 |
| Ground | 11 |
| Ground | 12 |
| Horizontal Sync | 13 |
| Vertical Sync | 14 |
| Ground | 15 |

The video port is female, 15-pin, D-Sub as shown in the following figure.  The recommended cable length is less than three meters.
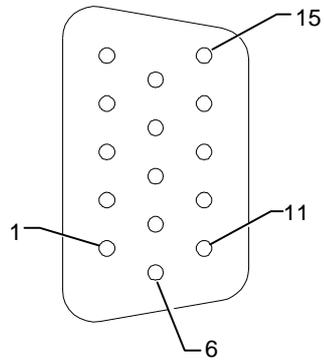
Figure 6-1.  Video Port

## *VGA Loopback Port*

The VGA loopback port provides connection between the host VGA
subsystem and the GLZ1 board.

Table 6-5.  VGA Loopback Port Pinouts

| Signal Name | Pin |
|---|---|
| Red Analog Video | 1 |
| Green Analog Video | 2 |
| Blue Analog Video | 3 |
| Ground | 4 |
| Ground | 5 |
| Ground | 6 |
| Ground | 7 |
| Ground | 8 |
| No Connect | 9 |
| Ground | 10 |
| Ground | 11 |
| Ground | 12 |
| Horizontal Sync | 13 |

| Vertical Sync | 14 |
|---------------|----|
| Ground        | 15 |

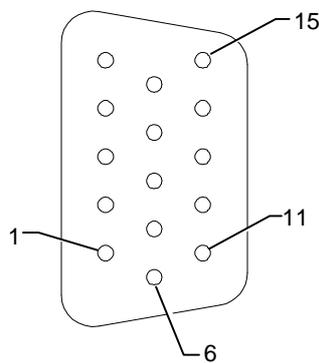The VGA loopback port is female, 15-pin, D-Sub as shown in the following figure.



Figure 6-2.  VGA Loopback Port

## *Stereo Port*

The stereo port provides connection to the LCD shutter glasses' emitter module.  The following table provides the pin connections for the stereo port.

Table 6-6.  Stereo Port Pinouts

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

The stereo port is female, 5-pin, mini-DIN as shown in the following figure.

Figure 6-3.  Stereo Port