GLINT R4®

Reference Guide Volume I - Overview

DRAFT ONLY

PROPRIETARY AND CONFIDENTIAL INFORMATION

3D*labs*®

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Reference Guide Volume I - Overview

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Issue 2

Proprietary Notice

Email: info@3dlabs.com
Web: http://www.3dlabs.com

3D*labs* Ltd.
Meadlake Place
Thorpe Lea Road, Egham
Surrey, TW20 8HE
United Kingdom
Tel: +44 (0) 1784 470555
Fax: +44 (0) 1784 470699

3D*labs* K.K.
Shiroyama JT Mori Bldg 16F
40301 Toranomon
Minato-ku, Tokyo, 105, Japan
Tel: +81-3-5403-4653
Fax: +91-3-5403-4646

3D*labs* Inc.
480 Potrero Avenue
Sunnyvale, CA 94086,
United States
Tel: (408) 530-4700
Fax: (408) 530-4701

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Table of Contents

1 FUNCTIONAL OVERVIEW 1-1

1.1 Introduction 1-1

1.2 Changes from P3/P4 1-3

1.3 Functional Blocks 1-5

1.4 AGP/PCI Interface 1-5

1.4.1 Unified 2D/3D/Video Integrated Graphics Processor 1-6

1.4.2 Memory Interface 1-6

1.4.3 SVGA 1-6

1.4.4 RAMDAC 1-7

1.4.5 Video Overlay 1-8

1.4.6 DMA1..DMA3 1-8

1.4.7 Video Streaming 1-8

1.4.8 ROM support 1-8

2 ADDRESS MAPS AND REGIONS 2-1

2.1 PCI Configuration Region 2-1

2.2 Region Zero Address Map 2-2

2.3 PCI Address Regions 2-3

3 VIDEO UNIT AND RAMDAC 3-1

3.1 RAMDAC Characteristics 3-1

3.1.1 Display Resolutions 3-1

3.1.2 Display Data Channels (DDC) 3-1

3.2 Display Timing Values 3-2

1 Functional Overview

1.1 Introduction

GLINT R4 is a high performance PCI/AGP graphics processor and rasterizer that balances high quality 3D polygon and textured graphics acceleration with 2D acceleration, and state-of-the-art MPEG1/MPEG2 playback with a fast integrated SVGA core, integrated RAMDAC and video ports.

GLINT R4 is optimized to work with GLINT *Gamma* geometry engines to deliver exceptional processing bandwidth for workstation applications. This includes dual on-chip setup units, 64MB fast local memory, virtual texture caching, AGP4X bus support and multi-rasterizer capability.

GLINT R4 offers significant advances over earlier rasterizers in both raw performance and functionality:

GLINT R4 Summary	
Interface and Memory	
Memory bus width (bits)	128 bits
Core clock speed (MHz) – *Provisional*	125
Max. memory	64Mbytes
AGP with sideband and pipelining, 2x/4x protocol	✔
AGP I/O Signal voltage - dual voltage	1.5V / 3.3V
PCI Bus Aperture	128 bits
Multi-rasterizer support and stripe ownership	✔
Low-latency command DMA	✔
Write-combined command FIFO	✔
Independant DMA machines	7
SSE dynamic load balancing	✔
Unified SGRAM or SDRAM incl. SGRAM block write	✔
Context dump and restore in hardware	✔
Statistic collection and extent picking	✔
Texture Mapping	
Texture read units	2
Texture compositing	✔

GLINT R4 Summary	
Single-pass dual texturing	✔
Single-pass bump mapping with surface texture	✔
Hardware texture paging	✔
Per polygon and per pixel mipmapping	✔
Bilinear and trilinear filtering, emulated anisotropic filtering	✔
Bump mapping, 3D textures, RGBA and palletized textures	✔
2k on-chip texture cache (max map size 2Kx2K)	✔
Virtual texture management, logical texture addressing	✔
3D Features	
Max. Z-buffer depth (bits)	32
Non-Linear 15 - 24-bit Z-buffer (Direct3D and OpenGL)	✔
W-Buffer Emulation with Non-Linear Z-buffer (Direct3D)	✔
Destination Alpha, Alpha and color key tests	✔
All OpenGL and Direct3D blend modes	✔
Native support for Direct3D vertex formats	limited
OpenGL 1.1/1.2 compliant / ready	✔
Fogging, Fog table	✔
Full hardware edge anti-aliasing	✔
YUV - RGB conversion	
Specular and diffuse lighting support	✔
2D Features	
Logic Ops for mode registers	✔
Single-register tag index setup for 2d primitives	✔
Stretch and high-speed blts	✔
Font caching	✔
DMA Packing / unpacking on output / input	✔
32x32 stipple pattern	✔
Run-length encode / decode	✔
Anti-aliased line and triangle setup	✔
Bitmaps and rectangular scissor clip	✔

GLINT R4 Summary	
Buffer Formats	
Unified framebuffer/localbuffer	✔
Flexible GID, stencil and depth formats	✔
Stencil planes	8
GID bits	4
Simultaneous framebuffer accesses	4
Any width framebuffer/localbuffer texture	✔
2d buffer tiling	✔
Video/DVD	
Hardware video overlay	✔
15 color on-chip cursor	✔
Display resolutions to 2048x1536x32 @ 60Hz	✔
Hardware scaling and filtering	✔
Digital Video out	✔
MPEG Motion compensation	✔
Memory to DVD accelerator DMA	✔
Flat panel LCD support, parallel bus panel output	✔
Video Genlock to any video source, R4 pixel bus	✔
Integrated 300MHz RAMDAC	✔
LUT Accuracy	8
Video overlay blend	2 bit
Video overlay with stretch and bilinear filtering	bilinear
Software	
SoftImage Compliant	✔
LightWave 6.0 (Win ’98 and NT)	✔
Power Management	
DPMS for monitors	✔
Memory array power-down	✔
Dynamic clock control	✔

Table 1.1 GLINT R4 Enhancement Summary

1.2 Changes from P3/P4

GLINT R4 removes a number of constraints found in Permedia3 and Permedia4. For more information see *GLINT R4 Errata* in Volume IV. The most significant pipeline change relative to the Permedia family is the use of dual on-chip setup (Delta) units which are primarily intended to provide the front-end capacity needed when working with geometry accelerators such as the GLINT *Gamma* chipset family. A switch unit allocates Draw and

Render commands to each Delta unit and a MUX recombines them for downstream processing.

The GLINT R4 setup units are designed to provide fast slope calculations and vertex data conversion to complement the functionality of the *Gamma* geometry engine. This pairing allows, for example, up to 16 simultaneous light sources and a throughput of 4.75M lit, transformed triangles/sec. in a typical *Gamma* plus GLINT R4 combination board.

There are several changes which specifically address the geometry accellerator + GLINT R4 combination. These provide a unified programming view of the chips when used in tandem. However GLINT R4 can function as a standalone rasterizer and still offer the significant price/performance benefits of dual setup engines, 64MB memory, 2K local cache, up to 256MB virtual texture etc.

Some of the GLINT R4 changes are:

ReadMonitorMode	Monitors memory reads operations to reduce dependence on the Suspend Reads mechanism to block out-of-sequence updates when subsequent framebuffer writes do not overlap.
SetDeltaPort	Improved port setting capability for test use
Begin/End	OGL-type primitve definition bounding supported
DeltaMode	Bitfield modifications to extend *Gamma* compatibility (e.g. *TargetChip* field). Redundant functionality (e.g. multi-texture setup) removed, flat shading added.
FilterMode	Support for external (i.e. *Gamma*) DMA
EndOfFeedback	RLE mode filtering is not used with external DMA because the tags are needed - see **FilterMode** in Volume III.
ContextDump	Integrates Gamma and R4 states dump/restore in one command.
ScanLineOwnership	Multi-rasterizer support enhancements including stripe and scanline ownership parameters
Stripe Management	Support for stripe width, height, offset and ID parameters in Framebuffer and local buffer operations.
Point, Line, Triangle	and other aliased and antialiased primitive drawing modes supported with logical operators (**PointModeAnd**, **LineModeOr**...)

There are other graphics processing changes (relative to Permedia3 in particular) which are either documented in the Errata chapter in volume IV or are documented as core registers but not specifically identified (e.g. where the register is a deprecated legacy but retained for backward compatibility).

Changes in hardware registers are not specifically identified, but are largely confined to AGP4X support etc. in the **ChipConfig** register *AutoCal Enable*, *Alternate DeviceID Enable* and the provision of a series of Test registers (**TestInputRdy**, **TestOutputControl** etc.) which are documented in volume II.

1.3 Functional Blocks

The major functional blocks are shown in Figure 1-1.

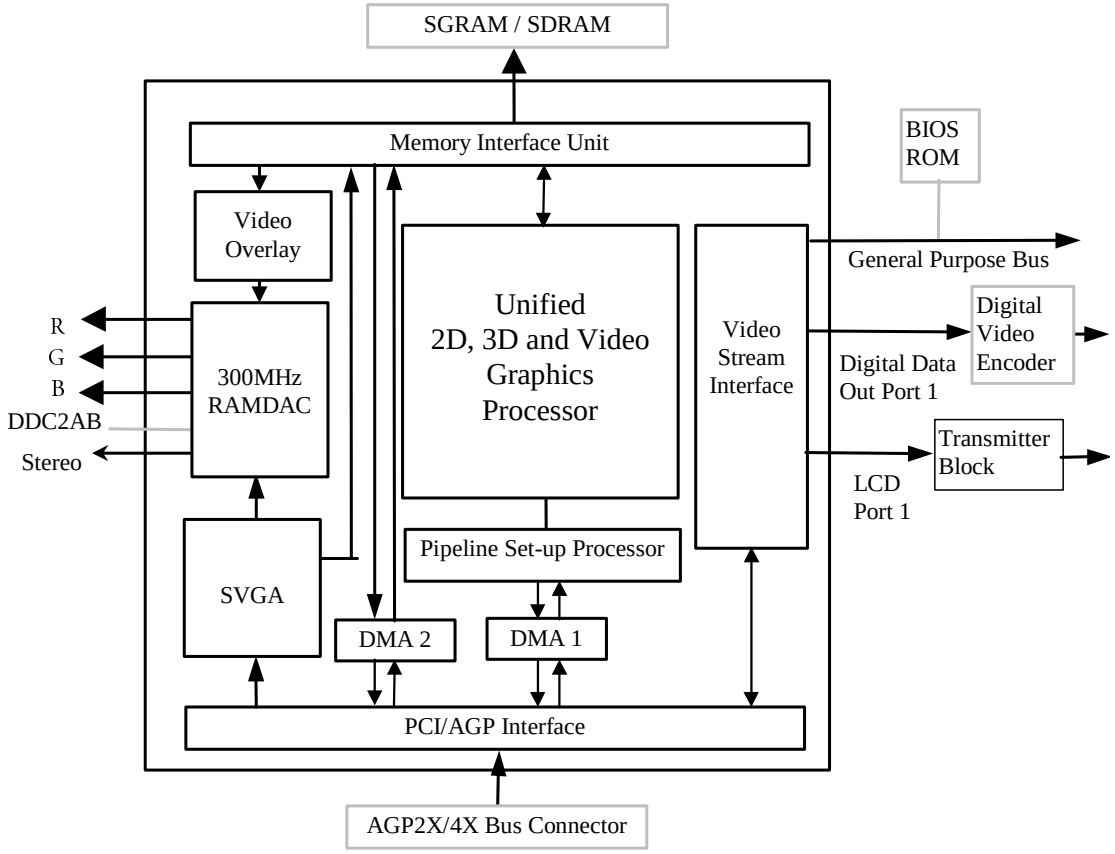


Figure 1-1 Chip Level Block Diagram

1.4 AGP/PCI Interface

The PCI interface conforms to the PCI Local Bus standard Revision 2.2. GLINT R4 is a PCI Local Bus Target, a PCI Local Bus Read Master, and a PCILocal Bus Write Master. It is also an AGP read master with support for pipelined reads and sideband addressing.

The PCI interface has an input FIFO for passing data to the Graphics Core, and an output FIFO for buffering up data to be read from the Graphics Core. The input FIFO is 256 words deep, the output FIFO is 8 words deep. A DMA controller is provided in the PCI interface to allow GLINT R4 to read data directly into the Graphics Core input FIFO or directly out of the output FIFO.

AGP 4X is Intel's high performance, component level interconnect targeted at 3D display applications, which uses a 66MHz PCI specification as an operation baseline and provides significant performance extensions to the PCI specification.

The specification for GLINT R4's AGP implementation is:

- 266 MHz transfer rate
- DMA and execute mode support
- Sideband addressing

Implementing these features enables GLINT R4 to achieve better than 1 GByte per second bandwidth from the host for instructions, textures, video data (limited by the host system throughput).

The add-in slot defined for AGP uses a connector body which is not compatible with the PCI connector. Boards designed for use in an AGP slot are not mechanically interchangeable with PCI boards.

GLINT R4 is also fully compliant with the AGP2X standard, including support for both 3.3VDC and 1.5VDC drivers.

1.4.1 Unified 2D/3D/Video Integrated Graphics Processor

The graphics core in GLINT R4 accelerates the key operations for 3D and 2D applications. For further information on the functionality of the graphics processor (GP), refer to chapter 5, Graphics Registers, in volume 2.

1.4.2 Memory Interface

The local memory is used to store color, depth, stencil, and texture data. For more information on the different data types and usage refer to Chapter 9 - Memory System.

The memory is organized as 1 to 4 blocks (blocks 0-3) of SGRAM or SDRAM. The memory interface is 128 bits wide with control lines for 4 blocks of memories (0-3). Block zero must always be fitted as the SVGA uses this area for local storage. Any other combination of banks may be fitted, but for contiguous memory banks should be added from 1 to 3.

GLINT R4 makes use of special SGRAM features including block fill and write-per-bit masking. SDRAM may be used in place of SGRAM if it is identical to SGRAM except for missing block write and write per bit masks.

1.4.3 SVGA

The on-chip SVGA unit is register level compatible with standard VGA devices and requires no software emulation. It natively supports all standard VGA modes and certain VESA VBE extended modes.

The following standard VESA VBE extended video modes are supported - those not supportable by the SVGA unit may be supported using the Graphics Processor:

Table 1- 2 VESA VBE Graphics Modes

Mode (hex)	Pixels	Colors	Window-ed	Lin-ear	Support-able in SVGA	Support-able in GP
0x100	640x400	256	✓	✓	✓	✓
0x101	640x480	256	✓	✓	✓	✓
0x103	800x600	256	✓	✓	✗	✓
0x105	1024x768	256	✓	✓	✗	✓
0x107	1280x1024	256	✓	✓	✗	✓
0x109	320x200	32K (5:5:5:1)	✓	✓	✗	✓
0x10D	320x200	64K (5:6:5)	✓	✓	✗	✓
0x10F	320x200	16.8M (8:8:8)	✓	✓	✗	✓
0x110	640x480	32K (5:5:5:1)	✓	✓	✗	✓
0x111	640x480	64K (5:6:5)	✓	✓	✗	✓
0x112	640x480	16.8M (8:8:8)	✓	✓	✗	✓
0x113	800x600	32K (5:5:5:1)	✓	✓	✗	✓
0x114	800x600	64K (5:6:5)	✓	✓	✗	✓
0x115	800x600	16.8M (8:8:8)	✓	✓	✗	✓
0x116	1024x768	32K (5:5:5:1)	✓	✓	✗	✓
0x117	1024x768	64K (5:6:5)	✓	✓	✗	✓
0x118	1024x768	16.8M (8:8:8)	✓	✓	✗	✓
0x119	1280x1024	32K (5:5:5:1)	✓	✓	✗	✓
0x11A	1280x1024	64K (5:6:5)	✓	✓	✗	✓
0x11B	1280x1024	16.8M (8:8:8)	✓	✓	✗	✓

The following VESA VBE text modes are supportable in the SVGA:

Table 1- 3 VESA VBE Text Modes

Mode (hex)	Characters (col/row)
0x108	80x60
0x109	132x25
0x10A	132x43
0x10B	132x50
0x10C	132x60

GLINT R4 allows VESA bankswitching to be done through the bypass to enable additional VESA mode support. ModeX is also supported.

1.4.4 RAMDAC

GLINT R4 incorporates a high performance 300MHz 128-bit RAMDAC. It supports typical screen resolutions up to 1600x1200 with refresh rates of 96Hz or 1920x1080 with refresh rates of 90Hz, or 2048x1536 at 60Hz. It supports packed pixel formats, with color depths

of 8, 16, and 32 bits per pixel. It has dot-clock phase locked loops (PLLs) and triple 8-bit D/A converters. The RAMDAC contains a 64x64x2 bit cursor array to support a 2, 4, or 16 color hardware cursor with cursor shapes cache.

1.4.5 Video Overlay

The video overlay is used to display incoming video data on screen. The overlay selection is based on a transparent color, the overlay key, which can be any RGB color or alpha value. Optionally, the overlay can be blended with the main image by using a 2-bit blend factor. A filter process supports zooming and shrinking at any rate. It combines four pixels into one by using bilinear filtering to achieve best results. Furthermore the filtered output is optionally converted from YUV to RGB color space format.

1.4.6 DMA1..DMA3

1.4.6.1 DMA1 Controller – System to Graphics Core and Graphics Core to System

- Autonomous - set-up/fetch parallelism
- No wait state - maximum transfer rate
- Programmable block size - large DMA buffers
- Separate DMA controllers for upload and download can run concurrently

1.4.6.2 DMA2 Controller - System to Memory and Memory to System

- Fast texture/image uploads and downloads
- Separate DMA controllers for upload and download can run concurrently
- DMA Controller supports scatter/gather
- Fast software MPEG2 download, fast frame capture

1.4.6.3 Interrupt Controller

- End-of-DMA - allows DMA chaining
- VSYNC - efficient double buffering
- Scanline - special effects
- Texture invalid
- Bypass DMA interrupt
- I2C start condition - alert host to start of I2C transfer
- Sync - indicates graphics core is idle
- Error - e.g. writing to a full FIFO

1.4.7 Video Streaming

GLINT R4 supports digital video output. The 24-bit streamed output is designed to work with common PAL/NTSC encoders or flat panel controllers.

1.4.8 ROM support

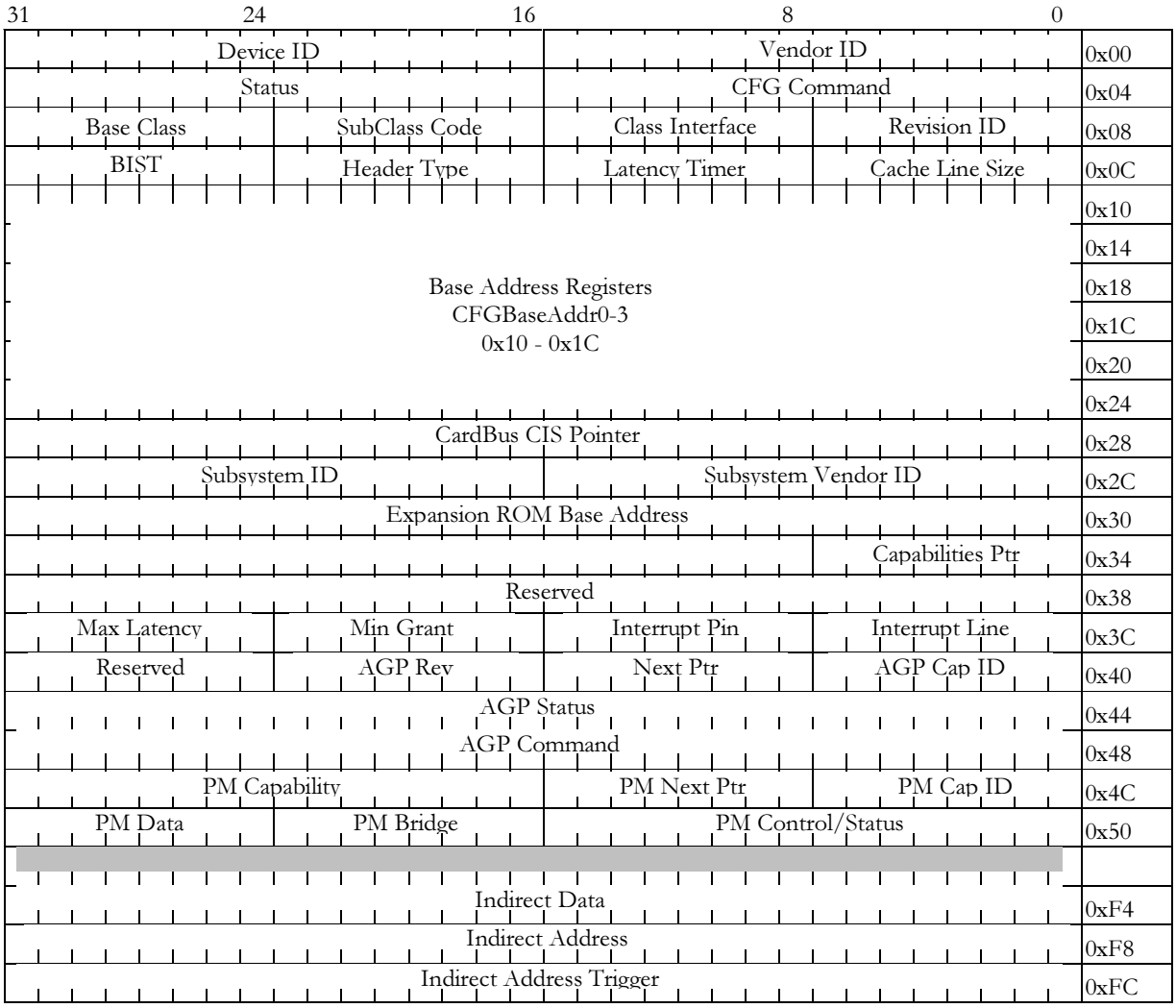
GLINT R4 supports a Flash ROM. This ROM may store code needed for device-specific initialization and the SVGA BIOS.

2

Address Maps and Regions

2.1 PCI Configuration Region

The PCI Configuration Region provides information that satisfies the needs of current and anticipated system configuration mechanisms. Configuration registers are read and modified via the Configuration registers (see volume II).



PCI Configuration Region

2.2 Region Zero Address Map

The GLINT R4 region zero address map is shown in Table 2-1:

Address Range	Region Select	Byte Swap/ Write Combined
0000.0000 -> 0000.02FF	Control Status	No
0000.0300 -> 0000.03FF	Bypass Control	No
0000.0400 -> 0000.0FFF	Repeat of the Control and Bypass Decodes	No
0000.1000 -> 0000.1FFF	Memory Control	No
0000.2000 -> 0000.2FFF	GP FIFO Access	No
0000.3000 -> 0000.30FF	Video Control	No
0000.3100 -> 0000.3FFF	Video Overlay Control	No
0000.4000 -> 0000.4FFF	RAMDAC	No
0000.5000 -> 0000.57FF	VS GP	No
0000.5800 -> 0000.5FFF	VSCtl	No
0000.6000 -> 0000.6FFF	VGA Control	No
0000.7000 -> 0000.7FFF	TextureData FIFO	No
0000.8000 -> 0000.FFFF	GP Registers	No
0001.0000 -> 0001.01FF	Control Status	Yes
0001.0300 -> 0001.03FF	Bypass Control	Yes
0001.0400 -> 0001.0FFF	Repeat of the Control and Bypass Decodes	Yes
0001.1000 -> 0001.1FFF	Memory Control	Yes
0001.2000 -> 0001.2FFF	GP FIFO Access	Yes
0001.3000 -> 0001.37FF	Video Control	Yes
0001.3800 -> 0001.3FFF	Video Overlay Control	Yes
0001.4000 -> 0001.4FFF	RAMDAC	Yes
0001.5000 -> 0001.57FF	VS GP	Yes
0001.5800 -> 0001.5FFF	VSCtl	Yes
0001.6000 -> 0001.6FFF	VGA Control	Yes
0001.7000 -> 0001.7FFF	TextureData FIFO	Yes
0001.8000 -> 0001.FFFF	GP Registers	Yes

Table 2- 1 Region Zero Address Map

2.3 PCI Address Regions

GLINT R4 has seven base address regions, as shown in Table 2-2:

Region	Address Space	Bytes	Description	Comments
Config	Configuration	256	PCI Configuration	PCI special
Zero	Memory	128K	Control Registers	Relocatable
One	Memory	128M	Memory Aperture One	Relocatable
Two	Memory	128M	Memory Aperture Two	Relocatable
Three	I/O	16	Indirect Access I/O	Optional and Relocatable
ROM	Memory	64 K	Expansion ROM	Relocatable
VGA	Memory & I/O	—	VGA Access	Optional and Fixed

Table 2- 2 GLINT R4 PCI Address Regions

3

Video Unit and RAMDAC

GLINT R4 incorporates a high performance 300MHz RAMDAC The video unit and RAMDAC should be configured to display the framebuffer data with the format, resolution, and refresh frequency required.

3.1 RAMDAC Characteristics

- High resolution 300 MHz, 128-bit RAMDAC
- Supporting screen resolutions up to 1600x1200@96Hz or 1920x1200@82Hz refresh rate
- Supports packed pixel formats
- Color depths of 8, 16 and 32 bits/pixel
- Dot clock phase-locked loop (PLL)
- Triple 8-bit D/A converters
- 64x64x2-bit cursor array to support a 2, 4 or 15 color hardware cursor with cursor shapes cache
- Analog and digital striping

3.1.1 Display Resolutions

GLINT R4 supports all the standard screen resolutions at ergonomic refresh rates.
For each resolution and color depth in the table below, the frequency figure represents the refresh rate supported using the VESA generalized Timing formula with 50% of the memory bandwidth used for screen refresh and 50% for drawing assuming a pixel clock of 300MHz.

Resolution	8 bpp	16 bpp	32 bpp
320x200	220 Hz	220 Hz	220 Hz
640x480	220 Hz	220 Hz	220 Hz
800x600	220 Hz	220 Hz	220 Hz
1024x768	217 Hz	217 Hz	217 Hz
1152x864	176 Hz	176 Hz	176 Hz
1280x1024	137 Hz	137 Hz	137 Hz
1600x1200	96 Hz	96 Hz	96 Hz
1920x1080	90 Hz	90 Hz	90 Hz
1920x1200	82.3 Hz	82.3 Hz	82.3 Hz

Table 3.2 Display Resolutions

Resolutions are driver and memory limited. A 32MB framebuffer for example can support 2048x1200 @ 32bit colour, 32bit Z; or 2048x1536 @ 32bit colour, 16bit Z.

3.1.2 Display Data Channels (DDC)

Two control lines are dedicated on GLINT R4 to support DDC1 and DDC2AB+ monitor configuration utilities. The DDC2 serial bus is independent of the serial bus in the video stream interface.

3.2 Display Timing Values

Table 3- 1 Timing Values for 640x480 16 BPP 75Hz

Parameter	Hex	Decimal
HTotal	0x065	101
HsStart	0x003	3
HsEnd	0x00B	11
HbEnd	0x016	22
HgEnd	0x016	22
VTotal	0x1F5	501
VsStart	0x000	0
VsEnd	0x003	3
VbEnd	0x016	22
ScreenStride	0x050	80
ScreenBase	0x000	0
VideoControl	0x029	41

Table 3- 2 Timing Values for 800x600 32 BPP 75Hz

Parameter	Hex	Decimal
HTotal	0x103	259
HsStart	0x00A	10
HsEnd	0x01E	30
HbEnd	0x03C	60
HgEnd	0x03C	60
VTotal	0x272	626
VsStart	0x000	0
VsEnd	0x003	3
VbEnd	0x01B	27
ScreenStride	0x0C8	200
ScreenBase	0x000	0
VideoControl	0x029	41

INDEX

AGP 2X 1-5
AGP/PCI Interface 1-5
address regions 2-3
Changes from P3/P4 1-3
Display Data Channels (DDC) 3-1
Display Resolutions 3-1
Display Timing Values 3-2
DMA1..DMA3 1-8
Enhancement summary 1-1, 1-3
Flash ROM 1-8
input FIFO 1-5
Introduction 1-1
Memory Interface 1-6
ModeX 1-7
PCI Address Regions 2-3
PCI Configuration Region 2-1
PCI Local Bus standard 1-5
RAMDAC 1-7
RAMDAC Characteristics 3-1
Region Zero Address Map 2-2
SGRAM
  block fill
    bit-masking 1-6
SVGA 1-6
Table 1- 2 VESA VBE Graphics Modes 1-7
Table 3- 1 Timing 3-2
Timing Values for 800x600 32 BPP 3-2
Unified 2D/3D/Video Integrated Graphics Processor 1-6
VESA bankswitching 1-7
VESA VBE Text Modes 1-7
Video Overlay 1-8
Video Unit and RAMDAC 3-1