CLE266 Chipset

VT8623 North Bridge

Single-Chip SMA North Bridge with 133 / 100 / 66 MHz Front Side Bus for VIA C3 CPUs with Integrated 2D / 3D AGP Graphics Core plus Advanced DDR Memory Controller supporting DDR266 / DDR200 (PC2100 / PC1600) DDR SDRAM and PC133 / PC100 SDR SDRAM for Desktop PC Systems

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REVISION HISTORY

Document Release	Date	Revision	Initials
0.1	4/3/01	Initial internal release based on the VT8613 TwisterT-DDR data sheet rev 0.9 Updated feature bullets, overview and block diagram per engineering spec rev 0.7 Added high-level internal block diagram to Functional Description per engg spec 0.7 Modified pinouts per engineering ballout 1.0 and changed package to 548 balls Added graphics register summary tables except for 3D registers Updated Device 0 Rx54[7-6] and Rx69[6] to remove 66 MHz FSB support Removed Device 0 Rx56,57,5E,5F (SDRAM bank 4-7 control) and Rx6E/6F (ECC)	DH
0.2	5/22/02	Fixed VIA Taiwan fax number on legal page; Changed CPU support to VIA C3 only Updated default values for Device 0 Rx3-2, 60[3-0], Device 1 Rx8, 41[3], 43, 44 Changed access type in register summary table for Device 0 Rx40-41, 44-43, 4C-4B Fixed misc typos and made non-zero defaults bold in register bit descriptions Changed Rx34 Device 0 and Device 1 from 32-bit to 8-bit Removed Device 0 Rx59, 60[7-4], 77, 7E-7F, B0-B3, BE, D0-D4, E4-E5 Changed Device 0 Rx51[0], 69[5], Device 1 Rx42[3,0]; Added Device 0 RxBC-BE Fixed font in figure 4 graphics block diagram; Fixed misalignments in package diagram	DH
0.21	5/22/02	Fixed cover page watermark	DH
0.3	5/23/02	Updated pinout to match engineering rev 1.1 (DVI pin rearrangement to match TV pins)	DH
0.4	5/29/02	Removed “Graphics” feature bullet for “Advanced automatic clock throttling. ” Removed 9-bit and 12-bit panel support from Overview Updated GCLK, DFTIN, and BISTIN pin descriptions Updated register summary tables Graphics Controller registers 3C5 Rx43-4B, Video Engine Rx33C, 3CC, 3F0-3FC, DMA Controller RxE4C (default)	DH
0.5	6/3/02	Changed package to 1mm ball pitch 27x27mm standard BGA	DH
0.6	6/27/02	Changed “Mobile” to “Desktop” on cover and in feature bullets and overview Changed Rx50[5] and E8[7-4] defaults and removed default from Rx50[6] (set from strap) Removed Rx54[0], 66[6], 69[1], AC[7], BD[7], E3[3-2]; Fixed typos in Rx84 Moved Rx54[2] to 51[0] & Rx54[1] to 54[2]; Updated RxBE[6-2], E1[6-4] Updated Device 1 Rx7-6[8], 3E[3], 40[4-3], 41[0]	DH
0.7	7/19/02	Fixed strapping and Rx50[7] IOQ depth from 4 to 8; Updated Rx88[1] bit name Fixed Rx54, AD, AE register names in register summary tables & register descriptions	DH
0.71	8/5/02	Added note to LCD Display section of Overview & added 64MB FB size to Table 1 Updated Device 0 RxE1[6-4] to add 64MB FB support	DH
0.8	9/3/02	Updated V-Link feature bullets; Removed DirectX texture compression references Removed “DSTN” from Overview; Fixed BISTIN and DFTIN pin descriptions	DH
0.9	9/19/02	Removed reference to “STN” panels in Overview “LCD Panel” section Added straps and internal pull-downs on FPD8-22; added strap details in pin descriptions Fixed missing internal block diagram in Functional Description section	DH
0.91	9/24/02	Updated FPD8-22 strap definitions	DH
0.92	1/14/03	Updated VIA logo in page headers; Removed VT8622 “2D-Only” version Added S3 Graphics logos, copyright notice, disclaimer and company address Updated DRAM notation for DDR266/DDR200; Reworded some DRAM feature bullets Swapped “typical usage” of SMB ports and fixed VLVREF voltage in pin descriptions Added graphics mode tables & FPD RGB mapping table in Functional Description section	DH

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supporting DDR266 / DDR200 (PC2100 / PC1600) DDR SDRAM
and PC133 / PC100 SDR SDRAM
for Desktop PC Systems

PRODUCT FEATURES

- **Defines Integrated Solutions for Value PC Desktop Designs**
  - High performance SMA North Bridge: Integrated Apollo Pro266T & graphics accelerator in a single chip
  - 64-bit advanced memory controller supporting DDR266 / DDR200 (PC2100/PC1600) DDR SDRAM and PC133 / PC100 SDR SDRAM
  - Combines with VIA VT8233A V-Link South Bridge for integrated audio, ATA-133 IDE, and 4 USB ports
- **High Performance CPU Interface**
  - Support for Socket-370 VIA C3 processors
  - 133 / 100 / 66 MHz CPU Front Side Bus (FSB)
  - Built-in Phase Lock Loop circuitry for optimal skew control within and between clocking regions
  - Five outstanding transactions (four In-Order Queue (IOQ) plus one output latch)
  - Dynamic deferred transaction support
- **High Bandwidth 266 MB / Sec 8-Bit V-Link Host Controller**
  - Supports 66 MHz V-Link Host interface with total bandwidth of 266 MB/Sec
  - V-Link operates at 2x or 4x modes
  - Full-duplex commands with separate strobe / command
  - Request / Data split transaction
  - Configurable outstanding transaction queue for Host to V-Link Client accesses
  - Supports Defer / Defer-Reply transactions
  - Transaction assurance for V-Link Host to Client access (eliminates V-Link Host-Client Retry cycles)
  - Intelligent V-Link transaction protocol to eliminate data wait-state / throttle transfer latency. All V-Link transactions (both Host and Client) have a consistent view of transaction data depth and buffer size to avoid data overflow.
  - Highly efficient V-Link arbitration with minimum overhead. All V-Link transactions have predictable cycle length with known Command / Data duration.

- **Advanced High-Performance DDR / SDR DRAM Controller**
  - Supports DDR266 / DDR200 DDR SDRAM and PC133 / PC100 SDR SDRAM memory types
  - DRAM interface synchronous with host CPU (133/100 MHz) for most flexible configuration
  - DRAM interface may be faster or slower than CPU by 33 MHz
  - Concurrent CPU, AGP, and V-Link access
  - Mixed 1M / 2M / 4M / 8M / 16M / 32M / 64MxN DRAMs
  - Supports 4 banks up to 2 GB DRAMs (512Mb x8/x16 DRAM technology)
  - Flexible row and column addresses. 64-bit data width only
  - LVTTL 3.3V DRAM interface with 2.5V SSTL-2 DRAM interface (DDR) and 5V-tolerant inputs (SDR)
  - Programmable I/O drive capability for MA, command, and MD signals
  - Two-bank interleaving for 16Mbit SDRAM support
  - Two-bank and four bank interleaving for 64Mbit SDRAM support
  - Supports maximum 8-bank interleave (i.e., 8 pages open simultaneously); banks are allocated based on LRU
  - Seamless DRAM command scheduling for maximum DRAM bus utilization (e.g., precharge other banks while accessing the current bank)
  - Four cache lines (16 quadwords) of CPU to DRAM write buffers
  - Four cache lines of CPU to DRAM read prefetch buffers
  - Read around write capability for non-stalled CPU read
  - Speculative DRAM read before snoop result
  - Burst read and write operation
  - x-1/2-1/2-1/2-1-1/2-1/2-1/2 back-to-back accesses for DDR SDRAM (x-1-1-1-1-1-1-1 for SDR)
  - Supports DDR SDRAM CL 2/2.5/3 and 1T per command
  - Decoupled and burst DRAM refresh with staggered RAS timing (CAS before RAS or self refresh)
- **Integrated Graphics / Video Accelerator**
  - Optimized Shared Memory Architecture (SMA)
  - 8 / 16 / 32 / 64MB frame buffer using system memory
  - Internal AGP 8x performance
  - Separate 128-bit data paths between north bridge and graphics core for pixel data flow and texture / command access
  - Graphics engine clocks up to 133 MHz decoupled from memory clock
  - Direct hardware inputs to force graphics accelerator into suspend / standby states
  - High quality DVD video playback
  - VIP 1.1 / VIP 2.0-compatible video capture inputs up to 165 MHz data rate
  - Internal hardware VGA controller with true-color / high-color sprite for hardware cursor implementation
  - 128-bit 2D graphics engine
  - 128-bit 3D graphics engine
  - Floating point triangle setup engine
  - 3M triangles/second setup engine
  - 133M pixels/second trilinear fill rate
- **Extensive Display Support**
  - CRT display interface with 24-bit true-color RAMDAC up to 250 MHz pixel rate with gamma correction capability
  - Direct TFT flat panel interface up to 24-bit data width supporting 18, 24, or 18+18 TFT panels or LVDS encoders
  - 12-bit DVI 1.0-compatible interface for drive of flat panel monitor using external TMDS encoders
  - Interface to external TV Encoder for NTSC or PAL TV display
  - Flexible output configuration: CRT output plus 8-bit video capture port plus either 1) LCD Panel + DVI or TV-Out or 2) DVI + TV-Out + 2nd 8-bit video capture port (or video capture port extension to 16-bit)
  - Support for CRT resolutions up to 1920x1440 and panel resolutions up to 1600x1200
  - Automatic panel power sequencing and VESA DPMS CRT power-down
  - Dual view capability where CRT and Flat Panel Monitor can have a different resolution and refresh rate
  - Built-in reference voltage generator and monitor sense circuits
  - I^2C Serial Bus and DDC Monitor Communications for CRT Plug-and-Play configuration

- **Video Support**
  - Up to three video windows for video conferencing applications
  - High quality scaler (up or down) for both horizontal and vertical scaling (linear interpolation for horizontal and vertical up-scaling and filtering for horizontal and vertical down-scaling)
  - Color space conversion
  - Color enhancement (contrast, hue, saturation, brightness, and gamma correction)
  - Color and chroma key support
  - Hardware sub-picture blending
  - Bob / weave de-interlacing mode and advanced de-interlacing to improve video quality
  - Video capture inputs (one or two 8-bit ports or one 16-bit port) with built-in phase adjuster to fine tune the clock/data signal timing
  - PAL / NTSC TV output capability using external TV encoder
  - Supports CCIR601standard
- **MPEG-2/1 Video Decoder**
  - Motion compensation for full speed DVD playback
  - Hardware accelerated Slice layer, IDCT and Motion compensation
- **2D Hardware Acceleration Features**
  - BitBLT (bit block transfer) functions including alpha blts
  - Text function
  - Bresenham line drawing / style line function
  - ROP3, 256 operation
  - Color expansion
  - Source and destination color keys
  - Transparency mode
  - Window clipping
  - 8, 15/16, and 32 bpp mode acceleration
- **3D Hardware Acceleration Features**
  - Microsoft DirectX 7.0 and 8.0 compatible
  - OpenGL driver available
  - Floating-point setup engine
  - Triangle rate up to 3-million triangles per second and Pixel rate up to 133-million pixels per second for 2 texture, depth test and alpha blending
  - Flat and Gouraud shading
  - Hardware back-face culling
  - 16-bit, 32-bit Z test, and 24+8 Z+Stencil test support
  - Z-Bias support
  - Stipple Test, Line-Pattern test, Texture-Transparence test, Alpha test support
  - Edge anti-aliasing support
  - Two textures per pass
  - Tremendous Texture Format: 16/32 bpp ARGB, 1/2/4/8 bpp Luminance, 1/2/4/8 bpp Intensity, 1/2/4/8 bpp Paletized (ARGB), YUV 422/420 format
  - Texture sizes up to 2048x2048
  - High quality texture filter modes: Nearest, Linear, Bi-linear, Tri-linear, Anisotropic
  - LOD-Bias support
  - Vertex Fog and Fog Table
  - Specular Lighting
  - Alpha Blending
  - High quality dithering
  - ROP2 support
  - Internal full 32-bit ARGB format for high rendering quality
  - System balance to achieve high performance

- **Advanced System Power Management**
  - Power down of SDRAM (CKE)
  - Independent clock stop controls for CPU / SDRAM and on-chip AGP bus
  - Suspend power plane for preservation of memory data
  - Suspend-to-DRAM and self-refresh power down
  - Low-leakage I/O pads
  - ACPI 1.0B and PCI Bus Power Management 1.1 compliant
- **Full Software Support**
  - Drivers for major operating systems and APIs: [Windows® 9x, Windows NT, Windows 2000, Windows XP, Direct3D™, DirectDraw™ and DirectShow™, OpenGL™ ICD for Windows 9x, NT, 2000, and XP]
  - North Bridge / Chipset and Video BIOS support (including all standard VESA CRT display modes)
- **2.5V Core and Mixed 3.3V / 5V Tolerant and GTL+ I/O**
- **27 x 27mm Ball Grid Array Package with 548 Balls and 1mm Ball Pitch**

OVERVIEW

CLE266 is a high performance, cost-effective and energy efficient SMA chipset for the implementation of desktop personal computer systems with 133 MHz, 100 MHz and 66 MHz CPU host bus ("Front Side Bus") frequencies and based on 64-bit Socket-370 VIA C3 processors.

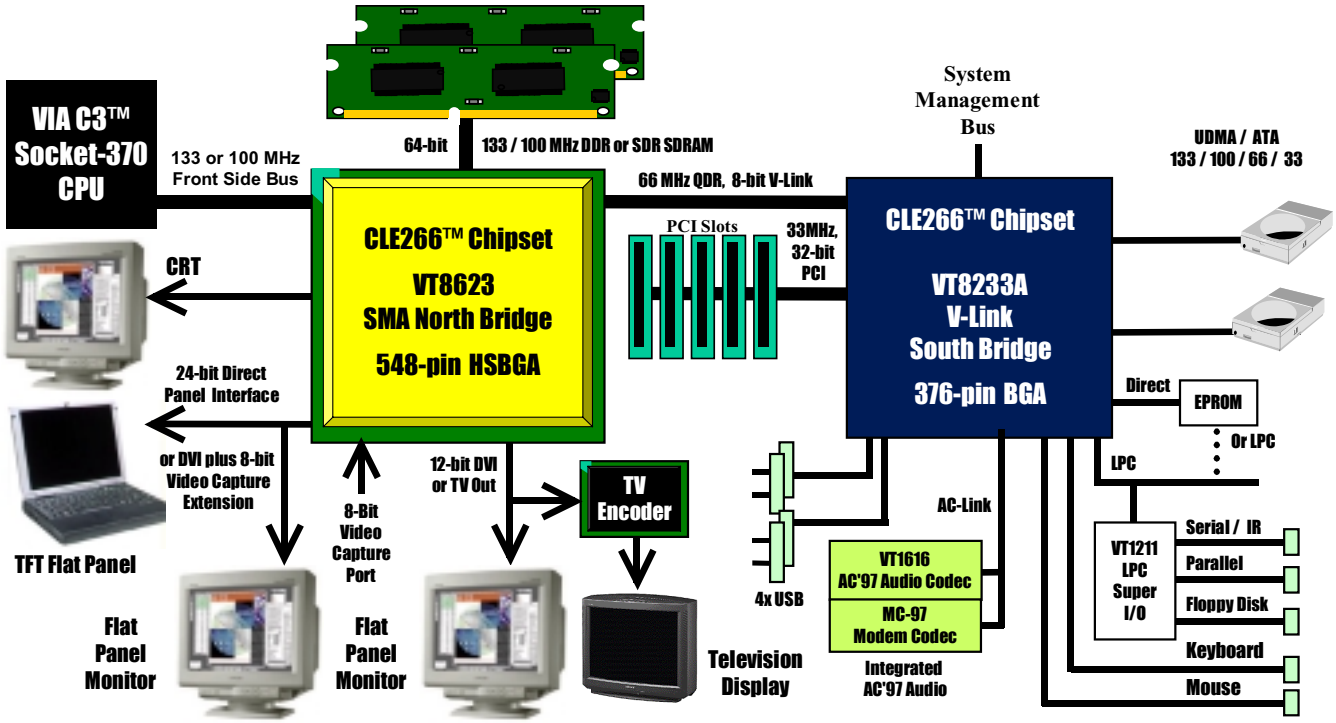


Figure 1. System Block Diagram

The CLE266 chipset consists of the **VT8623** north bridge (548 pin BGA) and the **VT8233A** V-Link south bridge (376 pin BGA). The CLE266 north bridge (or "Host System Controller") integrates VIA's VT8653 Apollo Pro266T system controller, 128-bit graphics accelerator and flat panel interfaces into a single 548 BGA package. The VT8623 provides superior performance between the CPU, DRAM, V-Link bus and internal AGP 8x graphics controller bus with pipelined, burst, and concurrent operation. The VT8233A V-Link Client controller is a highly integrated PCI / LPC controller. Its internal bus structure is based on a 66 MHz PCI bus that provides 2x bandwidth compared to previous generation PCI / ISA bridge chips. The VT8233A also provides a 266 MB / Sec bandwidth Host / Client V-Link interface with V-Link-PCI and V-Link-LPC controllers. It supports five PCI slots of arbitration and decoding for all integrated functions and LPC bus.

The VT8623 supports four banks of DDR / SDR SDRAMs up to 2 GB. The DRAM controller supports PC2100 / PC1600 Double-Data-Rated (DDR) SDRAM but can also support standard PC133 / PC100 Synchronous DRAM (SDR SDRAM). The DDR / SDR DRAM interface allows zero wait state bursting between the DRAM and the data buffers at 133 / 100 MHz. The different banks of DRAM can be composed of an arbitrary mixture of 1M / 2M / 4M / 8M / 16M / 32M / 64M xN DRAMs. The DRAM controller can run either synchronous or pseudo-synchronous with the host CPU bus.

The VT8623 host system controller supports a high speed 8-bit 66 MHz Quad Data Transfer interconnect (V-Link) to the VT8233A South Bridge. Each chip also contains a built-in bus-to-bus bridge to allow simultaneous concurrent operations on each bus. Five levels (doublewords) of post write buffers are included to allow for concurrent CPU and V-Link operation. For V-Link Host operation, forty-eight levels (doublewords) of post write buffers and sixteen levels (doublewords) of prefetch buffers are included for concurrent V-Link bus and DRAM/cache accesses. The combined V-Link Host and Client controllers realize a complete PCI sub-system that supports enhanced PCI bus commands such as Memory-Read-Line, Memory-Read-Multiple and Memory-Write-Invalid commands to minimize snoop overhead. In addition, advanced features are supported such as snoop ahead, snoop filtering, L1 write-back forward to PCI master, and L1 write-back merged with PCI post write buffers to minimize PCI master read latency and DRAM utilization. Delay transaction and read caching mechanisms are also implemented for further improvement of overall system performance.

The CLE266 north bridge also integrates a VIA-designed 128-bit graphics accelerator into the chip. This brings mainstream graphics performance to the Value PC with leading-edge 2D, 3D and DVD video acceleration into a cost effective package. Based on its capabilities, the CLE266 chipset is an ideal solution for the consumer, corporate desktop users and entry-level professionals.

The industry's first low-cost integrated AGP 8x solution to support DDR memory, the CLE266 north bridge combines internal AGP 8x equivalent performance with massive 2Kx2K textures to deliver unprecedented performance and image quality for the Value PC desktop market.

The 376-pin Ball Grid Array VT8233A Client V-Link PCI / LPC controller supports four levels (doublewords) of line buffers, type F DMA transfers and delay transaction to allow efficient PCI bus utilization and (PCI-2.1 compliant). The VT8233A integrated PCI controller and PCI arbitration for up to five PCI slots. One of the PCI REQ / GNT pairs can be configured as high-priority to better support a low latency PCI bus master device.

The VT8233A also includes an integrated keyboard controller with PS2 mouse support, integrated DS12885 style real time clock with extended 256 byte CMOS RAM, integrated master mode enhanced IDE controller with full scatter / gather capability and extension to UltraDMA-133/100/66/33 for 133/100/66/33 MB/sec transfer rate, integrated USB interface with two root hubs and four functional ports with built-in physical layer transceivers, Distributed DMA support, and OnNow / ACPI compliant advanced configuration and power management interface.

For sophisticated power management, the CLE266 chipset provides independent clock stop control for the CPU / SDRAM and PCI and CKE control for powering down of the SDRAM. A separate suspend-well plane is implemented for the SDRAM control signals for Suspend-to-DRAM operation. Using the VT8623 north bridge coupled with the VT8233A south bridge, a complete power conscious PC main board can be implemented with no external TTLs.

High-Performance 3D Accelerator

Featuring an internal 128-bit 3D graphics engine, the CLE266 VT8623 north bridge utilizes a single cycle architecture that provides high performance along with superior image quality. Several new features enhance the 3D architecture, including single-pass multitexturing, anisotropic filtering, and an 8-bit stencil buffer. The chip also offers the industry's only simultaneous usage of single-pass multitexturing and single-cycle trilinear filtering – enabling stunning image quality without performance loss. Image quality is further enhanced with true 32-bit color rendering throughout the 3D pipeline to produce more vivid and realistic images. The advanced triangle setup engine provides industry leading 3D performance for a realistic user experience in games and other interactive 3D applications. The 3D engine is optimized for AGP texturing from system memory.

128-bit 2D Graphics Engine

The CLE266 north bridge's advanced 128-bit 2D graphics engine delivers high-speed 2D acceleration for productivity applications. The enhanced 2D architecture optimizes SMA performance and provides acceleration of all color depths.

DVD Playback and Video Conferencing

The CLE266 north bridge provides the ideal architecture for high quality MPEG-2 based DVD applications and video conferencing. For DVD playback, the integrated video accelerator offloads the CPU by performing the planar to packed format conversion and motion compensation tasks, while its enhanced scaling algorithm delivers incredible full-screen video playback. For video conferencing, multiple video windows enable a cost effective solution.

TV Display Output Support

The CLE266 north bridge provides an interface to an external TV Encoder (VIA VT1621, VT1622, or compatible).

Video Capture Interface

The CLE266 north bridge provides a VIP 2.0-compatible interface to allow capture of video from an external source. This interface can be configured as one 8-bit, one 16-bit or two 8-bit ports.

LCD, Flat Panel Monitor, and TV Output Display Support

The CLE266 north bridge supports a wide variety of LCD panels through a direct interface up to 24-bits wide. This includes support for VGA, SVGA, XGA, SXGA+, UXGA, and UXGA+ TFT color panels with 18-bit and 24-bit interfaces (both 1 pixel/clock and 2 pixels/clock for both 18 and 24-bit interfaces). The CLE266 north bridge supports UXGA and higher resolutions only with the VIA VT1631 LVDS Transmitter chip since the VT1631 supports dual-edge data transfer.

In addition to the 24-bit panel interface, also provided is a 12-bit interface to a TMDS encoder. This interface is Digital Visual Interface (DVI) 1.0 compliant for driving an external flat panel monitor. The pins of the DVI port can optionally be configured for support of an external TV-Encoder for display of video on a TV display. An alternate configuration, however, allows the upper bits of the 24-bit direct flat panel interface to be configured as a DVI interface. This allows both TV out and DVI capability at the same time with the lower bits of the flat panel interface configured for either an 8-bit direct panel interface, a second 8-bit video capture port or an extension of the basic 8-bit capture port to 16 bits.

Available display interface combinations:

- CRT + DVI + TV-Out + 8-Bit or 16-Bit Video Capture Port
- CRT + DVI + TV-Out + Two 8-Bit Video Capture Ports
- CRT + 24-bit LCD Panel + DVI or TV-Out + 8-bit Video Capture Port

High Screen Resolution CRT Support

	System Memory Frame Buffer Size		
Resolutions Supported	**8 MB**	**16/32 MB**	**64 MB**
640x480x8/16/32	✔	✔	✔
800x600x8/16/32	✔	✔	✔
1024x768x8/16/32	✔	✔	✔
1280x1024x8	✔	✔	✔
1280x1024x16	✔	✔	✔
1280x1024x32	✔	✔	✔
1600x1200x8	✔	✔	✔
1600x1200x16	✔	✔	✔
1600x1200x32	✔	✔	✔
1920x1440x8	✔	✔	✔
1920x1440x16	✔	✔	✔

Table 1. Supported CRT Screen Resolutions

PINOUTS

Figure 2. Ball Diagram (Top View)

Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
A	TVVS DVIVS	TVD1 DVID1	TVD3 DVID3	TVD6 DVID6	TVD9 DVID9	DFT IN	AGP STDBY	SP CLK2	H SYNC	AB	RSET	**GND PLL1**	**GND PLL3**	HD56	HD54	HD57	HD47	HD51	HD39	HD36	HD34	HD32	HD33	HD26	HD23	HD21
B	TVHS DVIHS	TVD0 DVID0	TVD2 DVID2	TVD5 DVID5	TVD8 DVID8	INT A#	BIST IN	AGP BUSY#	V SYNC	AG	**GND RGB**	**VCC PLL1**	**GND**	HD61	HD55	**GND**	HD40	HD49	**GND**	HD37	HD22	**GND**	HD19	HD24	**GND**	HD16
C	NC DVIDT	TVCLK DVICLK	TVCKR NC	TVD4 DVID4	TVD7 DVID7	TVD10 DVID10	AGP SUSP	AGP STP#	SP DAT2	AR	**VCC DAC**	**GND PLL2**	**VCC PLL3**	HD60	HD46	HD52	HD63	HD41	HD45	HD38	HD28	HD31	HD25	HD30	HD7	HD3
D	CPD 3	CPD 2	CPD 1	CPD 0	TVBL# DVIDE	TVD11 DVID11	GPIO 0	GPIO 2	SP DAT1	**VCC RGB**	**GND DAC**	**VCC PLL2**	HD50	HD53	HD62	HD59	HD48	HD42	HD27	HD43	HD29	HD35	HD20	HD13	HD14	HD11
E	CPD 5	CPD 4	CP CLK	CPD 6	**VCC FP**	**GND**	GPIO 1	GPIO 3	SP CLK1	**GND**	**GND**	XIN	HD58	**GND**	**GND**	**VTT**	**VTT**	**GND**	HD44	**GTL VREF**	**GND**	**VTT**	HD2	HD9	**GND**	HD18
F	FPDE CPD8	FPHS CPHS	FPVS CPVS	CPD 7	**VCC FP**	**F6**	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**F21**	**VTT**	HD8	HD12	HD17	HD10
G	FPD2 CPD11	FPD1 CPD10	FPD0 CPD9	EN VDD	EN VEE	**G**		**VCC FP**	**VCC FP**	**VCC FP**	**VCC FP**	**VCC FP**	**GND**	**VTT**	**VTT**	**VTT**	**VTT**	**VTT**	**VTT**		**G**	HD5	HD1	HD4	HD6	HD15
H	FPD5 CPD13	FPD4 CPD12	FPD3 CPCK1	DCLK I	EN BLT	**H**	**VCC FP**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VTT**	**H**	HA26	HA18	CPU RST#	**GND**	HD0
J	FPD7 CPD15	FPD6 CPD14	FPCLK DFCLK	DCLK O	**GND**	**J**	**VCC FP**	**VCC 25**	**Flat**										**VCC 25**	**VTT**	**J**	**VTT**	HA29	HA24	HA27	HA30
K	FPD10 DFDE	FPD9 DFHS	FPD8 DFVS	FPD11 DFD0	**GND**	**K**	**VCC FP**	**VCC 25**	**Panel**	**K10**	11	12	13	14	15	16	**K17**	**CPU**	**VCC 25**	**VTT**	**K**	**VTT**	HA20	HA19	HA22	HA17
L	FPD15 DFD4	FPD14 DFD3	FPD13 DFD2	FPD12 DFD1	**VCC FP**	**L**	**VCC FP**	**VCC 25**		**L**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**L**		**VCC 25**	**VTT**	**L**	**GND**	HA23	HA31	**GND**	HA25
M	FPD18 DFD7	FPD17 DFD6	FPD19 DFD8	FPD16 DFD5	**VCC FP**	**M**	**VCC FP**	**VCC 25**		**M**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**M**		**VCC 25**	**VTT**	**M**	**GND**	HA15	HA28	HA21	HA10
N	FPD21 DFD10	FPD22 DFD11	FPD20 DFD9	FPD23 DFDET	**GND**	**N**	**VCC FP**	**VCC 25**		**N**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**N**		**VCC 25**	**VTT**	**N**	**GND**	HA5	HA12	HA16	HA13
P	VAD 0	**GND**	VAD 1	G CLK	**GND**	**P**	**VCC VL**	**VCC 25**		**P**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**P**		**VCC 25**	**VTT**	**P**	**GND**	HA6	HA9	**GND**	HA3
R	VAD 5	VDN STB	VDN STB#	VAD 3	VBE#	**R**	**VCC VL**	**VCC 25**	**VL**	**R**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**R**		**VCC 25**	**VTT**	**R**	BNR#	HA14	HA8	HA4	HA11
T	VUP STB#	VUP STB	VDN CMD	**VL VREF**	VUP CMD	**T**	**VCC VL**	**VCC 25**	**Bus**	**T**	**GND**	**GND**	**GND**	**GND**	**GND**	**GND**	**T**		**VCC 25**	**VTT**	**T**	**GTL VREF**	HREQ 1#	HA7	HREQ 4#	B PRI#
U	VAD 2	**GND**	VL PAR	**GND**	**VCC VL**	**U**	**VCC M**	**VCC 25**		**U10**	11	12	13	14	15	16	**U17**		**VCC 25**	**VTT**	**U**	**VTT**	DE FER#	H REQ0#	**GND**	H REQ2#
V	VAD 6	VAD 7	VAD 4	**VL COMP**	**VCC VL**	**V**	**VCC M**	**VCC 25**						**DRAM**					**VCC 25**	**VCC M**	**V**	**VTT**	HIT M#	H REQ3#	H LOCK#	RS1#
W	PWR OK	SUS ST#	RE SET#	CS3#	**VSUS 25**	**W**	**VCC M**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC 25**	**VCC M**	**W**	**GND**	HIT#	D BSY#	HT RDY#	RS0#
Y	MD59	**GND**	CS1#	**GND**	**VCC M**	**Y**		**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**	**VCC M**		**Y**	**GND**	H CLK	**GND HCK**	RS2#	D RDY#
AA	MD63	MD58	MD62	CS0#	**VCC M**	**AA6**	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**AA21**	**GND**	MD0	**VCC HCK**	ADS#	B REQ0#
AB	DQS 7#	DQM 7	MD57	S CAS#	S WE#	MA11	**M VREF**	**VCC M**	**VCC M**	NC	**GND**	**GND**	MA3	**GND**	**GND**	MA7	MA9	**VCC M**	**VCC M**	**M VREF**	**VCC M**	**VCC M**	MCLK	**VCC MCK**	MD5	MD4
AC	MD61	**GND**	CS2#	MD53	**GND**	MA10	MD42	**GND**	MD40	NC	MA2	MD32	MA4	MA5	DQM 3	MA8	MA13	**GND**	MA14	CKE 0	CKE 2	CKE 1	MCLK FB	**GND MCK**	**GND**	MD1
AD	MD56	MD60	MD51	MD52	S RAS#	MA12	DQS 5#	MD44	MD38	MA0	MA1	MD37	MD31	MA6	DQS 3#	MD24	MD23	MD18	MD17	MD11	MD10	DQM 1	CKE 3	MD2	DQM 0	DQS 0#
AE	MD55	**GND**	DQS 6#	**GND**	MD47	MD46	**GND**	MD41	MD39	**GND**	DQM 4	MD33	**GND**	MD30	MD25	**GND**	MD22	DQS 2#	**GND**	MD16	MD14	**GND**	MD12	MD8	**GND**	MD6
AF	MD50	MD54	DQM 6	MD49	MD48	MD43	DQM 5	MD45	MD35	MD34	DQS 4#	MD36	MD27	MD26	MD29	MD28	MD19	DQM 2	MD21	MD20	MD15	DQS 1#	MD13	MD9	MD3	MD7

Table 2. Pin List (Numerical Order)

Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Names	Pin #		Pin Name
A01	O	TVVS / DVIVS	D01	I	CPD03	**G19**	**P**	**VTT**	P01	IO	VAD0 / strap	**Y09**	**P**	**VCCM**	AD01	IO	MD56
A02	O	TVD01 / DVID01	D02	I	CPD02	G22	IO	HD05	**P02**	**P**	**GND**	**Y10**	**P**	**VCCM**	AD02	IO	MD60
A03	O	TVD03 / DVID03	D03	I	CPD01	G23	IO	HD01	P03	IO	VAD1 / strap	**Y11**	**P**	**VCCM**	AD03	IO	MD51
A04	O	TVD06 / DVID06	D04	I	CPD00	G24	IO	HD04	P04	I	GCLK	**Y12**	**P**	**VCCM**	AD04	IO	MD52
A05	O	TVD09 / DVID09	D05	O	TVBL# / DVIDE	G25	IO	HD06	**P05**	**P**	**GND**	**Y13**	**P**	**VCCM**	AD05	O	SRAS#
A06	I	DFTIN	D06	O	TVD11 / DVID11	G26	IO	HD15	**P07**	**P**	**VCCVL**	**Y14**	**P**	**VCCM**	AD06	O	MA12
A07	I	AGPSTDBY	D07	IO	GPIO0	H01	O	FPD05 / CPD13	**P20**	**P**	**VTT**	**Y15**	**P**	**VCCM**	AD07	O	DQS5#
A08	IO	SPCLK2	D08	IO	GPIO2	H02	O	FPD04 / CPD12	**P22**	**P**	**GND**	**Y16**	**P**	**VCCM**	AD08	IO	MD44
A09	O	HSYNC	D09	IO	SPDAT1	H03	O	FPD03 / CPCK1	P23	IO	HA06	**Y17**	**P**	**VCCM**	AD09	IO	MD38
A10	O	AB	**D10**	**P**	**VCCRGB**	H04	I	DCLKI	P24	IO	HA09	**Y18**	**P**	**VCCM**	AD10	O	MA00
A11	A	RSET	**D11**	**P**	**GNDDAC**	H05	O	ENBLT	**P25**	**P**	**GND**	**Y19**	**P**	**VCCM**	AD11	O	MA01
A12	**P**	**GNDPLL1**	**D12**	**P**	**VCCPLL2**	**H07**	**P**	**VCCFP**	P26	IO	HA03	**Y22**	**P**	**GND**	AD12	IO	MD37
A13	**P**	**GNDPLL3**	D13	IO	HD50	**H20**	**P**	**VTT**	R01	IO	VAD5	Y23	I	HCLK	AD13	IO	MD31
A14	IO	HD56	D14	IO	HD53	H22	IO	HA26	R02	O	VDNSTB	**Y24**	**P**	**GNDHCK**	AD14	O	MA06
A15	IO	HD54	D15	IO	HD62	H23	IO	HA18	R03	O	VDNSTB#	Y25	IO	RS2#	AD15	O	DQS3#
A16	IO	HD57	D16	IO	HD59	H24	O	CPURST#	R04	IO	VAD3 / strap	Y26	IO	DRDY#	AD16	IO	MD24
A17	IO	HD47	D17	IO	HD48	**H25**	**P**	**GND**	R05	IO	VBE#	AA01	IO	MD63	AD17	IO	MD23
A18	IO	HD51	D18	IO	HD42	H26	IO	HD00	**R07**	**P**	**VCCVL**	AA02	IO	MD58	AD18	IO	MD18
A19	IO	HD39	D19	IO	HD27	J01	O	FPD07 / CPD15	**R20**	**P**	**VTT**	AA03	IO	MD62	AD19	IO	MD17
A20	IO	HD36	D20	IO	HD43	J02	O	FPD06 / CPD14	R22	IO	BNR#	AA04	O	CS0#	AD20	IO	MD11
A21	IO	HD34	D21	IO	HD29	J03	O	FPCLK / DFCLK	R23	IO	HA14	**AA05**	**P**	**VCCM**	AD21	IO	MD10
A22	IO	HD32	D22	IO	HD35	J04	O	DCLKO	R24	IO	HA08	**AA22**	**P**	**GND**	AD22	O	DQM1
A23	IO	HD33	D23	IO	HD20	**J05**	**P**	**GND**	R25	IO	HA04	AA23	IO	MD00	AD23	O	CKE3
A24	IO	HD26	D24	IO	HD13	**J07**	**P**	**VCCFP**	R26	IO	HA11	**AA24**	**P**	**VCCHCK**	AD24	IO	MD02
A25	IO	HD23	D25	IO	HD14	**J20**	**P**	**VTT**	T01	I	VUPSTB#	AA25	IO	ADS#	AD25	O	DQM0
A26	IO	HD21	D26	IO	HD11	**J22**	**P**	**VTT**	T02	I	VUPSTB	AA26	O	BREQ0#	AD26	O	DQS0#
B01	O	TVHS / DVIHS	E01	I	CPD05	J23	IO	HA29	T03	O	VDNCMD	AB01	O	DQS7#	AE01	IO	MD55
B02	O	TVD00 / DVID00	E02	I	CPD04	J24	IO	HA24	**T04**	**P**	**VLVREF**	AB02	O	DQM7	**AE02**	**P**	**GND**
B03	O	TVD02 / DVID02	E03	I	CPCLK	J25	IO	HA27	T05	I	VUPCMD	AB03	IO	MD57	AE03	O	DQS6#
B04	O	TVD05 / DVID05	E04	I	CPD06	J26	IO	HA30	**T07**	**P**	**VCCVL**	AB04	O	SCAS#	**AE04**	**P**	**GND**
B05	O	TVD08 / DVID08	**E05**	**P**	**VCCFP**	K01	O	FPD10 / DFDE / strap	**T20**	**P**	**VTT**	AB05	O	SWE#	AE05	IO	MD47
B06	O	INTA#	**E06**	**P**	**GND**	K02	O	FPD09 / DFHS / strap	**T22**	**P**	**GTLVREF**	AB06	O	MA11	AE06	IO	MD46
B07	I	BISTIN	E07	IO	GPIO1	K03	O	FPD08 / DFVS / strap	T23	IO	HREQ1#	**AB07**	**P**	**MEMVREF**	**AE07**	**P**	**GND**
B08	O	AGPBUSY#	E08	IO	GPIO3	K04	O	FPD11 / DFD00 / strap	T24	IO	HA07	**AB08**	**P**	**VCCM**	AE08	IO	MD41
B09	O	VSYNC	E09	IO	SPCLK1	**K05**	**P**	**GND**	T25	IO	HREQ4#	**AB09**	**P**	**VCCM**	AE09	IO	MD39
B10	O	AG	**E10**	**P**	**GND**	**K07**	**P**	**VCCFP**	T26	IO	BPRI#	AB10	–	NC	**AE10**	**P**	**GND**
B11	**P**	**GNDRGB**	**E11**	**P**	**GND**	**K20**	**P**	**VTT**	U01	IO	VAD2 / strap	**AB11**	**P**	**GND**	AE11	O	DQM4
B12	**P**	**VCCPLL1**	E12	I	XIN	**K22**	**P**	**VTT**	**U02**	**P**	**GND**	**AB12**	**P**	**GND**	AE12	IO	MD33
B13	**P**	**GND**	E13	IO	HD58	K23	IO	HA20	U03	IO	VLPAR	AB13	O	MA03	**AE13**	**P**	**GND**
B14	IO	HD61	**E14**	**P**	**GND**	K24	IO	HA19	**U04**	**P**	**GND**	**AB14**	**P**	**GND**	AE14	IO	MD30
B15	IO	HD55	**E15**	**P**	**GND**	K25	IO	HA22	**U05**	**P**	**VCCVL**	**AB15**	**P**	**GND**	AE15	IO	MD25
B16	**P**	**GND**	**E16**	**P**	**VTT**	K26	IO	HA17	**U07**	**P**	**VCCM**	AB16	O	MA07	**AE16**	**P**	**GND**
B17	IO	HD40	**E17**	**P**	**VTT**	L01	O	FPD15 / DFD04 / strap	**U20**	**P**	**VTT**	AB17	O	MA09	AE17	IO	MD22
B18	IO	HD49	**E18**	**P**	**GND**	L02	O	FPD14 / DFD03 / strap	**U22**	**P**	**VTT**	**AB18**	**P**	**VCCM**	AE18	O	DQS2#
B19	**P**	**GND**	E19	IO	HD44	L03	O	FPD13 / DFD02 / strap	U23	IO	DEFER#	**AB19**	**P**	**VCCM**	**AE19**	**P**	**GND**
B20	IO	HD37	**E20**	**P**	**GTLVREF**	L04	O	FPD12 / DFD01 / strap	U24	IO	HREQ0#	**AB20**	**P**	**MEMVREF**	AE20	IO	MD16
B21	IO	HD22	**E21**	**P**	**GND**	**L05**	**P**	**VCCFP**	**U25**	**P**	**GND**	**AB21**	**P**	**VCCM**	AE21	IO	MD14
B22	**P**	**GND**	**E22**	**P**	**VTT**	**L07**	**P**	**VCCFP**	U26	IO	HREQ2#	**AB22**	**P**	**VCCM**	**AE22**	**P**	**GND**
B23	IO	HD19	E23	IO	HD02	**L20**	**P**	**VTT**	V01	IO	VAD6	AB23	O	MCLK	AE23	IO	MD12
B24	IO	HD24	E24	IO	HD09	**L22**	**P**	**GND**	V02	IO	VAD7	**AB24**	**P**	**VCCMCK**	AE24	IO	MD08
B25	**P**	**GND**	**E25**	**P**	**GND**	L23	IO	HA23	V03	IO	VAD4	AB25	IO	MD05	**AE25**	**P**	**GND**
B26	IO	HD16	E26	IO	HD18	L24	IO	HA31	**V04**	**A**	**VLCOMP**	AB26	IO	MD04	AE26	IO	MD06
C01	I	DVIDET	F01	O	FPDE / CPD08	**L25**	**P**	**GND**	**V05**	**P**	**VCCVL**	AC01	IO	MD61	AF01	IO	MD50
C02	O	TVCLK / DVICLK	F02	O	FPHS / CPHS	L26	IO	HA25	**V07**	**P**	**VCCM**	**AC02**	**P**	**GND**	AF02	IO	MD54
C03	I	TVCLKR / NC	F03	O	FPVS / CPVS	M01	O	FPD18 / DFD07 / strap	**V20**	**P**	**VCCM**	AC03	O	CS2#	AF03	O	DQM6
C04	O	TVD04 / DVID04	F04	I	CPD07	M02	O	FPD17 / DFD06 / strap	**V22**	**P**	**VTT**	AC04	IO	MD53	AF04	IO	MD49
C05	O	TVD07 / DVID07	**F05**	**P**	**VCCFP**	M03	O	FPD19 / DFD08 / strap	V23	I	HITM#	**AC05**	**P**	**GND**	AF05	IO	MD48
C06	O	TVD10 / DVID10	**F22**	**P**	**VTT**	M04	O	FPD16 / DFD05 / strap	V24	IO	HREQ3#	AC06	O	MA10	AF06	IO	MD43
C07	I	AGPSUSP	F23	IO	HD08	**M05**	**P**	**VCCFP**	V25	I	HLOCK#	AC07	IO	MD42	AF07	O	DQM5
C08	IO	AGPSTP#	F24	IO	HD12	**M07**	**P**	**VCCFP**	V26	IO	RS1#	**AC08**	**P**	**GND**	AF08	IO	MD45
C09	IO	SPDAT2	F25	IO	HD17	**M20**	**P**	**VTT**	W01	I	PWROK	AC09	IO	MD40	AF09	IO	MD35
C10	O	AR	F26	IO	HD10	**M22**	**P**	**GND**	W02	I	SUSST#	AC10	–	NC	AF10	IO	MD34
C11	**P**	**VCCDAC**	G01	O	FPD02 / CPD11	M23	IO	HA15	W03	I	RESET#	AC11	O	MA02	AF11	O	DQS4#
C12	**P**	**GNDPLL2**	G02	O	FPD01 / CPD10	M24	IO	HA28	W04	O	CS3#	AC12	IO	MD32	AF12	IO	MD36
C13	**P**	**VCCPLL3**	G03	O	FPD00 / CPD9	M25	IO	HA21	**W05**	**P**	**VSUS25**	AC13	O	MA04	AF13	IO	MD27
C14	IO	HD60	G04	O	ENVDD	M26	IO	HA10	**W07**	**P**	**VCCM**	AC14	O	MA05	AF14	IO	MD26
C15	IO	HD46	G05	O	ENVEE	N01	O	FPD21 / DFD10 / strap	**W20**	**P**	**VCCM**	AC15	O	DQM3	AF15	IO	MD29
C16	IO	HD52	**G08**	**P**	**VCCFP**	N02	O	FPD22 / DFD11 / strap	**W22**	**P**	**GND**	AC16	O	MA08	AF16	IO	MD28
C17	IO	HD63	**G09**	**P**	**VCCFP**	N03	O	FPD20 / DFD09 / strap	W23	IO	HIT#	AC17	O	MA13	AF17	IO	MD19
C18	IO	HD41	**G10**	**P**	**VCCFP**	N04	O	FPD23 / DFDET	W24	IO	DBSY#	**AC18**	**P**	**GND**	AF18	O	DQM2
C19	IO	HD45	**G11**	**P**	**VCCFP**	**N05**	**P**	**GND**	W25	IO	HTRDY#	AC19	O	MA14	AF19	IO	MD21
C20	IO	HD38	**G12**	**P**	**VCCFP**	**N07**	**P**	**VCCFP**	W26	IO	RS0#	AC20	O	CKE0	AF20	IO	MD20
C21	IO	HD28	**G13**	**P**	**GND**	**N20**	**P**	**VTT**	Y01	IO	MD59	AC21	O	CKE2	AF21	IO	MD15
C22	IO	HD31	**G14**	**P**	**VTT**	**N22**	**P**	**GND**	**Y02**	**P**	**GND**	AC22	O	CKE1	AF22	O	DQS1#
C23	IO	HD25	**G15**	**P**	**VTT**	N23	IO	HA05	Y03	O	CS1#	AC23	I	MCLKFB	AF23	IO	MD13
C24	IO	HD30	**G16**	**P**	**VTT**	N24	IO	HA12	**Y04**	**P**	**GND**	**AC24**	**P**	**GNDMCK**	AF24	IO	MD09
C25	IO	HD07	**G17**	**P**	**VTT**	N25	IO	HA16	**Y05**	**P**	**VCCM**	**AC25**	**P**	**GND**	AF25	IO	MD03
C26	IO	HD03	**G18**	**P**	**VTT**	N26	IO	HA13	**Y08**	**P**	**VCCM**	AC26	IO	MD01	AF26	IO	MD07

Center **VCC25** Pins (44 pins): **H8-19, J8,19, K8,19, L8,19, M8,19, N8,19, P8,19, R8,19, T8,19, V8,19, W8,19, Y8-19**
Center **GND** Pins (37 pins): **G13, L11-16, M11-16, N11-16, P11-16, R11-16, T11-16**

Table 3. Pin List (Alphabetical Order)

Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Name	Pin #		Pin Names	Pin #		Pin Name
A10	O	AB	N01	O	FPD21 / DFD10 / strap	P24	IO	HA09	A15	IO	HD54	AC09	IO	MD40	**K07**	**P**	**VCCFP**
B10	O	AG	N02	O	FPD22 / DFD11 / strap	M26	IO	HA10	B15	IO	HD55	AE08	IO	MD41	**L05**	**P**	**VCCFP**
AA25	IO	ADS#	N04	O	FPD23 / DFDET	R26	IO	HA11	A14	IO	HD56	AC07	IO	MD42	**L07**	**P**	**VCCFP**
B08	O	AGPBUSY#	F01	O	FPDE / CPD08	N24	IO	HA12	A16	IO	HD57	AF06	IO	MD43	**M05**	**P**	**VCCFP**
A07	I	AGPSTDBY	F02	O	FPHS / CPHS	N26	IO	HA13	E13	IO	HD58	AD08	IO	MD44	**M07**	**P**	**VCCFP**
C08	IO	AGPSTP#	F03	O	FPVS / CPVS	R23	IO	HA14	D16	IO	HD59	AF08	IO	MD45	**N07**	**P**	**VCCFP**
C07	I	AGPSUSP	P04	I	GCLK	M23	IO	HA15	C14	IO	HD60	AE06	IO	MD46	**AA24**	**P**	**VCCHCK**
C10	O	AR	**B13**	**P**	**GND**	N25	IO	HA16	B14	IO	HD61	AE05	IO	MD47	**U07**	**P**	**VCCM**
B07	I	BISTIN	**B16**	**P**	**GND**	K26	IO	HA17	D15	IO	HD62	AF05	IO	MD48	**V07**	**P**	**VCCM**
R22	IO	BNR#	**B19**	**P**	**GND**	H23	IO	HA18	C17	IO	HD63	AF04	IO	MD49	**V20**	**P**	**VCCM**
T26	IO	BPRI#	**B22**	**P**	**GND**	K24	IO	HA19	W23	IO	HIT#	AF01	IO	MD50	**W07**	**P**	**VCCM**
AA26	O	BREQ0#	**B25**	**P**	**GND**	K23	IO	HA20	V23	I	HITM#	AD03	IO	MD51	**W20**	**P**	**VCCM**
AC20	O	CKE0	**E06**	**P**	**GND**	M25	IO	HA21	V25	I	HLOCK#	AD04	IO	MD52	**Y05**	**P**	**VCCM**
AC22	O	CKE1	**E10**	**P**	**GND**	K25	IO	HA22	U24	IO	HREQ0#	AC04	IO	MD53	**Y08**	**P**	**VCCM**
AC21	O	CKE2	**E11**	**P**	**GND**	L23	IO	HA23	T23	IO	HREQ1#	AF02	IO	MD54	**Y09**	**P**	**VCCM**
AD23	O	CKE3	**E14**	**P**	**GND**	J24	IO	HA24	U26	IO	HREQ2#	AE01	IO	MD55	**Y10**	**P**	**VCCM**
E03	I	CPCLK	**E15**	**P**	**GND**	L26	IO	HA25	V24	IO	HREQ3#	AD01	IO	MD56	**Y11**	**P**	**VCCM**
D04	I	CPD00	**E18**	**P**	**GND**	H22	IO	HA26	T25	IO	HREQ4#	AB03	IO	MD57	**Y12**	**P**	**VCCM**
D03	I	CPD01	**E21**	**P**	**GND**	J25	IO	HA27	A09	O	HSYNC	AA02	IO	MD58	**Y13**	**P**	**VCCM**
D02	I	CPD02	**E25**	**P**	**GND**	M24	IO	HA28	W25	IO	HTRDY#	Y01	IO	MD59	**Y14**	**P**	**VCCM**
D01	I	CPD03	**G13**	**P**	**GND**	J23	IO	HA29	B06	O	INTA#	AD02	IO	MD60	**Y15**	**P**	**VCCM**
E02	I	CPD04	**H25**	**P**	**GND**	J26	IO	HA30	AD10	O	MA00	AC01	IO	MD61	**Y16**	**P**	**VCCM**
E01	I	CPD05	**J05**	**P**	**GND**	L24	IO	HA31	AD11	O	MA01	AA03	IO	MD62	**Y17**	**P**	**VCCM**
E04	I	CPD06	**K05**	**P**	**GND**	Y23	I	HCLK	AC11	O	MA02	AA01	IO	MD63	**Y18**	**P**	**VCCM**
F04	I	CPD07	**L22**	**P**	**GND**	H26	IO	HD00	AB13	O	MA03	**AB07**	**P**	**MEMVREF**	**Y19**	**P**	**VCCM**
H24	O	CPURST#	**L25**	**P**	**GND**	G23	IO	HD01	AC13	O	MA04	**AB20**	**P**	**MEMVREF**	**AA05**	**P**	**VCCM**
AA04	O	CS0#	**M22**	**P**	**GND**	E23	IO	HD02	AC14	O	MA05	AB10	–	NC	**AB08**	**P**	**VCCM**
Y03	O	CS1#	**N05**	**P**	**GND**	C26	IO	HD03	AD14	O	MA06	AC10	–	NC	**AB09**	**P**	**VCCM**
AC03	O	CS2#	**N22**	**P**	**GND**	G24	IO	HD04	AB16	O	MA07	W01	I	PWROK	**AB18**	**P**	**VCCM**
W04	O	CS3#	**P02**	**P**	**GND**	G22	IO	HD05	AC16	O	MA08	W03	I	RESET#	**AB19**	**P**	**VCCM**
W24	IO	DBSY#	**P05**	**P**	**GND**	G25	IO	HD06	AB17	O	MA09	W26	IO	RS0#	**AB21**	**P**	**VCCM**
H04	I	DCLKI	**P22**	**P**	**GND**	C25	IO	HD07	AC06	O	MA10	V26	IO	RS1#	**AB22**	**P**	**VCCM**
J04	O	DCLKO	**P25**	**P**	**GND**	F23	IO	HD08	AB06	O	MA11	Y25	IO	RS2#	**AB24**	**P**	**VCCMCK**
U23	IO	DEFER#	**U02**	**P**	**GND**	E24	IO	HD09	AD06	O	MA12	A11	A	RSET	**B12**	**P**	**VCCPLL1**
A06		DFTIN	**U04**	**P**	**GND**	F26	IO	HD10	AC17	O	MA13	AB04	O	SCAS#	**D12**	**P**	**VCCPLL2**
AD25	O	DQM0	**U25**	**P**	**GND**	D26	IO	HD11	AC19	O	MA14	E09	IO	SPCLK1	**C13**	**P**	**VCCPLL3**
AD22	O	DQM1	**W22**	**P**	**GND**	F24	IO	HD12	AC23	I	MCLKFB	A08	IO	SPCLK2	**D10**	**P**	**VCCRGB**
AF18	O	DQM2	**Y02**	**P**	**GND**	D24	IO	HD13	AB23	O	MCLK	D09	IO	SPDAT1	**P07**	**P**	**VCCVL**
AC15	O	DQM3	**Y04**	**P**	**GND**	D25	IO	HD14	AA23	IO	MD00	C09	IO	SPDAT2	**R07**	**P**	**VCCVL**
AE11	O	DQM4	**Y22**	**P**	**GND**	G26	IO	HD15	AC26	IO	MD01	AD05	O	SRAS#	**T07**	**P**	**VCCVL**
AF07	O	DQM5	**AA22**	**P**	**GND**	B26	IO	HD16	AD24	IO	MD02	W02	I	SUSST#	**U05**	**P**	**VCCVL**
AF03	O	DQM6	**AB11**	**P**	**GND**	F25	IO	HD17	AF25	IO	MD03	AB05	O	SWE#	**V05**	**P**	**VCCVL**
AB02	O	DQM7	**AB12**	**P**	**GND**	E26	IO	HD18	AB26	IO	MD04	D05	O	TVBL# / DVIDE	T03	O	VDNCMD
AD26	IO	DQS0#	**AB14**	**P**	**GND**	B23	IO	HD19	AB25	IO	MD05	C02	O	TVCLK / DVICLK	R02	O	VDNSTB
AF22	IO	DQS1#	**AB15**	**P**	**GND**	D23	IO	HD20	AE26	IO	MD06	C03	I	TVCLKR	R03	O	VDNSTB#
AE18	IO	DQS2#	**AC02**	**P**	**GND**	A26	IO	HD21	AF26	IO	MD07	B02	O	TVD00 / DVID00	**V04**	**A**	**VLCOMP**
AD15	IO	DQS3#	**AC05**	**P**	**GND**	B21	IO	HD22	AE24	IO	MD08	A02	O	TVD01 / DVID01	U03	IO	VLPAR
AF11	IO	DQS4#	**AC08**	**P**	**GND**	A25	IO	HD23	AF24	IO	MD09	B03	O	TVD02 / DVID02	**T04**	**P**	**VLVREF**
AD07	IO	DQS5#	**AC18**	**P**	**GND**	B24	IO	HD24	AD21	IO	MD10	A03	O	TVD03 / DVID03	**W05**	**P**	**VSUS25**
AE03	IO	DQS6#	**AC25**	**P**	**GND**	C23	IO	HD25	AD20	IO	MD11	C04	O	TVD04 / DVID04	B09	O	VSYNC
AB01	IO	DQS7#	**AE02**	**P**	**GND**	A24	IO	HD26	AE23	IO	MD12	B04	O	TVD05 / DVID05	**E16**	**P**	**VTT**
Y26	IO	DRDY#	**AE04**	**P**	**GND**	D19	IO	HD27	AF23	IO	MD13	A04	O	TVD06 / DVID06	**E17**	**P**	**VTT**
C01	I	DVIDET	**AE07**	**P**	**GND**	C21	IO	HD28	AE21	IO	MD14	C05	O	TVD07 / DVID07	**E22**	**P**	**VTT**
H05	O	ENBLT	**AE10**	**P**	**GND**	D21	IO	HD29	AF21	IO	MD15	B05	O	TVD08 / DVID08	**F22**	**P**	**VTT**
G04	O	ENVDD	**AE13**	**P**	**GND**	C24	IO	HD30	AE20	IO	MD16	A05	O	TVD09 / DVID09	**G14**	**P**	**VTT**
G05	O	ENVEE	**AE16**	**P**	**GND**	C22	IO	HD31	AD19	IO	MD17	C06	O	TVD10 / DVID10	**G15**	**P**	**VTT**
J03	O	FPCLK / DFCLK	**AE19**	**P**	**GND**	A22	IO	HD32	AD18	IO	MD18	D06	O	TVD11 / DVID11	**G16**	**P**	**VTT**
G03	O	FPD00 / CPD9	**AE22**	**P**	**GND**	A23	IO	HD33	AF17	IO	MD19	B01	O	TVHS / DVIHS	**G17**	**P**	**VTT**
G02	O	FPD01 / CPD10	**AE25**	**P**	**GND**	A21	IO	HD34	AF20	IO	MD20	A01	O	TVVS / DVIVS	**G18**	**P**	**VTT**
G01	O	FPD02 / CPD11	**D11**	**P**	**GNDDAC**	D22	IO	HD35	AF19	IO	MD21	P01	IO	VAD0 / strap	**G19**	**P**	**VTT**
H03	O	FPD03 / CPCK1	**Y24**	**P**	**GNDHCK**	A20	IO	HD36	AE17	IO	MD22	P03	IO	VAD1 / strap	**H20**	**P**	**VTT**
H02	O	FPD04 / CPD12	**AC24**	**P**	**GNDMCK**	B20	IO	HD37	AD17	IO	MD23	U01	IO	VAD2 / strap	**J20**	**P**	**VTT**
H01	O	FPD05 / CPD13	**A12**	**P**	**GNDPLL1**	C20	IO	HD38	AD16	IO	MD24	R04	IO	VAD3 / strap	**J22**	**P**	**VTT**
J02	O	FPD06 / CPD14	**C12**	**P**	**GNDPLL2**	A19	IO	HD39	AE15	IO	MD25	V03	IO	VAD4	**K20**	**P**	**VTT**
J01	O	FPD07 / CPD15	**A13**	**P**	**GNDPLL3**	B17	IO	HD40	AF14	IO	MD26	R01	IO	VAD5	**K22**	**P**	**VTT**
K03	O	FPD08 / DFVS / strap	**B11**	**P**	**GNDRGB**	C18	IO	HD41	AF13	IO	MD27	V01	IO	VAD6	**L20**	**P**	**VTT**
K02	O	FPD09 / DFHS / strap	D07	IO	GPIO0	D18	IO	HD42	AF16	IO	MD28	V02	IO	VAD7	**M20**	**P**	**VTT**
K01	O	FPD10 / DFDE / strap	E07	IO	GPIO1	D20	IO	HD43	AF15	IO	MD29	R05	IO	VBE#	**N20**	**P**	**VTT**
K04	O	FPD11 / DFD00 / strap	D08	IO	GPIO2	E19	IO	HD44	AE14	IO	MD30	**C11**	**P**	**VCCDAC**	**P20**	**P**	**VTT**
L04	O	FPD12 / DFD01 / strap	E08	IO	GPIO3	C19	IO	HD45	AD13	IO	MD31	**E05**	**P**	**VCCFP**	**R20**	**P**	**VTT**
L03	O	FPD13 / DFD02 / strap	**E20**	**P**	**GTLVREF**	C15	IO	HD46	AC12	IO	MD32	**F05**	**P**	**VCCFP**	**T20**	**P**	**VTT**
L02	O	FPD14 / DFD03 / strap	**T22**	**P**	**GTLVREF**	A17	IO	HD47	AE12	IO	MD33	**G08**	**P**	**VCCFP**	**U20**	**P**	**VTT**
L01	O	FPD15 / DFD04 / strap	P26	IO	HA03	D17	IO	HD48	AF10	IO	MD34	**G09**	**P**	**VCCFP**	**U22**	**P**	**VTT**
M04	O	FPD16 / DFD05 / strap	R25	IO	HA04	B18	IO	HD49	AF09	IO	MD35	**G10**	**P**	**VCCFP**	**V22**	**P**	**VTT**
M02	O	FPD17 / DFD06 / strap	N23	IO	HA05	D13	IO	HD50	AF12	IO	MD36	**G11**	**P**	**VCCFP**	T05	I	VUPCMD
M01	O	FPD18 / DFD07 / strap	P23	IO	HA06	A18	IO	HD51	AD12	IO	MD37	**G12**	**P**	**VCCFP**	T02	I	VUPSTB
M03	O	FPD19 / DFD08 / strap	T24	IO	HA07	C16	IO	HD52	AD09	IO	MD38	**H07**	**P**	**VCCFP**	T01	I	VUPSTB#
N03	O	FPD20 / DFD09 / strap	R24	IO	HA08	D14	IO	HD53	AE09	IO	MD39	**J07**	**P**	**VCCFP**	E12	I	XIN

Center **VCC25** Pins (44 pins): **H8-19, J8,19, K8,19, L8,19, M8,19, N8,19, P8,19, R8,19, T8,19, V8,19, W8,19, Y8-19**
Center **GND** Pins (37 pins): **G13, L11-16, M11-16, N11-16, P11-16, R11-16, T11-16**

Pin Descriptions

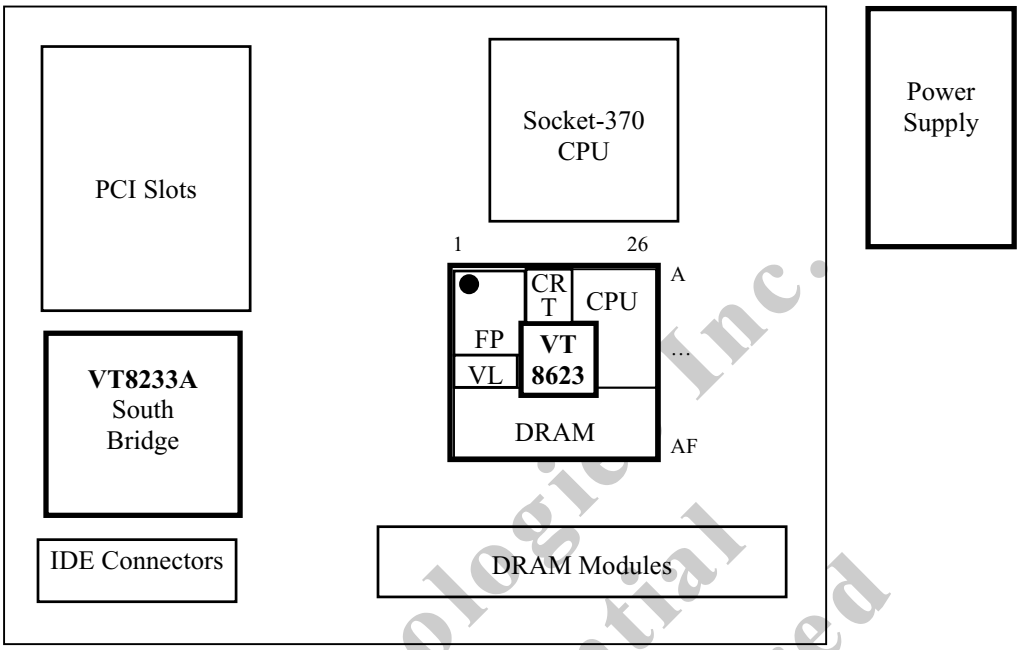
Table 4. Pin Descriptions

CPU Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
HA[31:3]#	(see pin list)	IO	**Host Address Bus.** HA[31:3] connect to the address bus of the host CPU. During CPU cycles HA[31:3] are inputs. These signals are driven by the CLE266 north bridge during cache snooping operations.
HD[63:0]#	(see pin list)	IO	**Host CPU Data.** These signals are connected to the CPU data bus.
ADS#	AA25	IO	**Address Strobe**. The CPU asserts ADS# in T1 of the CPU bus cycle.
BNR#	R22	IO	**Block Next Request**. Used to block the current request bus owner from issuing new requests. This signal is used to dynamically control the processor bus pipeline depth.
BPRI#	T26	IO	**Priority Agent Bus Request**. The owner of this signal will always be the next bus owner. This signal has priority over symmetric bus requests and causes the current symmetric owner to stop issuing new transactions unless the HLOCK# signal is asserted. The CLE266 north bridge drives this signal to gain control of the processor bus.
DBSY#	W24	IO	**Data Bus Busy**. Used by the data bus owner to hold the data bus for transfers requiring more than one cycle.
DEFER#	U23	IO	**Defer**. A dynamic deferring policy is used to optimize system performance. The DEFER# signal is also used to indicate a processor retry response.
DRDY#	Y26	IO	**Data Ready**. Asserted for each cycle that data is transferred.
HIT#	W23	IO	**Hit**. Indicates that a caching agent holds an unmodified version of the requested line. Also driven in conjunction with HITM# by the target to extend the snoop window.
HITM#	V23	I	**Hit Modified**. Asserted by the CPU to indicate that the address presented with the last assertion of EADS# is modified in the L1 cache and needs to be written back.
HLOCK#	V25	I	**Host Lock**. All CPU cycles sampled with the assertion of HLOCK# and ADS# until the negation of HLOCK# must be atomic.
HREQ[4:0]#	T25, V24, U26, T23, U24	IO	**Request Command**. Asserted during both clocks of the request phase. In the first clock, the signals define the transaction type to a level of detail that is sufficient to begin a snoop request. In the second clock, the signals carry additional information to define the complete transaction type.
HTRDY#	W25	IO	**Host Target Ready**. Indicates that the target of the processor transaction is able to enter the data transfer phase.
RS[2:0]#	Y25, V26, W26	IO	**Response Signals**. Indicates the type of response per the table below: **RS[2:0]# — Response type** 000 — Idle State 001 — Retry Response 010 — Defer Response 011 — Reserved 100 — Hard Failure 101 — Normal Without Data 110 — Implicit Writeback 111 — Normal With Data
CPURST#	H24	O	**CPU Reset.** Reset output to CPU. External pullup and filter capacitor to ground should be provided per CPU manufacturer's recommendations.
BREQ0#	AA26	O	**Bus Request 0.** Bus request output to CPU.

Note: Clocking of the CPU interface is performed with HCLK.

Note: Internal pullup resistors are provided on all GTL interface pins. If the CPU does not have internal pullups, the north bridge internal pullups may be enabled to allow the interface to meet GTL bus interface specifications (see strap descriptions).

The pinouts were defined assuming the ATX PCB layout model shown below (and general pin layout shown) as a guide for PCB component placement. Other PCB layouts (AT, LPX, and NLX) were also considered and can typically follow the same general component placement.



V-Link Interface							
Signal Name	**Pin #**	**I/O**	**Signal Description**				
VAD7,	V2	IO	**Address/Data Bus.**				
VAD6,	V1	IO					
VAD5,	R1	IO					
							SB
VAD4,	V3	IO	Strap	Function	Setting (L=strap low, H=strap high)	Register	Pin
VAD3 / strap,	R4	IO	VAD3	GTL Pullup Enable	L=Disable, H=Enable	Rx50[6]	SA19
VAD2 / strap,	U1	IO	VAD2	IOQ Depth	L=1-Level, H=8-Level	Rx50[7]	SA18
VAD1 / strap,	P3	IO	VAD1	CPU FSB Clock Msb	LL=66 MHz, LH=100 MHz	Rx54[7]	SA17
VAD0 / strap	P1	IO	VAD0	CPU FSB Clock Lsb	Hx=133 MHz	Rx54[6]	SA16
VLPAR	U3	IO	**Parity.**				
VBE#	R5	IO	**Byte Enable.**				
VUPCMD	T5	I	**Command from Client-to-Host.**				
VUPSTB	T2	I	**Strobe from Client-to-Host.**				
VUPSTB#	T1	I	**Complement Strobe from Client-to-Host.**				
VDNCMD	T3	O	**Command from Host-to-Client.**				
VDNSTB	R2	O	**Strobe from Host-to-Client.**				
VDNSTB#	R3	O	**Complement Strobe from Host-to-Client.**				

DDR Synchronous DRAM Memory Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
MD[63:0]	(see pinout tables)	IO	**Memory Data.** These signals are connected to the DRAM data bus. Output drive strength may be set by Device 0 Rx6D[1-0].
MA[14-0]	AC19, AC17, AD6, AB6, AC6, AB17, AC16, AB16, AD14, AC14, AC13, AB13, AC11, AD11, AD10	O	**Memory Address.** DRAM address lines. Output drive strength may be set by Device 0 Rx6C[7-6].
CS[3:0]#	W4, AC3, Y3, AA4	O	**Chip Select.** Chip select of each bank. Output drive strength may be set by Device 0 Rx6D[3-2].
DQM[7:0]	AB2, AF3, AF7, AE11, AC15, AF18, AD22, AD25	O	**Data Mask.** Data mask of each byte lane. Output drive strength may be set by Device 0 Rx6D[5-4].
DQS[7:0]#	AB1, AE3, AD7, AF11, AD15, AE18, AF22, AD26	IO	**DDR Data Strobe.** Data strobe of each byte lane. Output drive strength may be set by Device 0 Rx6C[3-2].
SRAS#	AD5	O	**Row Address Command Indicator.** Output drive strength may be set by Device 0 Rx6C[7-4].
SCAS#	AB4	O	**Column Address Command Indicator.** Output drive strength may be set by Device 0 Rx6C[7-4].
SWE#	AB5	O	**Write Enable Command Indicator.** Output drive strength may be set by Device 0 Rx6C[7-4].
CKE[3:0]	AD23, AC21, AC22, AC20	O	**Clock Enables.** Clock enables for each DRAM bank for powering down the SDRAM or clock control for reducing power usage and for reducing heat / temperature in high-speed memory systems. See Device 0 Rx6B[4].

SMB / I2C Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
SPCLK[2:1]	A8, E9	IO	**Serial Port (SMB/I2C) Clocks.** These are the clocks for serial data transfer. SPCLK1 is typically used for DDC communications with a CRT monitor. As an output, it is programmed via CRA0[0]. As an input, its status is read via CRA0[2]. In either case the serial port must be enabled by CRA0[4] = 1. SPCLK2 is typically used for I^2C communications. As an output, it is programmed via CRB1[0]. As an input, its status is read via CRB1[2]. The port is enabled via CRB1[4] = 1.
SPDAT[2:1]	C9, D9	IO	**Serial Port (SMB/I2C) Data.** These are the data signals used for serial data transfer. SPDAT1 is typically used for DDC communications with a CRT monitor. As an output, it is programmed via CRA0[1]. As an input, its status is read via CRA0[3]. In either case the serial port must be enabled by CRA0[4] = 1. SPDAT2 is typically used for I^2C communications. As an output, it is programmed via CRB1[1]. As an input, its status is read via CRB1[3]. The port is enabled via CRB1[4] = 1.

Digital Monitor (DVI) Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
DVID11 / TVD11, **DVID10** / TVD10, **DVID09** / TVD9, **DVID08** / TVD8, **DVID07** / TVD7, **DVID06** / TVD6, **DVID05** / TVD5, **DVID04** / TVD4, **DVID03** / TVD3, **DVID02** / TVD2, **DVID01** / TVD1, **DVID00** / TVD0	D6 C6 A5 B5 C5 A4 B4 C4 A3 B3 A2 B2	O	**Digital Monitor Data Out.** Internally pulled down during reset
DVICLK / TVCLK	C2	O	**Digital Monitor Clock Out.** Internally pulled down during reset
DVIHS / TVHS	B1	O	**Digital Monitor Horizontal Sync.** Internally pulled down during reset
DVIVS / TVVS	A1	O	**Digital Monitor Vertical Sync.** Internally pulled down during reset
DVIDE / TVBL#	D5	O	**Digital Monitor Display Enable.** Indicates valid data on DVID[11:0]. Internally pulled down during reset
DVIDET / NC	C1	I	**Digital Monitor Detect.** Rx?? will read 1 if a digital monitor is connected. Must be tied to GND if not used.

TV Encoder Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
TVD11 / DVID11, **TVD10** / DVID10, **TVD9** / DVID09, **TVD8** / DVID08, **TVD7** / DVID07, **TVD6** / DVID06, **TVD5** / DVID05, **TVD4** / DVID04, **TVD3** / DVID03, **TVD2** / DVID02, **TVD1** / DVID01, **TVD0** / DVID00	D6 C6 A5 B5 C5 A4 B4 C4 A3 B3 A2 B2	O	**TV Encoder Data.** Internally pulled down during reset
TVCLKR / NC	C3	I	**TV Encoder Clock In.** Input clock from encoder. Internally pulled down.
TVCLK / DVICLK	C2	O	**TV Encoder Clock Out.** Output clock to TV encoder. Internally pulled down.
TVHS / DVIHS	B1	O	**TV Encoder Horizontal Sync.** Internally pulled down during reset
TVVS / DVIVS	A1	O	**TV Encoder Vertical Sync.** Internally pulled down during reset
TVBL# / DVIDE	D5	O	**TV Encoder Blanking.** Internally pulled down during reset

CRT Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
AR	C10	A	**Analog Red.** Analog red output to the CRT monitor.
AB	A10	A	**Analog Blue.** Analog blue output to the CRT monitor.
AG	B10	A	**Analog Green.** Analog green output to the CRT monitor.
HSYNC	A9	O	**Horizontal Sync.** Output to CRT.
VSYNC	B9	O	**Vertical Sync.** Output to CRT.
RSET	A11	A	**Reference Resistor.** Tie to GNDRGB through an external 140 Ω resistor to control the RAMDAC full-scale current value.

Direct LCD Panel Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
FPD23 / DFDET,	N4	O	**Flat Panel Data Out.** Bits 8-22 also function as strap inputs that are sampled on the rising edge of RESET#. These straps are defined per the table below. "L" indicates strap low (4.7KΩ to ground), "H" = strap high (4.7KΩ to 10KΩ t 3.3V). See Design Guide for details.
FPD22 / DFD11 / strap,	N2	O	
FPD21 / DFD10 / strap,	N1	O	
FPD20 / DFD09 / strap,	N3	O	
FPD19 / DFD08 / strap,	M3	O	
FPD18 / DFD07 / strap,	M1	O	Strap / Function / Setting / Register
FPD17 / DFD06 / strap,	M2	O	FPD22 / Reserved for Test / Always Strap Low / –
FPD16 / DFD05 / strap,	M4	O	
FPD15 / DFD04 / strap,	L1	O	FPD21-20 / TV Mode / LL=PAL, LH=NTSC, HL=PAL-N, HH=PAL-NC / EXSR13[4:3]
FPD14 / DFD03 / strap,	L2	O	
FPD13 / DFD02 / strap,	L3	O	FPD19 / TV # of Lines / L=525 Lines, H=625 Lines / EXSR12[6]
FPD12 / DFD01 / strap,	L4	O	
FPD11 / DFD00 / strap,	K4	O	FPD18 / DVI Port Configuration / L=DVI, H=TV / EXSR12[5]
FPD10 / DFDE / strap,	K1	O	FPD17 / Panel Interface Config / L=DVI / Capture, H=Panel / EXSR12[4]
FPD9 / DFHS / strap,	K2	O	FPD16-13 / Panel Type / Customer Defined (contact VIA) / EXSR12[3:0]
FPD8 / DFVS / strap,	K3	O	
FPD7 / CPD15,	J1	O	FPD12 / Reserved for Test / Always Strap Low / –
FPD6 / CPD14,	J2	O	FPD11 / Reserved for Test / Always Strap Low / –
FPD5 / CPD13,	H1	O	FPD10 / Reserved for Test / Always Strap Low / –
FPD4 / CPD12,	H2	O	FPD9 / Reserved for Test / Always Strap Low / –
FPD3 / CPCK1,	H3	O	FPD8 / Reserved for Test / Always Strap Low / –
FPD2 / CPD11,	G1	O	
FPD1 / CPD10,	G2	O	
FPD0 / CPD09	G3	O	
FPVS / CPVS	F3	O	**Flat Panel Vertical Sync.** Internally pulled down.
FPHS / CPHS	F2	O	**Flat Panel Horizontal Sync.** Internally pulled down.
FPDE / CPD08	F1	O	**Flat Panel Data Enable.** Internally pulled down.
FPCLK / DFCLK	J3	O	**Flat Panel Clock.** Internally pulled down during reset.
ENVDD	G4	O	**Enable VDD.** This signal is driven high to initiate a flat panel power up sequence.
ENVEE	G5	O	**Enable VEE.** This signal is driven high for a programmable time after ENVDD is driven high during a flat panel power up sequence.
ENBLT	H5	O	**Enable Backlight.**

Video Capture Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
CPD15 / FPD7, **CPD14** / FPD6, **CPD13** / FPD5 **CPD12** / FPD4, **CPD11** / FPD2, **CPD10** / FPD1, **CPD09** / FPD0 **CPD08** / FPDE **CPD07** **CPD06** **CPD05** **CPD04** **CPD03** **CPD02** **CPD01** **CPD00**	J1 J2 H1 H2 G1 G2 G3 F1 F4 E4 E1 E2 D1 D2 D3 D4	I	**Flat Panel Data Out.**
CPVS / FPVS	F3	I	**Video Capture Vertical Sync.** Internally pulled down.
CPHS / FPHS	F2	I	**Video Capture Horizontal Sync.** Internally pulled down.
CPCLK	E3	I	**Video Capture Clock 0.** Clock for capture data inputs 0-7 (or 0-15 when capture port is configured as 16-bit)
CPCK1 / FPD3	H3	I	**Video Capture Clock 1.** Clock for capture data inputs 8-15 when used as a second 8-bit capture port.

Note: The Video Capture Port may always be used in 8-bit input mode. The "upper" data bits (CPD[15:8] may be used as a 16-bit extension or as a second 8-bit port if the 24-bit direct flat panel interface is not used.

Alternate Digital Monitor (DVI) Interface			
Signal Name	**Pin #**	**I/O**	**Signal Description**
DFD11 / FPD22, **DFD10** / FPD21, **DFD09** / FPD20, **DFD08** / FPD19, **DFD07** / FPD18, **DFD06** / FPD17, **DFD05** / FPD16, **DFD04** / FPD15, **DFD03** / FPD14, **DFD02** / FPD13, **DFD01** / FPD12, **DFD00** / FPD11	N2 N1 N3 M3 M1 M2 M4 L1 L2 L3 L4 K4	O	**Digital Monitor Data Out.**
DFCLK / FPCLK	J3	O	**Digital Monitor Clock.** Internally pulled down during reset.
DFHS / FPD9	K2	O	**Digital Monitor Horizontal Sync.** Internally pulled down during reset
DFVS / FPD8	K3	O	**Digital Monitor Vertical Sync.** Internally pulled down during reset
DFDE / FPD10	K1	O	**Digital Monitor Display Enable.** Indicates valid data on DFD[11:0]. Internally pulled down during reset
DFDET / FPD23	N4	O	**Digital Monitor Detect.** Rx?? will read 1 if a digital monitor is connected. Must be tied to GND if not used.

Note: All "DFxxx" pins perform the same function as the "DMxxx" pins (the other DVI interface muxed with the TV-out pins).

Clocks, Resets, Power Control, General Purpose I/O, Interrupts and Test			
Signal Name	**Pin #**	**I/O**	**Signal Description**
HCLK	Y23	I	**Host Clock.** This pin receives the host CPU clock (100 / 133 MHz). This clock is used by all CLE266 logic that is in the host CPU domain.
MCLK	AB23	O	**Memory (SDRAM) Clock.** Output from the internal clock generator to the external clock buffer.
MCLKFB	AC23	I	**Memory (SDRAM) Clock Feedback.** Input from the external clock buffer.
DCLKI	H4	I	**Dot Clock (Pixel Clock) In.** Used for external EMI reduction circuit if used. Loop back from DCLKO if external EMI reduction circuit not implemented.
DCLKO	J4	O	**Dot Clock (Pixel Clock) Out.** Used for external EMI reduction circuit if used. Loop back to DCLKI if external EMI reduction circuit not implemented.
XIN	E12	I	**Reference Frequency Input.** 14.31818 MHz reference clock input for the internal graphics controller Phase Locked Loops (PLLs). All internal graphics controller clocks are synthesized on chip using this frequency as a reference.
RESET#	W3	I	**Reset.** When asserted low, this signal resets the internal logic of the chip and sets all register bits to thier default values. The rising edge of this signal is used to sample all power-up strap options. Normally driven by the south bridge.
PWROK	W1	I	**Power OK.** When asserted high, this signal indicates that system voltages are correct and stable. Driven by on-board Power Good circuitry. Also connected to the chipset south bridge.
SUSST#	W2	I	**Suspend Status.** For implementation of the Suspend-to-DRAM feature. Normally driven by the south bridge. Connect to an external pullup if not used.
INTA#	B6	O	**Interrupt.** PCI interrupt output (handled by the interrupt controller in the South Bridge)
AGPBUSY#	B8	O	**AGP Interface Busy.** Connect to a south bridge GPIO pin for monitoring the status of the internal AGP bus. See CLE266 Design Guide for details.
GPIO0	D7	O	**General Purpose Input / Output 0.**
GPIO1	E7	O	**General Purpose Input / Output 1.**
GPIO2	D8	O	**General Purpose Input / Output 2.**
GPIO3	E8	O	**General Purpose Input / Output 3.**
AGPSTOP#	C8	I	**AGP Stop.** Assert low to stop the internal AGP interface (for power measurement only, not used in normal operation)
AGPSTDBY	A7	I	**AGP Standby.** Assert high to put the internal AGP interface into standby mode (for power measurement only, not used in normal operation)
AGPSUSP	C7	I	**AGP Suspend.** Assert high to put the internal AGP interface into suspend mode (for power measurement only, not used in normal operation)
GCLK	P4	I	**Graphics Clock.** 66 MHz clock from system clock sythesizer.
BISTIN	B7	I	**BIST (Built-In-Self-Test) In.** This pin is used for testing and must be tied low on all board designs.
DFTIN	A6	I	**DFT (Design-For-Test) In.** This pin is used for testing and must be tied low on all board designs.
NC	AB10, AC10	–	**No Connect.** Do not connect. Reserved for future use.

Power, Ground, and Test			
Signal Name	**Pin #**	**I/O**	**Signal Description**
VTT	(see pin list)	P	**Power** for **CPU I/O Interface Logic.** Voltage is CPU dependent. See CLE266 Design Guide for details.
GTLVREF	E20, T22	P	**CPU Interface GTL+ Voltage Reference.** 2/3 VTT ±2% typically derived using a resistive voltage divider. See CLE266 Design Guide for details.
VCCM	(see pin list)	P	**Power** for **Memory I/O Interface Logic.** 2.5 ±5%.
MEMVREF	AB7, AB20	P	**Memory Voltage Reference.**
VCCVL	P7, R7, T7, U5, V5	P	**Power** for **V-Link I/O Interface Logic.** 2.5V ±5%.
VLCOMP	V4	I	**V-Link P-Channel Compensation.** Connect 70 Ω 1% resistor to ground.
VLVREF	T4	P	**V-Link Voltage Reference.** 0.9V derived using a resistive voltage divider between VCC25 and ground (see Design Guide for details).
VCC25	(see pin list)	P	**Power** for **Internal Digital Logic.** 2.5V ±5%.
VSUS25	W5	P	**Suspend Power.** 2.5V ±5%.
VCCHCK	AA24	P	**Power for Host CPU Clock DLL.** 2.5V ±5%.
VCCMCK	AB24	P	**Power for Memory Clock DLL.** 2.5V ±5%.
VCCFP	(see pin table)	P	**Power for Flat Panel, DVI, TV-Out and Video Capture Interfaces.** 3.3V ±5%.
VCCRGB	D10	P	**Power for CRT RGB Outputs.** 2.5V ±5%.
VCCDAC	C11	P	**Power for DAC Digital Logic.** 2.5V ±5%.
VCCPLL1	B12	P	**Power for Graphics Controller PLL 1.** 2.5V ±5%.
VCCPLL2	D12	P	**Power for Graphics Controller PLL 2.** 2.5V ±5%.
VCCPLL3	C13	P	**Power for Graphics Controller PLL 3.** 2.5V ±5%.
GND	(see pin table)	P	**Ground** for **Internal Digital Logic.** Connect to primary PCB ground plane.
GNDHCK	Y24	P	**Ground for Host CPU Clock Circuitry.** Connect to main ground plain through a ferrite bead.
GNDMCK	AC24	P	**Ground for Memory Clock Circuitry.** Connect to main ground plain through a ferrite bead.
GNDRGB	B11	P	**Connection Point for RGB Load Resistors.**
GNDDAC	D11	P	**Ground for DAC Digital Circuitry.**
GNDPLL1	A12	P	**Ground for Graphics Controller PLL 1.**
GNDPLL2	C12	P	**Ground for Graphics Controller PLL 2.**
GNDPLL3	A13	P	**Ground for Graphics Controller PLL 3.**

REGISTERS

Register Overview

The following tables summarize the configuration and I/O registers. These tables also document the power-on default value ("Default") and access type ("Acc") for each register. Access type definitions used are RW (Read/Write), RO (Read/Only), "—" for reserved / used (essentially the same as RO), and RWC (or just WC) (Read / Write 1's to Clear individual bits). Registers indicated as RW may have some read/only bits that always read back a fixed value (usually 0 if unused); registers designated as RWC or WC may have some read-only or read write bits (see individual register descriptions following these tables for details). All offset and default values are shown in hexadecimal unless otherwise indicated.

Table 5. Registers

I/O Ports

Port #	I/O Port	Default	Acc
0022	PCI / AGP Arbiter Disable	00	RW
0CFB-0CF8	Configuration Address	0000 0000	RW
0CFF-0CFC	Configuration Data	0000 0000	RW

Device 0 Registers - Host Bridge

Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	**1106**	RO
3-2	Device ID	**3123**	RO
5-4	Command	**0006**	**RW**
7-6	Status	**0210**	**WC**
8	Revision ID	**0n**	RO
9	Program Interface	00	RO
A	Sub Class Code	00	RO
B	Base Class Code	**06**	RO
C	-reserved-	00	—
D	Latency Timer	00	**RW**
E	Header Type	00	RO
F	Built In Self Test (BIST)	00	RO
13-10	Graphics Aperture Base	**0000 0008**	**RW**
14-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	0000	**W1**
2F-2E	Subsystem ID	0000	**W1**
30-33	-reserved-	00	—
34	Capability Pointer	**A0**	RO
35-3F	-reserved-	00	—

Device-Specific Registers

Offset	V-Link Control	Default	Acc
40	V-Link Revision ID	00	**RO**
41	V-Link NB Capability	**18**	**RO**
42	V-Link NB Downlink Command	**88**	RW
44-43	V-Link NB Uplink Status	**8280**	**RO**
45	V-Link NB Bus Timer	**44**	RW
46	V-Link Misc NB Control	00	RW
47	V-Link Control	00	RW
48	V-Link NB/SB Configuration	**18**	RW
49	V-Link SB Capability	**18**	RW
4A	V-Link SB Downlink Status	**88**	**RO**
4C-4B	V-Link SB Uplink Command	**8280**	RW
4D	V-Link SB Bus Timer	**44**	RW
4E	CCA Master High Priority	00	RW
4F	V-Link SB Miscellaneous Control	00	RW

Offset	Host CPU Protocol Control	Default	Acc
50	CPU Interface Request Phase Control	**20**	RW
51	CPU Interface Basic Control	00	RW
52	CPU Interface Advanced Control	00	RW
53	CPU Interface Arbitration Control	**03**	RW
54	CPU Miscellaneous Control	00	RW

Device-Specific Registers (continued)

Offset	DRAM Control	Default	Acc
55	DRAM Control	00	RW
56-57	-reserved-	00	—
58	MA Map Type	**22**	RW
59	-reserved-	00	—
5F-5A	DRAM Row Ending Address:		
5A	Bank 0 Ending (HA[31:24])	**01**	RW
5B	Bank 1 Ending (HA[31:24])	**01**	RW
5C	Bank 2 Ending (HA[31:24])	**01**	RW
5D	Bank 3 Ending (HA[31:24])	**01**	RW
5E-5F	-reserved-	**01**	RW
60	DRAM Type	00	RW
61	ROM Shadow Control C0000-CFFFF	00	RW
62	ROM Shadow Control D0000-DFFFF	00	RW
63	ROM Shadow Control E0000-FFFFF	00	RW
64	DRAM Timing for All Banks	**E4**	RW
65	DRAM Arbitration Timer	00	RW
66	DRAM Arbitration Control	00	RW
67	DRAM DQS/SDR/MD Read Delay	00	RW
68	DRAM DDR Control	00	RW
69	Extended SMRAM Control	00	RW
6A	DRAM Refresh Counter	00	RW
6B	DRAM Arbitration Control	00	RW
6C	SDRAM Control	00	RW
6D	DRAM Control Drive Strength	00	RW
6E-6F	-reserved-	00	—

Offset	PCI Bus Control	Default	Acc
70	PCI Buffer Control	00	RW
71	CPU to PCI Flow Control	**48**	RW
72	-reserved-	00	—
73	PCI Master Control 1	00	RW
74	-reserved-	00	—
75	PCI Arbitration 1	00	RW
76	PCI Arbitration 2	00	RW
77-7F	-reserved-	00	—

Device 0 Device-Specific Registers (continued)

Offset	GART/TLB Control	Default	Acc
83-80	GART/TLB Control	0000 0000	RW
84	Graphics Aperture Size	00	RW
85	Write Policy	00	RW
86-87	-reserved-	00	—
8B-88	Gr. Aperture TLB Base Register Base	0000 0000	RW
8C-9F	-reserved-	00	—

Offset	AGP Control	Default	Acc
A0	AGP ID	**02**	**RO**
A1	AGP Next Item Pointer	**C0**	**RO**
A2	AGP Specification Revision	**20**	**RO**
A3	-reserved-	00	—
A7-A4	AGP Status	**1F00 0207**	**RO**
AB-A8	AGP Command	0000 0000	RW
AC	AGP Control	00	RW
AD	AGP Miscellaneous Control 1	**02**	RW
AE	AGP Miscellaneous Control 2	00	RW
AF-B3	-reserved-	00	—

Offset	V-Link Control	Default	Acc
B4	V-Link NB Compensation Control	00	RW
B5	V-Link NB Drive Control	00	RW
B6-B7	-reserved-	00	—
B8	V-Link SB Compensation Control	00	RW
B9	V-Link SB Drive Control	00	RW
BA-BB	-reserved-	00	—

Device 0 Device-Specific Registers (continued)

Offset	Power Management Control	Default	Acc
BC	Power Management Mode	00	RW
BD	DRAM Power Management	00	RW
BE	Dynamic Clock Stop	00	RW
BF	MA / SCMD Pad Toggle Reduction	00	RW
C0	Power Management Capability	**01**	**RO**
C1	Power Management Next Pointer	00	**RO**
C2	Power Management Capabilities I	02	**RO**
C3	Power Management Capabilities II	00	**RO**
C4	Power Management Control/Status	00	RW
C5	Power Management Status	00	RW
C6	PCI-to-PCI Bridge Support Extension	00	RW
C7	Power Management Data	00	RW
C8-DF	-reserved-	00	—

Offset	Frame Buffer & High Memory Ctrl	Default	Acc
E0	CPU Direct Access FB Base	00	RW
E1	CPU Direct Access FB Size	00	RW
E2	VGA Arbitration Timer 1	00	RW
E3	UMA Control	00	RW
E4-E5	-reserved-	00	—
E6	SMM / APIC Decoding	**01**	RW
E7	-reserved-	00	—
E8	VGA Arbitration Timer 2	**40**	RW
E9-EF	-reserved-	00	—

Offset	Test, BIOS Scratch, Miscellaneous	Default	Acc
F7-F0	BIOS Scratch Registers	00	RW
F8-FB	-reserved-	00	—
FC-FF	Reserved (Do Not Program)	0000	RW

Device 1 Registers - PCI-to-PCI Bridge

Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	**1106**	RO
3-2	Device ID	**B091**	RO
5-4	Command	**0007**	**RW**
7-6	Status	**0230**	**WC**
8	Revision ID	**0n**	RO
9	Programming Interface	00	RO
A	Sub Class Code	**04**	RO
B	Base Class Code	**06**	RO
C	-reserved-	00	—
D	Latency Timer	00	RO
E	Header Type	**01**	RO
F	-reserved- (Built In Self Test)	00	—
10-17	-reserved-	00	—
18	Primary Bus Number	00	**RW**
19	Secondary Bus Number	00	**RW**
1A	Subordinate Bus Number	00	**RW**
1B	Secondary Latency Timer	00	RO
1C	I/O Base	**F0**	**RW**
1D	I/O Limit	00	**RW**
1F-1E	Secondary Status	0000	RO
21-20	Memory Base	**FFF0**	**RW**
23-22	Memory Limit (Inclusive)	0000	**RW**
25-24	Prefetchable Memory Base	**FFF0**	**RW**
27-26	Prefetchable Memory Limit	0000	**RW**
28-33	-reserved-	00	—
34	Capability Pointer	**80**	RO
35-3D	-reserved-	00	—
3F-3E	PCI-to-PCI Bridge Control	0000	**RW**

Device-Specific Registers

Offset	AGP Bus Control	Default	Acc
40	CPU-to-AGP Flow Control 1	00	RW
41	CPU-to-AGP Flow Control 2	**08**	RW
42	AGP Master Control	00	RW
43	AGP Master Latency Timer	**22**	RW
44	Reserved (Do Not Program)	**20**	RW
45	Fast Write Control	**72**	RW
47-46	PCI-to-PCI Bridge Device ID	0000	RW
48	AGP Parity Error Control	00	RW
49-7F	-reserved-	00	—

Offset	Power Management	Default	Acc
80	Capability ID	**01**	**RO**
81	Next Pointer	00	**RO**
82	Power Management Capabilities 1	**02**	**RO**
83	Power Management Capabilities 2	00	**RO**
84	Power Management Control / Status	00	RW
85	Power Management Status	00	**RO**
86	PCI-PCI Bridge Support Extensions	00	**RO**
87	Power Management Data	00	**RO**
88-FF	-reserved-	00	—

Graphics Controller Registers

PCI Configuration Space Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	**1106**	RO
3-2	Device ID	**3122**	RO
5-4	Command	**0000**	**RW**
7-6	Status	**0230**	**WC**
8	Revision ID	**0n**	RO
9	Program Interface	00	RO
A	Sub Class Code	00	RO
B	Base Class Code	**03**	RO
C	-reserved-	00	—
D	Latency Timer	00	RO
E	Header Type	00	RO
F	Built In Self Test (BIST)	00	RO
13-10	Memory Base 0	**0000 0008**	**RW**
17-14	Memory Base 1	0000 0000	**RW**
18-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	0000	RO
2F-2E	Subsystem ID	0000	RO
30-33	-reserved-	00	—
34	Capability Pointer	**60**	RO
35-3B	-reserved-	00	—
3C	Interrupt Line	00	**RW**
3D	Interrupt Pin	**01**	**RW**
3E-3F	-reserved-	00	—

PCI Configuration Space Device-Specific Registers

Offset	Power Management Configuration	Default	Acc
40-5F	-reserved-	00	—
60	Capability ID	**01**	**RO**
61	Next Item Pointer	**70**	**RO**
63-62	Power Management Capabilities	**0622**	**RO**
65-64	Power Management Control / Status	0000	RW
67-66	Data + PM Control / Status BSE	0000	**RO**
68-6F	-reserved-	00	—

Offset	AGP Configuration	Default	Acc
70	Capability ID	**02**	**RO**
71	Next Item Pointer	00	**RO**
73-72	Revision Number	**0020**	**RO**
77-74	AGP Status	**1F00 0207**	**RO**
7B-78	AGP Command	0000 0000	RW
7C-FF	-reserved-	00	—

Memory Base 0

Up to 64 MB for the graphics and video playback buffer.

Memory Base 1

16 MB for memory mapped I/O, 2D host Bitblt space, and burst command area.

Offset Range	Memory Mapped I/O (0 to 2M-1)	Acc
0000-01FF	2D Engine Control	RW
0200-03FF	Video-related Engines Control	RW
0400-07FF	3D Engine Control	RW
0800-0BFF	Burst Command Area	RW
0C00-0DFF	DVD Engine (MPEG) Control	RW
0E00-0FFF	DMA / AGP Control	RW
1000-83BF	-reserved-	—
83Cx-83Dx	VGA Memory Mapped I/O	RW
83E0-FFFF	-reserved-	—

Offset Range	2D Host Bitblt / Burst Command Area	Acc
2M to 4M-1	2D Host Bitblt Space	RW
4M to 8M-1	Burst Command Area	RW
8M to 16M-1	-reserved-	—

VGA Registers

Port	Index	General Registers	Acc
3C2	-	Miscellaneous Output	**WO**
3CC	-	Miscellaneous Output	**RO**
3C2	-	Input Status 0	**RO**
3?A	-	Input Status 1	**RO**
3C3	-	Video Subsystem Enable	RW
46E8	-	Video Adapter Enable	RW

In the port column above "?" = B for monochrome mode and D for color mode.

Port	Index	Attribute Controller Registers	Acc
3C0	-	Index	RW
3C1	00-0F	Color Palette	RW
3C1	10	Mode Control	RW
3C1	11	Overscan Color	RW
3C1	12	Color Plane Enable	RW
3C1	13	Horizontal Pixel Panning	RW
3C1	14	Color Select	RW
3C1	15-7F	-reserved-	—

Port	Index	Sequencer Registers	Acc
3C4	-	Index	RW
3C5	00	Reset	RW
3C5	01	Clocking Mode	RW
3C5	02	Map Mask	RW
3C5	03	Character Map Select	RW
3C5	04	Memory Mode	RW
3C5	05-0F	-reserved-	—
3C5	10-7F	**(extended registers - see next page)**	

Port	Index	Graphics Controller Registers	Acc
3CE	-	Index	RW
3CF	00	Set / Reset	RW
3CF	01	Set / Reset Enable	RW
3CF	02	Color Compare	RW
3CF	03	Data Rotate	RW
3CF	04	Read Map Select	RW
3CF	05	Mode	RW
3CF	06	Miscellaneous	RW
3CF	07	Color Don't Care	RW
3CF	08	Bit Mask	RW
3CF	09-1F	-reserved-	—
3CF	20-7F	**(extended registers - see next page)**	

Refer to any VGA book or technical reference for detailed descriptions of the bits of the above VGA-standard registers.

Port	Index	CRT Controller Registers	Acc
3?4	-	Index	RW
3?5	00	Horizontal Total	RW
3?5	01	Horizontal Display End	RW
3?5	02	Start Horizontal Blank	RW
3?5	03	End Horizontal Blank	RW
3?5	04	Start Horizontal Retrace	RW
3?5	05	End Horizontal Retrace	RW
3?5	06	Vertical Total	RW
3?5	07	Overflow	RW
3?5	08	Preset Row Scan	RW
3?5	09	Max Scan Line	RW
3?5	0A	Cursor Start	RW
3?5	0B	Cursor End	RW
3?5	0C	Start Address High	RW
3?5	0D	Start Address Low	RW
3?5	0E	Cursor Location High	RW
3?5	0F	Cursor Location Low	RW
3?5	10	Vertical Retrace Start	RW
3?5	11	Vertical Retrace End	RW
3?5	12	Vertical Display End	RW
3?5	13	Offset	RW
3?5	14	Underline Location	RW
3?5	15	Start Vertical Blank	RW
3?5	16	End Vertical Blank	RW
3?5	17	CRTC Mode Control	RW
3?5	18	Line Compare	RW
3?5	19-31	-reserved-	—
3?5	32-7F	**(extended registers - see next page)**	

In the port column above "?" = B for monochrome mode and D for color mode.

Refer to any VGA book or technical reference for detailed descriptions of the bits of the above VGA-standard registers.

VGA Extended Registers

Port	Index	Extended Sequencer Registers	Acc
3C5	10	Extended Register Unlock	RW
3C5	11	Configuration 0	**RO**
3C5	12	Configuration 1	**RO**
3C5	13	Configuration 2	**RO**
3C5	14	Memory Clock DPA 0	RW
3C5	15	Display Mode Control	RW
3C5	16	Display FIFO Threshold Control	RW
3C5	17	Display FIFO Control	RW
3C5	18	Display Arbitor Control 0	RW
3C5	19	Clock Control	RW
3C5	1A	PCI Bus Control	RW
3C5	1B	Power Management Control 0	RW
3C5	1C	Horiz Display Quadword Count Data	RW
3C5	1D	Horiz Display Quadword Count Control	RW
3C5	1E	Power Management Control	RW
3C5	1F	Memory Control 0	RW
3C5	20	Typical Arbiter Control 0	RW
3C5	21	Typical Arbiter Control 1	RW
3C5	22	Display Arbiter Control 1	RW
3C5	23	Memory Control 1	RW
3C5	24	Memory Control 2	RW
3C5	25	General Purpose I/O Port	RW
3C5	26	IIC Serial Port Control 0	RW
3C5	27	Memory Control 3	RW
3C5	28	Memory Control 4	RW
3C5	29	Memory Control 5	RW
3C5	2A	MCK De-skew Control 0	RW
3C5	2B	MCK De-skew Control 1	RW
3C5	2C	General Purpose I/O Port	RW
3C5	2D	Power Management Control 1	RW
3C5	2E	Power Management Control 2	RW
3C5	2F	PCI Config Memory Base Shadow 0	RW
3C5	30	PCI Config Memory Base Shadow 1	RW
3C5	31	IIC Serial Port Control 1	RW
3C5	32	SPR 1	RW
3C5	33	SPR 2	RW
3C5	34	SPR 3	RW
3C5	36-35	Subsystem Vender ID	RW
3C5	38-37	Subsystem ID	RW
3C5	3A-39	BIOS Reserved Register 1-0	RW
3C5	3F-3B	-reserved-	—
3C5	40	AGP Pad Control 1	RW
3C5	41	Typical Arbitor Control 1	RW
3C5	42	Typical Arbitor Control 2	RW
3C5	43	-reserved-	—

("3C5" Sequencer Extended Registers table continued at top of next column)

Port	Index	Extended Sequencer Regs (continued)	Acc
3C5	44	LCDCK Clock Synth D Value (def=C3h)	RW
3C5	45	LCDCK Clock Synth N Value (def=2Ah)	RW
3C5	46	VCK Clock Synthesizer D Value (C3h)	RW
3C5	47	VCK Clock Synthesizer N Value (2Ah)	RW
3C5	48	ECK Clock Synthesizer D Value (47h)	RW
3C5	49	ECK Clock Synthesizer N Value (6Ah)	RW
3C5	4A	MCK Clock Synthesizer D Value	RW
3C5	4B	MCK Clock Synthesizer N Value	RW
3C5	4C-7F	-reserved-	—

Port	Index	Extended Graphics Controller Regs	Acc
3CF	20	Offset Register Control	RW
3CF	21	Offset Register A	RW
3CF	22	Offset Register B	RW
3CF	23-7F	-reserved-	—

Port	Index	Extended CRT Controller Regs	Acc
3?5	32	Mode Control	RW
3?5	33	HSYNC Adjuster	RW
3?5	34	Starting Address Overflow	RW
3?5	35	Extended Overflow	RW
3?5	36	Power Mgmt Control 3 (Monitor Control)	RW
3?5	37	-reserved-	—
3?5	38	Signature Data Register B0	RW
3?5	39	Signature Data Register B1	RW
3?5	3A	Signature Data Register B2	RW
3?5	3F-3B	BIOS Reserved Register 6-2	RW
3?5	40	Test Mode Control 0	RW
3?5	41-45	-reserved-	—
3?5	46	Test Mode Control 1	RW
3?5	47	Test Mode Control 2	RW
3?5	48	Test Mode Control 3	RW
3?5	49-7F	-reserved-	—

2D Graphics Engine Registers

Offset	2D Graphics Engine Registers	Acc
0000	GE Command	RW
0004	GE Mode / Status	RW
0008	BitBLT Source Address	RW
000C	BitBLT Destination Address	RW
0010	Dimension	RW
0014	Pattern Address	RW
0018	FG Color or Destination Color Key	RW
001C	BG Color or Source Color Key	RW
0020	Scissors Top and Left Limit	RW
0024	Scissors Bottom and Right Limit	RW
0028	Offset	RW
002C	Direct3D Control	RW
0030	Source Map Base Address	RW
0034	Destination Map Base Address	RW
0038	Pitch	RW
003C	Mono Pattern Data Port 0	WO
0040	Mono Pattern Data Port 1	WO
0044	-reserved-	—
0100-01FF	Color Pattern RAM Ports 0-63	WO

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1.

Video Engine Registers

Offset	Video Playback & Blending Registers	Acc
0200	Interrupt Flags & Masks Control	RW
0204	Ram Table & Address Flip Status	**RO**
0208	Alpha Win & HI H & V Start	RW
020C	Alpha Win H & V End & HI Center Offset	RW
0210	Alpha Window Control	RW
0214	CRT Starting Address	RW
0218	Second Display Start Address	RW
021C	Alpha Stream Frame Buffer Stride	RW
0220	CRT Color Key	RW
0224	Alpha Win & HI FB Start Address	RW
0228	Chroma Key Lower Bound	RW
022C	Chroma Key Upper Bound	RW
0230	Video Stream 1 Control	RW
0234	Video Win 1 Fetch Count.	RW
0238	Video Win 1 FB Y Start Address 1	RW
023C	Video Win 1 FB Stride	RW
0240	Video Win 1 H & V Start	RW
0244	Video Win 1 H & V End	RW
0248	Video Win 1 FB Y Start Address 2	RW
024C	Video Win 1 Display Zoom Control	RW
0250	Video Win 1 Minify & Interpolation Ctrl	RW
0254	Video Win 1 FB Y Start Address 0	RW
0258	Video 1 FIFO Depth / Threshold Control	RW
025C	Video Win 1 FB Y Start Address 3	RW
0260	HI Control	RW
0264	Second Display Color Key	RW
0268	V3 & Alpha Win FIFO Depth & Thr Ctrl	RW
026C	V1 Source Image Line Count	RW
0270	HI Transparent Color	RW
0274	V1 Display Temporary Zoom Control	RW
0278	V3 & Alpha Win FIFO Depth / Thr Ctrl	RW
027C, 0280	-reserved-	—
0284	V1 CSC & Enhancement Control (I)	RW
0288	V1 CSC & Enhancement Control (II)	RW
028C	V1 FB U Start Address 0	RW
0290, 0294	-reserved-	—
0298	Compose Outputs Mode Select	RW
029C	-reserved-	—
02A0	V3 Control	RW
02A4	V3 Frame Buffer Starting Address 0	RW
02A8	V3 Frame Buffer Starting Address 1	RW
02AC	V3 Frame Buffer Stride	RW
02B0	V3 Horizontal and Vertical Start	RW
02B4	V3 Horizontal and Vertical End	RW
02B8	V3 & Alpha Window Fetch Count	RW
02BC	V3 Display Zoom Control 1	RW
02C0	V3 Minify & Interpolation Control	RW
02C4	V3 CSC & Enhancement Control (I)	RW
02C8	V3 CSC & Enhancement Control (II)	RW
02CC	V3 Display Temporary Zoom Control	RW

Offset	Video Playback & Blending Regs (cont)	Acc
02D0	Graphics Hardware Cursor Mode Control	RW
02D4	Graphics Hardware Cursor Position	RW
02D8	Graphics Hardware Cursor Origin	RW
02DC	Graphics Hardware Cursor FG Color	RW
02E0	Graphics Hardware Cursor BG Color	RW
02E4	Video Window 1 FB U Start Address 1	RW
02E8	Video Window 1 FB U Start Address 2	RW
02EC	Video Window 1 FB U Start Address 3	RW
02F0	Video Window 1 FB V Start Address 0	RW
02F4	Video Window 1 FB V Start Address 1	RW
02F8	Video Window 1 FB V Start Address 2	RW
02FC	Video Window 1 FB V Start Address 3	RW

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1. FG = Foreground, BG = Background, Win = Window, FB = Frame Buffer, CSC = Color Space Conversion, Thr = Threshold

Video Engine Registers (continued)

Offset	Video Capture Engine & HQV Regs	Acc
0300	C0 Interrupt Flags and Masks Control	RW
0304	C1 Interrupt Flags and Masks Control	RW
0308, 030C	-reserved-	—
0310	C0 Interface Control	RW
0314	C0 Video H Range (CCIR601 only)	RW
0318	C0 Video V Range (CCIR601 only)	RW
031C	C0 Scaling Control	RW
0320	C0 VBI Data Horizontal Range	RW
0324	C0 VBI Data Vertical Range	RW
0328	C0 VBI Memory Starting Address	RW
032C	C0 VBI Memory Stride	RW
0330	C0 Ancillary Data Count Setting	RW
0334	C0 Max Count of Active Video Data	RW
0338	C0 Max VBI or ANC Memory Data Count	RW
033C	C0 Capture Data Count	**RO**
0340	C0 Video Capture Data 1st FB Start Addr	RW
0344	C0 Video Capture Data 2nd FB Start Addr	RW
0348	C0 Video Capture Data 3rd FB Start Addr	RW
034C	-reserved-	—
0350	C0 Active Video Data Memory Stride & Coring Function	RW
0354	C1 Interface Control	RW
0358-377	-reserved-	—
0378	C1 Max Count of Active Video Data	RW
037C	-reserved-	—
0380	C1 Capture Data Count	RW
0384	C1 Video Capture Data 1st FB Start Addr	RW
0388	C1 Video Capture Data 2nd FB Start Addr	RW
038C	C1 Active Video Data Memory Stride & Coring function	RW
0390-3BF	-reserved-	—
03C0	Sub-picture FB Stride & Control	RW
03C4	Sub-picture FB Start Address	RW
03C8	Sub-picture 4 X 16 RAM Table Write Ctrl	RW
03CC	Sub-picture RAM Table Read Data	**RO**
03D0	HQV Stream Control / Status	RW
03D4	HQV SW Source Data Start Address 0 (Y)	RW
03D8	HQV SW Source Data Start Address 1 (U)	RW
03DC	HQV SW Source Data Start Address 2 (V)	RW
03E0	HQV Source Data Line Count & Fetch Count Per Line	RW
03E4	HQV Filter Control	RW
03E8	HQV Minify Control	RW
03EC	HQV Destination Data Start Address 0	RW
03F0	HQV Destination Data Start Address 1	RW
03F4	HQV Destination FB Stride	RW
03F8	HQV Source FB Stride	RW
03FC	-reserved-	—

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1. FB = Frame Buffer, C0 = Capture 0, C1 = Capture 1, HQV = High Quality Video, VBI = Vertical Blanking Interval

3D Engine Registers

Offset	3D Graphics Engine Registers	Acc
(see CLE266 graphics programming manual for details)		

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1.

DVD Engine Registers

Offset	DVD Engine (MPEG) Regs	Default	Acc
0C00	Picture Description	0000 0000	RW
0C04	Macroblock Description	0000 0000	RW
0C08	Null	xxxx xxxx	W
0C0C	MPEG Control	0000 0000	RW
0C10	Motion Vector 0	xxxx xxxx	W
0C14	Motion Vector 1	xxxx xxxx	W
0C18	Motion Vector 2	xxxx xxxx	W
0C1C	Motion Vector 3	xxxx xxxx	W
0C20	Buffer 0 Y Base Address	xxxx xxxx	W
0C24	Buffer 0 Cb Base Address	xxxx xxxx	W
0C28	Buffer 0 Cr Base Address	xxxx xxxx	W
0C2C	Buffer 1 Y Base Address	xxxx xxxx	W
0C30	Buffer 1 Cb Base Address	xxxx xxxx	W
0C34	Buffer 1 Cr Base Address	xxxx xxxx	W
0C38	Buffer 2 Y Base Address	xxxx xxxx	W
0C3C	Buffer 2 Cb Base Address	xxxx xxxx	W
0C40	Buffer 2 Cr Base Address	xxxx xxxx	W
0C44	Buffer 3 Y Base Address	xxxx xxxx	W
0C48	Buffer 3 Cb Base Address	xxxx xxxx	W
0C4C	Buffer 3 Cr Base Address	xxxx xxxx	W
0C50	Line Offset	xxxx xxxx	W
0C54	MPEG Decoder Status	xxxx xxxx	RW
0C58	IDCT Block Data	xxxx xxxx	W
0C5C	Quantizer Matrix Selection	xxxx xxxx	W
0C60	Quantizer Matrix Content	xxxx xxxx	W
0C64	Slice Bit Stream Content	xxxx xxxx	R
0C80-0C8C	IDCT Coefficients / Datum	xxxx xxxx	W
0C90	Slice Control 1	xxxx xxxx	W
0C94	Slice Control 2	xxxx xxxx	W
0C98	Slice Control 3	xxxx xxxx	W
0C9C	Slice Control 4	xxxx xxxx	W
0CA0	Slice Bit Stream	xxxx xxxx	W
0CA4-0DFF	-reserved-	—	—

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1.

DMA Controller Registers

Offset	DMA Controller Registers	Default	Acc
0E00-0E3F	-reserved-	—	—
0E40	Channel 0 Memory Address	0000 0000	RW
0E44	Channel 0 Device Address	0000 0000	RW
0E48	Channel 0 Byte Count	0000 0000	RW
0E4C	Channel 0 Descriptor Pointer	0000 0000	RW
0E50	Channel 1 Memory Address	0000 0000	RW
0E54	Channel 1Device Address	0000 0000	RW
0E58	Channel 1Byte Count	0000 0000	RW
0E5C	Channel 1Descriptor Pointer	0000 0000	RW
0E60	Channel 2 Memory Address	0000 0000	RW
0E64	Channel 2 Device Address	0000 0000	RW
0E68	Channel 2 Byte Count	0000 0000	RW
0E6C	Channel 2 Descriptor Pointer	0000 0000	RW
0E70	Channel 3 Memory Address	0000 0000	RW
0E74	Channel 3 Device Address	0000 0000	RW
0E78	Channel 3 Byte Count	0000 0000	RW
0E7C	Channel 3 Descriptor Pointer	0000 0000	RW
0E80	Channel 0 Mode	0000 0000	RW
0E84	Channel 1 Mode	0000 0000	RW
0E88	Channel 2 Mode	0000 0000	RW
0E8C	Channel 3 Mode	0000 0000	RW
0E90	Channel 0 Command / Status	0000 0000	RW
0E94	Channel 1 Command / Status	0000 0000	RW
0E98	Channel 2 Command / Status	0000 0000	RW
0E9C	Channel 3 Command / Status	0000 0000	RW
0EA0	Priority Type	0000 0000	RW
0EA4-0FFF	-reserved-	—	—

All registers above are 32-bit memory mapped with offsets relative to Memory Base 1. Channels 2 and 3 are currently reserved.

North Bridge Miscellaneous I/O

One I/O port is defined: Port 22.

Port 22 – PCI / AGP Arbiter Disable .....RW

7-2 Reserved ..... always reads 0

1 AGP Arbiter Disable
- 0 Respond to GREQ# signal .....default
- 1 Do not respond to GREQ# signal

0 PCI Arbiter Disable
- 0 Respond to all REQ# signals .....default
- 1 Do not respond to any REQ# signals, including PREQ#

This port can be enabled for read/write access by setting bit-7 of Device 0 Configuration Register 78.

PCI Configuration Space I/O

All registers (listed above in the "register summary" section of this document) are addressed via the following configuration mechanism:

Mechanism #1

These ports respond only to double-word accesses. Byte or word accesses will be passed on unchanged.

Port CFB-CF8 - Configuration Address..... RW

31 Configuration Space Enable
- 0 Disabled..... default
- 1 Convert configuration data port writes to configuration cycles on the PCI bus

30-24 Reserved .....always reads 0

23-16 PCI Bus Number
Used to choose a specific PCI bus in the system

15-11 Device Number
Used to choose a specific device in the system (devices 0 and 1 are defined)

10-8 Function Number
Used to choose a specific function if the selected device supports multiple functions (only function 0 is defined).

7-2 Register Number (also called the "Offset")
Used to select a specific DWORD in the configuration space

1-0 Fixed .....always reads 0

Port CFF-CFC - Configuration Data..... RW

Refer to PCI Bus Specification Version 2.2 for further details on operation of the above configuration registers.

Device 0 Register Descriptions

Device 0 Host Bridge Header Registers

All registers are located in PCI configuration space. They should be programmed using PCI configuration mechanism 1 through 0CF8 / 0CFC with bus number, function number, and device number equal to zero.

Device 0 Offset 1-0 - Vendor ID (1106h) .....RO

15-0 ID Code (reads 1106h to identify VIA Technologies)

Device 0 Offset 3-2 - Device ID (3123h).....RO

15-0 ID Code (reads 3123h to identify the VT8623 north bridge chip)

Device 0 Offset 5-4 –Command (0006h).....RW

15-10 Reserved ..... always reads 0

9 Fast Back-to-Back Cycle Enable .....**RO**
- 0 Fast back-to-back transactions only allowed to the same agent.....default
- 1 Fast back-to-back transactions allowed to different agents

8 SERR# Enable.....**RO**
- 0 SERR# driver disabled.....default
- 1 SERR# driver enabled

(SERR# is used to report ECC errors)

7 Address / Data Stepping.....**RO**
- 0 Device never does stepping.....default
- 1 Device always does stepping

6 Parity Error Response.....**RW**
- 0 Ignore parity errors & continue.....default
- 1 Take normal action on detected parity errors

5 VGA Palette Snoop.....**RO**
- 0 Treat palette accesses normally.....default
- 1 Don't respond to palette accesses on PCI bus

4 Memory Write and Invalidate Command .....**RO**
- 0 Bus masters must use Mem Write.....default
- 1 Bus masters may generate Mem Write & Inval

3 Special Cycle Monitoring .....**RO**
- 0 Does not monitor special cycles.....default
- 1 Monitors special cycles

2 PCI Bus Master.....**RO**
- 0 Never behaves as a bus master
- 1 Can behave as a bus master**.....default**

1 Memory Space.....**RO**
- 0 Does not respond to memory space
- 1 Responds to memory space**.....default**

0 I/O Space .....**RO**
- 0 Does not respond to I/O space .....default
- 1 Responds to I/O space

Device 0 Offset 7-6 – Status (0210h).....RWC

15 Detected Parity Error
- 0 No parity error detected..... default
- 1 Error detected in either address or data phase. This bit is set even if error response is disabled (command register bit-6)**. ....write one to clear**

14 Signaled System Error (SERR# Asserted)
.....always reads 0

13 Signaled Master Abort
- 0 No abort received ..... default
- 1 Transaction aborted by the master .....
.....write one to clear

12 Received Target Abort
- 0 No abort received ..... default
- 1 Transaction aborted by the target .....
.....write one to clear

11 Signaled Target Abort .....always reads 0
- 0 Target Abort never signaled

10-9 DEVSEL# Timing
- 00 Fast
- 01 Medium **..... always reads 01**
- 10 Slow
- 11 Reserved

8 Data Parity Error Detected
- 0 No data parity error detected ..... default
- 1 Error detected in data phase. Set only if error response enabled via command bit-6 = 1 and The VT8623 was initiator of the operation in which the error occurred
. **.....write one to clear**

7 Fast Back-to-Back Capable.....always reads 0

6 User Definable Features .....always reads 0

5 66MHz Capable.....always reads 0

4 Supports New Capability list..... always reads 1

3-0 Reserved .....always reads 0

Device 0 Offset 8 - Revision ID (0nh)..... RO

7-0 Chip Revision Code.....always reads 0nh

Device 0 Offset 9 - Programming Interface (00h)..... RO

7-0 Interface Identifier.....always reads 00h

Device 0 Offset A - Sub Class Code (00h)..... RO

7-0 Sub Class Code.....reads 00 to indicate Host Bridge

Device 0 Offset B - Base Class Code (06h)..... RO

7-0 Base Class Code.. reads 06 to indicate Bridge Device

Device 0 Offset D - Latency Timer (00h)..... RW

Specifies the latency timer value in PCI bus clocks.

7-3 Guaranteed Time Slice for CPU ..... default=0

2-0 Reserved (fixed granularity of 8 clks).. always read 0
Bits 2-1 are writeable but read 0 for PCI specification compatibility. The programmed value may be read back in Offset 75 bits 5-4 (PCI Arbitration 1).

Device 0 Host Bridge Header Registers (continued)

Device 0 Offset E - Header Type (00h).....RO

7-0 Header Type Code ..... reads 00: single function

Device 0 Offset F - Built In Self Test (BIST) (00h).....RO

7 BIST Supported .....reads 0: no supported functions

6-0 Reserved ..... always reads 0

Device 0 Offset 13-10 - Graphics Aperture Base (00000008h) .....RW

31-28 Upper Programmable Base Address Bits ..... def=0

27-20 Lower Programmable Base Address Bits ..... def=0

These bits behave as if hardwired to 0 if the corresponding Graphics Aperture Size register bit (Device 0 Offset 84h) is 0.

27	26	25	24	23	22	21	20	(This Register)
7	6	5	4	3	2	1	0	(Gr Aper Size)
RW	RW	RW	RW	RW	RW	RW	RW	1M
RW	RW	RW	RW	RW	RW	RW	0	2M
RW	RW	RW	RW	RW	RW	0	0	4M
RW	RW	RW	RW	RW	0	0	0	8M
RW	RW	RW	RW	0	0	0	0	16M
RW	RW	RW	0	0	0	0	0	32M
RW	RW	0	0	0	0	0	0	64M
RW	0	0	0	0	0	0	0	128M
0	0	0	0	0	0	0	0	256M

19-0 Reserved .....always reads 00008

Note: The locations in the address range defined by this register are prefetchable.

Device 0 Host Bridge Header Registers (continued)

Device 0 Offset 2D-2C – Subsys Vendor ID (0000h)... W1/R

15-0 Subsystem Vendor ID ..... default = 0

This register may be written once and is then read only.

Device 0 Offset 2F-2E – Subsystem ID (0000h)..... W1/R

15-0 Subsystem ID ..... default = 0

This register may be written once and is then read only.

Device 0 Offset 34 - Capability Pointer (A0h)..... RO

Contains a byte offset from the start of configuration space.

7-0 AGP Capability List Pointer ..... always reads A0h

Device 0 Host Bridge Device-Specific Registers

These registers are normally programmed once at system initialization time.

V-Link Control

Device 0 Offset 40 – V-Link Specification ID (00h) .....RO

7-0 Specification Revision..... always reads 00

Device 0 Offset 41 – NB V-Link Capability (18h) .....RO

7-6 Reserved ..... always reads 0

5 16-bit Bus Width Supported .....RO
- 0 Not Supported .....default
- 1 Supported

4 8-Bit Bus Width Supported.....RO
- 0 Not Supported
- 1 Supported .....default

3 4x Rate Supported .....RO
- 0 Not Supported
- 1 Supported .....default

2 2x Rate Supported .....RO
- 0 Not Supported .....default
- 1 Supported

1-0 Reserved ..... always reads 0

Device 0 Offset 42 – NB Downlink Command (88h) .....RW

7-4 DnCmd Max Request Depth (0=1 DnCmd) . def = 8

3-0 DnCmd Write Buffer Size (doublewords)..... def = 8

Device 0 Offset 44-43 – NB Uplink Status (8280h).....RO

15-12 UpCmd P2C Write Buffer Size (max lines).. def = 8

11-8 UpCmd P2P Write Buffer Size (max lines).. def = 2

7-4 UpCmd Max Request Depth (0=1 UpCmd) . def = 8

3-0 Reserved ..... always reads 0

Device 0 Offset 45 –NB V-Link Bus Timer (44h)..... RW

7-4 Timer for Normal Priority Requests from SB
- 0000 Immediate
- 0001 1*4 VCLKs
- 0010 2*4 VCLKs
- 0011 3*4 VCLKs
- 0100 4*4 VCLKs .....default (both timers)
- 0101 5*4 VCLKs
- 0110 6*4 VCLKs
- 0111 7*4 VCLKs
- 1000 8*4 VCLKs
- 1001 16*4 VCLKs
- 1010 32*4 VCLKs
- 1011 64*4 VCLKs
- 11xx Own the bus for as long as there is a request

3-0 Timer for High Priority Requests from SB
- 0000 Immediate
- 0001 1*2 VCLKs
- 0010 2*2 VCLKs
- 0011 3*2 VCLKs
- 0100 4*2 VCLKs .....default (both timers)
- 0101 5*2 VCLKs
- 0110 6*2 VCLKs
- 0111 7*2 VCLKs
- 1000 8*2 VCLKs
- 1001 16*2 VCLKs
- 1010 32*2 VCLKs
- 1011 64*2 VCLKs
- 11xx Own the bus for as long as there is a request

Device 0 Offset 46 – NB V-Link Misc Control (00h).....RW

- **7 Downstream High Priority**
  - 0 Disable High Priority Down Commands .....def
  - 1 Enable High Priority Down Commands
- **6 Downlink Priority**
  - 0 Treat Downlink Cycles as Normal Priority.def
  - 1 Treat Downlink Cycles as High Priority
- **5-4 Combine Multiple STPGNT Cycles into V-Link Command**
  - 00 Compatible, 1 command per V-Link cmd....def
  - 01 2 commands per V-Link command
  - 10 3 commands per V-Link command
  - 11 4 commands per V-Link command
- **3-2 V-Link Master Access Ordering Rules**
  - 00 High priority read, pass normal read (not pass write) .....default
  - 01 Read (high/normal) pass write (HR>LR>W)
  - 1x Read / write in order
- **1-0 Reserved** ..... always reads 0

Device 0 Offset 47 – V-Link Control (00h) .....RW

- **7-6 Reserved** ..... always reads 0
- **5 C2P Read L1 Ready Returned After P2C Write Flush**
  - 0 Disable .....default
  - 1 Enable
- **4-3 Reserved** ..... always reads 0
- **2 Auto-Disconnect**
  - 0 Disable .....default
  - 1 Enable
- **1 V-Link Disconnect Cycle for HALT cycle**
  - 0 Disable .....default
  - 1 Enable
- **0 V-Link Disconnect Cycle for STPGNT Cycle**
  - 0 Disable .....default
  - 1 Enable

Device 0 Offset 48 – NB/SB V-Link Configuration (18h)RW

- **7 Reserved** .....always reads 0
- **6 Rest Bus Width Supported**
  - 0 Not Supported ..... default
  - 1 Supported
- **5 16-bit Bus Width Supported**
  - 0 Not Supported ..... default
  - 1 Supported
- **4 8-Bit Bus Width Supported**
  - 0 Not Supported
  - 1 Supported ..... default
- **3 4x Rate Supported**
  - 0 Not Supported
  - 1 Supported ..... default
- **2 2x Rate Supported**
  - 0 Not Supported ..... default
  - 1 Supported
- **1-0 Reserved** .....always reads 0

Device 0 Offset 49 – SB V-Link Capability (18h) ..... RO

7-6 Reserved ..... always reads 0
5 16-bit Bus Width Supported ..... RO
0 Not Supported ..... default
1 Supported
4 8-Bit Bus Width Supported ..... RO
0 Not Supported
1 Supported ..... default
3 4x Rate Supported ..... RO
0 Not Supported
1 Supported ..... default
2 2x Rate Supported ..... RO
0 Not Supported ..... default
1 Supported
1-0 Reserved ..... always reads 0

Device 0 Offset 4A – SB Downlink Status (88h) ..... RO

7-4 DnCmd Max Request Depth (0=1 DnCmd) . def = 8
3-0 DnCmd Write Buffer Size (doublewords)..... def = 8

Device 0 Offset 4C-4B – SB Uplink Command (8280h). RW

15-12 UpCmd P2C Write Buffer Size (max lines).. def = 8
11-8 UpCmd P2P Write Buffer Size (max lines).. def = 2
7-4 UpCmd Max Request Depth (0=1 UpCmd) . def = 8
3-0 Reserved ..... always reads 0

Device 0 Offset 4D – SB V-Link Bus Timer (44h) ..... RW

7-4 Timer for Normal Priority Requests from SB
0000 Immediate
0001 1*4 VCLKs
0010 2*4 VCLKs
0011 3*4 VCLKs
0100 4*4 VCLKs ..... default (both timers)
0101 5*4 VCLKs
0110 6*4 VCLKs
0111 7*4 VCLKs
1000 8*4 VCLKs
1001 16*4 VCLKs
1010 32*4 VCLKs
1011 64*4 VCLKs
11xx Own the bus for as long as there is a request
3-0 Timer for High Priority Requests from SB
0000 Immediate
0001 1*2 VCLKs
0010 2*2 VCLKs
0011 3*2 VCLKs
0100 4*2 VCLKs ..... default (both timers)
0101 5*2 VCLKs
0110 6*2 VCLKs
0111 7*2 VCLKs
1000 8*2 VCLKs
1001 16*2 VCLKs
1010 32*2 VCLKs
1011 64*2 VCLKs
11xx Own the bus for as long as there is a request

Device 0 Offset 4E – CCA Master Priority (00h) ..... RW

7 1394 High Priority
0 Low priority ..... default
1 High priority
6 LAN / NIC High Priority
0 Low priority ..... default
1 High priority
5 Reserved ..... always reads 0
4 USB High Priority
0 Low priority ..... default
1 High priority
3 Reserved ..... always reads 0
2 IDE High Priority
0 Low priority ..... default
1 High priority
1 AC97-ISA High Priority
0 Low priority ..... default
1 High priority
0 PCI High Priority
0 Low priority ..... default
1 High priority

Device 0 Offset 4F – SB V-Link Misc Control (00h) ..... RW

7 Upstream Command High Priority
0 Disable high priority up commands..... default
1 Enable high priority up commands
6-1 Reserved ..... always reads 0
0 Down Cycle Wait for Up Cycle Write Flush (Except Down Cycle Post Write)
0 Disable ..... default
1 Enable

Host CPU Control

Device 0 Offset 50 – Request Phase Control (00h) .....RW

7 CPU Hardwired IOQ (In Order Queue) Size
Default via VAD2 from strap on South Bridge LA18.
0 1-Level
1 8-Level

6 GTL Pullup
Default via VAD3 from strap on South Bridge LA19.
0 Disable
1 Enable

5 GTL Always Pullup Mode
0 Disable
1 Enable .....**default**

4-0 Dynamic Defer Snoop Stall Count

Device 0 Offset 51 – CPU Interface Basic Control (00h)RW

7 Add 1T Delay for CPU-to-Memory Requests
0 Disable .....default
1 Enable

6 Read Around Write
0 Disable .....default
1 Enable

5 DRQ Control
0 Non pipelined.....default
1 Pipelined

4 CPU to PCI Read Defer
0 Disable .....default
1 Enable

3 Two Defer / Retry Entries
0 Disable .....default
1 Enable

2 Two Defer / Retry Entries Shared
0 Each entry is dedicated to 1 CPU.....default
1 Each entry is shared by 2 CPUs

1 PCI Master Pipelined Access
0 Disable .....default
1 Enable

0 Dual Processor Mode Enhancement
0 Disable .....default
1 Enable

Device 0 Offset 52 – CPU Interface Advanced Ctrl (00h)RW

7 CPU RW DRAM 0WS for Back-to-Back Pipeline Access
0 Disable..... default
1 Enable

6 HREQ / HPRI
0 Disable..... default
1 Enable

5 GTL POS
0 Disable..... default
1 Enable

4 Dynamic Snoop Stall for CPU FIFO Full
0 Disable..... default
1 Enable

3 Write Retire Policy After 2 Writes
0 Disable..... default
1 Enable

2 133 / 100 DADS Fast Conversion
0 Disable..... default
1 Enable

1 Consecutive Speculative Read
0 Disable..... default
1 Enable

0 Speculative Read
0 Disable..... default
1 Enable

Device 0 Offset 53 – CPU Arbitration Control (03h) .... RW

7-4 Host Timer ..... default = 0
3-0 BPRI Timer (units of 4 HCLKs) ..... default = 3

Device 0 Offset 54 – CPU Miscellaneous Control (00h) RW

7-6 CPU Frequency (VAD1-0 strap from south bridge pins SA[16-17])
00 -reserved-
01 100
1x 133

5 SDRAM Burst Length of 8
0 Disable..... default
1 Enable

4-3 Reserved .....always reads 0

2 AGP Capability Header Support
0 Disable..... default
1 Enable

1-0 Reserved .....always reads 0

DRAM Control

These registers are normally set at system initialization time and not accessed after that during normal system operation. Some of these registers, however, may need to be programmed using specific sequences during power-up initialization to properly detect the type and size of installed memory (refer to the CLE266 BIOS porting guide for details).

Table 6. System Memory Map

Space	Start	Size	Address Range	Comment
DOS	0	640K	00000000-0009FFFF	Cacheable
VGA	640K	128K	000A0000-000BFFFF	Used for SMM
BIOS	768K	16K	000C0000-000C3FFF	Shadow Ctrl 1
BIOS	784K	16K	000C4000-000C7FFF	Shadow Ctrl 1
BIOS	800K	16K	000C8000-000CBFFF	Shadow Ctrl 1
BIOS	816K	16K	000CC000-000CFFFF	Shadow Ctrl 1
BIOS	832K	16K	000D0000-000D3FFF	Shadow Ctrl 2
BIOS	848K	16K	000D4000-000D7FFF	Shadow Ctrl 2
BIOS	864K	16K	000D8000-000DBFFF	Shadow Ctrl 2
BIOS	880K	16K	000DC000-000DFFFF	Shadow Ctrl 2
BIOS	896K	64K	000E0000-000EFFFF	Shadow Ctrl 3
BIOS	960K	64K	000F0000-000FFFFF	Shadow Ctrl 3
Sys	1MB	—	00100000-DRAM Top	Can have hole
Bus	D Top		DRAM Top-FFFEFFFF	
Init	4G-64K	64K	FFFEFFFF-FFFFFFFF	000Fxxxx alias

Device 0 Offset 55 – DRAM Control (00h)..... RW

7 0WS Back-to-Back Write to Different DDR Bank
- 0 Disable..... default
- 1 Enable

6 Reserved .....always reads 0

5 DQS Input DLL Adjustment
- 0 Disable..... default
- 1 Enable

4 DQS Output DLL Adjustment
- 0 Disable..... default
- 1 Enable

3 DQM Removal (Always Perform 4-Burst RW)
- 0 Disable..... default
- 1 Enable

2 DQS Output
- 0 Disable..... default
- 1 Enable

1 Auto Precharge for TLB Read or CPU WriteBack
- 0 Disable..... default
- 1 Enable

0 Write Recovery Time
- 0 1T ..... default
- 1 2T

Device 0 Offset 58 - DRAM MA Map Type (22h) .....RW

7-5 Bank 1/0 MA Map Type (see Table 7 below)

4 Bank 1/0 1T Command Rate

0 2T Command .....default

1 1T Command

3-1 Bank 3/2 MA Map Type (see Table 7 below)

0 Bank 3/2 1T Command Rate

0 2T Command .....default

1 1T Command

Table 7. MA Map Type Encoding

000	16Mb	8-bit, 9-bit, 10-bit Column Address
001	64/128Mb	8-bit Column Address .....default
010	64/128Mb	9-bit Column Address
011	64/128Mb	10/11-bit Column Address
100		-reserved-
101	256Mb	8-bit Column Address
110	256Mb	9-bit Column Address
111	256Mb	10/11-bit Column Address

Device 0 Offset 5F-5A – DRAM Row Ending Address:

Offset 5A – Bank 0 Ending (HA[31:24]) (01h)..... RW

Offset 5B – Bank 1 Ending (HA[31:24]) (01h) ..... RW

Offset 5C – Bank 2 Ending (HA[31:24]) (01h)..... RW

Offset 5D – Bank 3 Ending (HA[31:24]) (01h)..... RW

Note : BIOS is required to fill the ending address registers for all banks even if no memory is populated. The endings have to be in incremental order.

Device 0 Offset 60 – DRAM Type (00h)..... RW

7-4 Reserved .....always reads 0

3-2 DRAM Type for Bank 3/2

00 SDR SDRAM..... default

01 -reserved-

10 DDR SDRAM

11 -reserved-

1-0 DRAM Type for Bank 1/0

00 SDR SDRAM..... default

01 -reserved-

10 DDR SDRAM

11 -reserved-

Table 8. Memory Address Mapping Table

SDR / DDR SDRAM (x4 DRAMs supported by SDR only)

MA:	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
16Mb		24		13	12	11	14	22	21	20	19	18	17	16	15	12 row
(000)				13	PC	24	23	10	9	8	7	6	5	4	3	10,9,8 col
64/128Mb																x16 (14,8)
2K page	14	24	14	13	12	11	23	22	21	20	19	18	17	16	15	x32 (14,8)
001		27	14	13	PC	26	25	10	9	8	7	6	5	4	3	x8 (14,9)
4K page	14	25	14	13	12	24	23	22	21	20	19	18	17	16	15	x16 (14,9)
010		27	14	13	PC	26	11	10	9	8	7	6	5	4	3	x4 (14,10)
8K page	14	26	14	13	25	24	23	22	21	20	19	18	17	16	15	x8 (14,10)
011		27	14	13	PC	12	11	10	9	8	7	6	5	4	3	x4 (14,11)
256Mb																
2K page	25	24	14	13	12	11	23	22	21	20	19	18	17	16	15	x32 (15,8)
101		27	14	13	PC	26	25	10	9	8	7	6	5	4	3	
4K page	26	25	14	13	12	24	23	22	21	20	19	18	17	16	15	x16 (15,9)
110		27	14	13	PC	26	11	10	9	8	7	6	5	4	3	
8K page	27	26	14	13	25	24	23	22	21	20	19	18	17	16	15	x8 (15,10)
111		28	14	13	PC	12	11	10	9	8	7	6	5	4	3	x4 (15,11)

Device 0 Offset 61 - Shadow RAM Control 1 (00h).....RW

7-6 CC000h-CFFFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

5-4 C8000h-CBFFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

3-2 C4000h-C7FFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

1-0 C0000h-C3FFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

Device 0 Offset 62 - Shadow RAM Control 2 (00h).....RW

7-6 DC000h-DFFFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

5-4 D8000h-DBFFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

3-2 D4000h-D7FFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

1-0 D0000h-D3FFFh
- 00 Read/write disable.....default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

Device 0 Offset 63 - Shadow RAM Control 3 (00h)..... RW

7-6 E0000h-EFFFFh
- 00 Read/write disable ..... default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

5-4 F0000h-FFFFFh
- 00 Read/write disable ..... default
- 01 Write enable
- 10 Read enable
- 11 Read/write enable

3-2 Memory Hole
- 00 None ..... default
- 01 512K-640K
- 10 15M-16M (1M)
- 11 14M-16M (2M)

1-0 SMI Mapping Control

	SMM		Non-SMM	
	Code	Data	Code	Data
00	DRAM	DRAM	PCI	PCI
01	DRAM	DRAM	DRAM	DRAM
10	DRAM	PCI	PCI	PCI
11	DRAM	DRAM	DRAM	DRAM

Device 0 Offset 64 - DRAM Timing for All Banks (E4h)RW

7 Precharge Command to Active Command Period
- 0 TRP = 2T
- 1 TRP = 3T.....default

6 Active Command to Precharge Command Period
- 0 TRAS = 5T
- 1 TRAS = 6T.....def

5-4 CAS Latency

	SDR	DDR
00	1T	-
01	2T	2T
10	3T	2.5T.....default
11	-	3T

3 Reserved ..... always reads 0

2 ACTIVE to CMD
- 0 2T
- 1 3T .....default

1-0 Bank Interleave
- 00 No Interleave.....default
- 01 2-way
- 10 4-way
- 11 Reserved

For 16Mb SDRAMs bank interleave is always 2-way

Device 0 Offset 65 - DRAM Arbitration Timer (00h) ....RW

7-4 AGP Timer (units of 4 MCLKs) ..... default = 0

3-0 CPU Timer (units of 4 MCLKs)..... default = 0

Device 0 Offset 66 - DRAM Arbitration Control (00h)..RW

7 SDR – Feedback Clock Select
DDR - DQS Input Delay Setting
- 0 Auto (Rx67 reads DLL calibration result) ...def
- 1 Manual (Rx67 reads DQS input delay)

6 Reserved ..... always reads 0

5-4 Arbitration Parking Policy
- 00 Park at last bus owner .....default
- 01 Park at CPU
- 10 Park at AGP
- 11 -reserved-

3-0 AGP / CPU Priority (units of 4 MCLKs)

Device 0 Offset 67 – DDR Strobe Input Delay (00h) ..... RW

SDR:

7-5 Reserved .....always reads 0

4 MD Latch Clock Select
- 0 Internal clock..... default
- 1 External feedback clock

3 Reserved .....always reads 0

2-0 MD Latch Delay

DDR:

7-6 CS Early Clock Select ..... default = 0

5-0 DQS Input Delay ..... default = 0

(if Rx66[7]=0, read DLL calibration result)

Device 0 Offset 68 – DDR Strobe Output Delay (00h)... RW

7-0 DDR DQS Output Delay ..... default = 0

Device 0 Offset 69 – DRAM Clock Select (00h).....RW

7 CPU Operating Frequency Faster Than DRAM
- 0 CPU Same As or Equal to DRAM.....default
- 1 CPU Faster Than DRAM by 33 MHz

6 DRAM Operating Frequency Faster Than CPU
- 0 DRAM Same As or Equal to CPU.....default
- 1 DRAM Faster Than CPU by 33 MHz

Rx54[7-6]	Rx69[7-6]	CPU / DRAM
01	10	100 / 66
01	00	100 / 100
01	01	100 / 133†
1x	10	133 / 100
1x	00	133 / 133

†Rx53[6] must also be set to 1 for DRAM > CPU

5 DRAM Controller Queue Greater Than 2
- 0 Disable .....default
- 1 Enable

4 DRAM Controller Queue Not Equal to 4
- 0 Disable .....default
- 1 Enable

3 DRAM 8K Page Enable
- 0 Disable .....default
- 1 Enable

2 DRAM 4K Page Enable
- 0 Disable .....default
- 1 Enable

1 Reserved ..... always reads 0

0 Multiple Page Mode
- 0 Disable .....default
- 1 Enable

Device 0 Offset 6A - Refresh Counter (00h)..... RW

7-0 Refresh Counter (in units of 16 MCLKs)
- 00 DRAM Refresh Disabled ..... default
- 01 32 MCLKs
- 02 48 MCLKs
- 03 64 MCLKs
- 04 80 MCLKs
- 05 96 MCLKs
- … …

The programmed value is the desired number of 16-MCLK units minus one.

Device 0 Offset 6B - DRAM Arbitration Control (00h) RW

7 Fast Read to Write turn-around
- 0 Disable..... default
- 1 Enable

6 Page Kept Active When Cross Bank
- 0 Disable..... default
- 1 Enable

5 Burst Refresh
- 0 Disable..... default
- 1 Enable

4 CKE Function
- 0 Disable..... default
- 1 Enable

3 CA22 / CA14 Swap
- 0 Disable..... default
- 1 Enable for performance enhancement

2-0 SDRAM Operation Mode Select
- 000 Normal SDRAM Mode ..... default
- 001 NOP Command Enable
- 010 All-Banks-Precharge Command Enable (CPU-to-DRAM cycles are converted to All-Banks-Precharge commands).
- 011 MSR Enable
  CPU-to-DRAM cycles are converted to commands and the commands are driven on MA[14:0]. The BIOS selects an appropriate host address for each row of memory such that the right commands are generated on MA[14:0].
- 100 CBR Cycle Enable (if this code is selected, CAS-before-RAS refresh is used; if it is not selected, RAS-Only refresh is used)
- 101 Reserved
- 11x Reserved

Device 0 Offset 6C - Drive Control 1 (00h) ..... RW

7-6 SRAS#, SCAS#, SWE#, MA Drive
- 00 Lowest.....default
- 01
- 10
- 11 Highest

5-4 Reserved ..... always reads 0

3-2 DDR DQS# Drive
- 00 Lowest.....default
- 01
- 10
- 11 Highest

1-0 MD/MECC/CAS/CKE Early Clock Select
- 00 Latest .....default
- 01
- 10
- 11 Earliest

Device 0 Offset 6D - Drive Control 2 (00h)..... RW

7-6 Early Clock Select for SCMD, MA Output (for 1T Command)
- 00 Latest ..... default
- 01
- 10
- 11 Earliest

5-4 DQM Drive
- 00 Lowest ..... default
- 01
- 10
- 11 Highest

3-2 CS# Drive
- 00 Lowest ..... default
- 01
- 10
- 11 Highest

1-0 Memory Data Drive (MD, MECC)
- 00 Lowest ..... default
- 01
- 10
- 11 Highest

PCI Bus Control

These registers are normally programmed once at system initialization time.

Device 0 Offset 70 - PCI Buffer Control (00h).....RW

7 CPU to PCI Post-Write
- 0 Disable .....default
- 1 Enable

6 Reserved ..... always reads 0

5-4 PCI Master to DRAM Prefetch
- 00 Always prefetch .....default
- x1 Never prefetch
- 10 Prefetch only for Enhance command

3 Reserved ..... always reads 0

2 PCI Master Read Caching
- 0 Disable .....default
- 1 Enable

1 Delay Transaction
- 0 Disable .....default
- 1 Enable

0 Reserved ..... always reads 0

Device 0 Offset 71 - CPU to PCI Flow Control (48h)..RWC

7 Retry Status.....RWC
- 0 No retry occurred .....default
- 1 Retry occurred

6 Retry Timeout Action
- 0 Retry forever (record status only)
- 1 Flush buffer or return FFFFFFFFh for reads .....default

5-4 Retry Count and Retry Backoff
- 00 Retry 2 times, backoff CPU .....default
- 01 Retry 16 times
- 10 Retry 4 times
- 11 Retry 64 times

3 PCI Burst
- 0 Disable
- 1 Enable .....default

2 Reserved ..... always reads 0

1 Compatible Type#1 Configuration Cycles
- 0 Disable (fixed AD31).....default
- 1 Enable

0 IDSEL Control
- 0 AD11, AD12 .....default
- 1 AD30, AD31

Device 0 Offset 73 - PCI Master Control (00h)..... RW

7 Reserved .....always reads 0

6 PCI Master 1-Wait-State Write
- 0 Zero wait state TRDY# response..... default
- 1 One wait state TRDY# response

5 PCI Master 1-Wait-State Read
- 0 Zero wait state TRDY# response..... default
- 1 One wait state TRDY# response

4 WSC#
- 0 Disable..... default
- 1 Enable

3-1 Reserved .....always reads 0

0 PCI Master Broken Timer Enable
- 0 Disable..... default
- 1 Enable. Force into arbitration when there is no FRAME# 16 PCICLK's after the grant.

Device 0 Offset 75 - PCI Arbitration 1 (00h) ..... RW

7 Arbitration Mode
- 0 REQ-based (arbitrate at end of REQ#) ..default
- 1 Frame-based (arbitrate at FRAME# assertion)

6-4 Latency Timer..... read only, reads Rx0D bits 2:0

3 Reserved ..... always reads 0

2-0 PCI Master Bus Time-Out
(force into arbitration after a period of time)
- 000 Disable .....default
- 001 1x16 PCICLKs
- 010 2x16 PCICLKs
- 011 3x16 PCICLKs
- 100 4x16 PCICLKs
- ... ...
- 111 7x16 PCICLKs

Device 0 Offset 76 - PCI Arbitration 2 (00h)..... RW

7 I/O Port 22 Access
- 0 CPU access to I/O address 22h is passed on to the PCI bus ..... default
- 1 CPU access to I/O address 22h is processed internally

6 Reserved .....always reads 0

5-4 Master Priority Rotation Control
- 00 Disable..... default
- 01 Grant to CPU after every PCI master grant
- 10 Grant to CPU after every 2 PCI master grants
- 11 Grant to CPU after every 3 PCI master grants

Setting 01: the CPU will always be granted access after the current bus master completes, no matter how many PCI masters are requesting.

Setting 10: if other PCI masters are requesting during the current PCI master grant, the highest priority master will get the bus after the current master completes, but the CPU will be guaranteed to get the bus after that master completes.

Setting 11: if other PCI masters are requesting, the highest priority will get the bus next, then the next highest priority will get the bus, then the CPU will get the bus.

In other words, with the above settings, even if multiple PCI masters are continuously requesting the bus, the CPU is guaranteed to get access after every master grant (01), after every other master grant (10) or after every third master grant (11).

3-2 Select REQn# to REQ4# mapping
- 00 REQ4#..... default
- 01 REQ0#
- 10 REQ1#
- 11 REQ2#

1 Reserved .....always reads 0

0 REQ4# is High Priority Master
- 0 Disable..... default
- 1 Enable

GART / Graphics Aperture Control

The function of the Graphics Address Relocation Table (GART) is to translate virtual 32-bit addresses issued by an AGP device into 4K-page based physical addresses for system memory access. In this translation, the upper 20 bits (A31-A12) are remapped, while the lower 12 address bits (A11-A0) are used unchanged.

A one-level fully associative lookup scheme is used to implement the address translation. In this scheme, the upper 20 bits of the virtual address are used to point to an entry in a page table located in system memory. Each page table entry contains the upper 20 bits of a physical address (a "physical page" address). For simplicity, each page table entry is 4 bytes. The total size of the page table depends on the GART range (called the "aperture size") which is programmable.

This scheme is shown in the figure below.

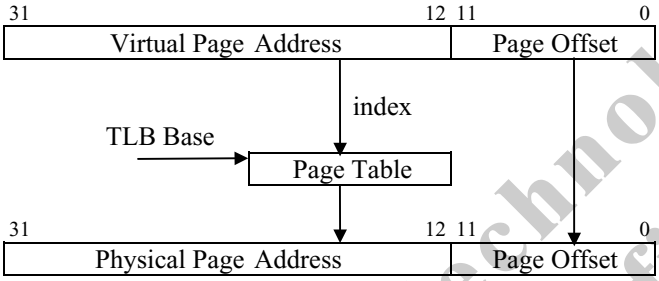


Figure 3. Graphics Aperture Address Translation

Since address translation using the above scheme requires an access to system memory, an on-chip cache (called a "Translation Lookaside Buffer" or TLB) is utilized to enhance performance. The on-chip TLB contains 16 entries. Address "misses" in the TLB require an access of system memory to retrieve translation data. Entries in the TLB are replaced using an LRU (Least Recently Used) algorithm.

Addresses are translated only for accesses within the "Graphics Aperture" (GA). The Graphics Aperture can be any power of two in size from 1MB to 256MB (i.e., 1MB, 2MB, 4MB, 8MB, etc). The base of the Graphics Aperture can be anywhere in the system virtual address space on an address boundary determined by the aperture size (e.g., if the aperture size is 4MB, the base must be on a 4MB address boundary). The Graphics Aperture Base is defined in register offset 10 of device 0. The Graphics Aperture Size and TLB Table Base are defined in the following register group (offsets 84 and 88 respectively) along with various control bits.

Device 0 Offset 83-80 - GART/TLB Control (00000000h) RW

31-16 Reserved ..... always reads 0
15-8 Reserved (test mode status) ..... RO
7 Flush Page TLB
0 Disable ..... default
1 Enable
6-0 Reserved (always program to 0) ..... RW

Note: For any master access to the Graphics Aperture range, snoop will not be performed.

Device 0 Offset 84 - Graphics Aperture Size (00h) ..... RW

7-0 Graphics Aperture Size
00000000 256M ..... default
10000000 128M
11000000 64M
11100000 32M
11110000 16M
11111000 8M
11111100 4M
11111110 2M
11111111 1M

Offset 85 – Write Policy (00h) ..... RW

7 Reserved ..... always reads 0
6-4 Write Request Limit ..... default = 0
3 DRAM Bus Float When Idle
0 Disable ..... default
1 Enable
2-0 Write Request Base ..... default = 0

Offset 8B-88 - GA Translation Table Base (00000000h) RW

31-12 Graphics Aperture Translation Table Base. Pointer to the base of the translation table in system memory used to map addresses in the aperture range (the pointer to the base of the "Directory" table).
11-2 Reserved ..... always reads 0
1 Graphics Aperture A[31:28]
0 Disable ..... default
1 Enable
Note: To disable the Graphics Aperture, set this bit to 0 and set all bits of the Graphics Aperture Size to 0. To enable the Graphics Aperture, set this bit to 1 and program the Graphics Aperture Size to the desired aperture size.
0 Reserved ..... always reads 0

AGP Control

Device 0 Offset A3-A0 - AGP Capability Identifier (0020C002h) ..... RO

31-24 Reserved ..... always reads 00
23-20 Major Specification Revision ..... always reads 0010
Major rev # of AGP spec to which device conforms
19-16 Minor Specification Revision ..... always reads 0000
Minor rev # of AGP spec to which device conforms
Bits 23-16 indicate the device conforms to AGP 2.0
15-8 Pointer to Next Item .... always reads C0h (last item)
7-0 AGP ID .. (always reads 02 to indicate it is AGP)

Device 0 Offset A7-A4 - AGP Status (1F000207h) ..... RO

31-24 Maximum AGP Requests ..... always reads 1F†
Max # of AGP requests the device can manage (32)
† See also RxFC[1] and RxFD[2-0]
23-10 Reserved ..... always reads 0
9 Supports SideBand Addressing ..... always reads 1
8-6 Reserved ..... always reads 0
5 4G Supported ..... (can be written at RxAE[5]
4 Fast Write Supported .... (can be written at RxAE[4]
3 Reserved ..... always reads 0
2 4X Rate Supported ..... always reads 1
1 2X Rate Supported ..... always reads 1
0 1X Rate Supported ..... always reads 1

Device 0 Offset AB-A8 - AGP Command (00000000h).. RW

31-24 Request Depth (reserved for target) .. always reads 0s
23-10 Reserved ..... always reads 0s
9 SideBand Addressing Enable
0 Disable ..... default
1 Enable
8 AGP Enable
0 Disable ..... default
1 Enable
7-6 Reserved ..... always reads 0s
5 4G Enable
0 Disable ..... default
1 Enable
4 Fast Write Enable
0 Disable ..... default
1 Enable
3 Reserved ..... always reads 0s
2 4X Mode Enable
0 Disable ..... default
1 Enable
1 2X Mode Enable
0 Disable ..... default
1 Enable
0 1X Mode Enable
0 Disable ..... default
1 Enable

Device 0 Offset AC - AGP Control (00h)..... RW

7 Reserved ..... always reads 0
6 AGP Read Synchronization
0 Disable ..... default
1 Enable
5 AGP Read Snoop DRAM Post-Write Buffer
0 Disable ..... default
1 Enable
4 GREQ# Priority Becomes Higher When Arbiter is Parked at AGP Master
0 Disable ..... default
1 Enable
3 2X Rate Supported
0 Disable ..... default
1 Enable
2 Fence / Flush
0 Disable – low priority requests may be executed out of order. ..... default
1 Enable – all normal priority AGP operations will be executed in order
1 AGP Grant Parking Policy
0 Non-Parking Grant – if GFRM# or GPIPE# is asserted, GGNT# is deasserted ..... default
1 Parking Grant – if GFRM# or GPIPE# is asserted, GGNT# is not de-asserted until GREQ# is deasserted or timeout
0 AGP to PCI Master or CPU to PCI Turnaround Cycle
0 2T or 3T Timing ..... default
1 1T Timing

Device 0 Offset AD – AGP Misc Control 1 (02h).....RW

7-6 Reserved ..... always reads 0

5 Input on AGP GD / GBE Pads
- 0 Disable .....default
- 1 Enable

4 Choose First or Last Ready of DRAM
- 0 Last ready chosen.....default
- 1 First ready chosen

3-0 AGP Data Phase Latency Timer ..... default = 02h

Device 0 Offset AE – AGP Misc Control 2 (00h) ..... RW

7-6 Reserved .....always reads 0

5 4G Supported
- 0 4G not supported ..... default
- 1 4G supported

4 Fast Write Supported
- 0 Fast Write not supported ..... default
- 1 Fast Write supported

3 Reserved .....always reads 0

2 4X Rate Supported
- 0 Disable..... default
- 1 Enable

1-0 Reserved .....always reads 0

V-Link Control

Device 0 Offset B4 – V-Link NB Compensation Ctrl (00h)RW

7-6 V-Link Autocomp Output Value..... always reads 0
5 Pullup Compensation Selection
0 Auto Comp (use values in bits 7-6).....default
1 Manual Comp (use values in bits 3-2)
4 Pulldown Compensation Selection
0 Auto Comp (use values in bits 7-6).....default
1 Manual Comp (use values in bits 1-0)
3-2 Pullup Compensation Manual Setting ..... def = 0
1-0 Pulldown Compensation Manual Setting .... def = 0

Device 0 Offset B5 – V-Link NB Drive Control (00h)....RW

7-6 NB V-Link Strobe Pullup Manual Setting
5-4 NB V-Link Strobe Pulldown Manual Setting
3-1 Reserved ..... always reads 0
0 NB V-Link Slew Rate Control
0 Disable .....default
1 Enable

Device 0 Offset B8 – V-Link SB Compensation Ctrl (00h)RW

7-6 V-Link Autocomp Output Value .....always reads 0
5 Pullup Compensation Selection
0 Auto Comp (use values in bits 7-6)..... default
1 Manual Comp (use values in bits 3-2)
4 Pulldown Compensation Selection
0 Auto Comp (use values in bits 7-6)..... default
1 Manual Comp (use values in bits 1-0)
3-2 Pullup Compensation Manual Setting.....def = 0
1-0 Pulldown Compensation Manual Setting.....def = 0

Device 0 Offset B9 – V-Link SB Drive Control (00h).... RW

7-6 SB V-Link Strobe Pullup Manual Setting
5-4 SB V-Link Strobe Pulldown Manual Setting
3-1 Reserved .....always reads 0
0 SB V-Link Slew Rate Control
0 Disable..... default
1 Enable

Power Management

Device 0 Offset BC – Power Management Mode (00h)..RW

7 Dynamic Power Management
- 0 Disable .....default
- 1 Enable

6-0 Reserved ..... always reads 0

Device 0 Offset BD – DRAM Power Mgmt Mode (00h) RW

7 Reserved ..... always reads 0

6 Dynamic CKE When DRAM Is Idle
- 0 Disable .....default
- 1 Enable

5 Dynamic DRAM I/O Pad Power-Down (Float)
- 0 Disable .....default
- 1 Enable

4-0 Reserved ..... always reads 0

Device 0 Offset BE – Dynamic Clock Stop Control (00h)RW

7 Host CPU Interface Power Management
- 0 Disable .....default
- 1 Enable

6 System Memory Interface Power Management
- 0 Disable .....default
- 1 Enable

5 V-Link Interface Power Management
- 0 Disable .....default
- 1 Enable

4 AGP Interface Power Management
- 0 Disable .....default
- 1 Enable

3 Reserved .....always reads 0

2 Graphics Memory Interface Power Management
- 0 Disable .....default
- 1 Enable

1 Configuration Registers Power Management
- 0 Disable .....default
- 1 Enable

0 Reserved ..... always reads 0

Device 0 Offset BF – DRAM Pad Toggle Reduction (00h)RW

7 MA / SCMD Pin Toggle Reduction
- 0 Disable .....default
- 1 Enable (MA and S command pins won't toggle if not accessed)

6 Slew Rate Control for MA / SCMD
- 0 Disable .....default
- 1 Enable

5-0 Reserved ..... always reads 0

Device 0 Offset C0 – Power Management Capability ID RO

7-0 Capability ID .....always reads 01h

Device 0 Offset C1 – Power Management Next Pointer. RO

7-0 Next Pointer..... always reads 00h ("Null" Pointer)

Device 0 Offset C2 – Power Mgmt Capabilities I ..... RO

7-0 Power Management Capabilities ..always reads 02h

Device 0 Offset C3 – Power Mgmt Capabilities II..... RO

7-0 Power Management Capabilities ..always reads 00h

Device 0 Offset C4 – Power Mgmt Control / Status ..... RW

7-2 Reserved .....always reads 0

1-0 Power State
- 00 D0 ..... default
- 01 -reserved-
- 10 -reserved-
- 11 D3 Hot

Device 0 Offset C5 – Power Management Status..... RW

7-0 Power Management Status..... default = 00h

Device 0 Offset C6 – PCI-to-PCI Bridge Support Ext... RW

7-0 P2P Bridge Support Extensions..... default = 00h

Device 0 Offset C7 – Power Management Data ..... RW

7-0 Power Management Data ..... default = 00h

Frame Buffer and High Memory Control

Device 0 Offset E0 – CPU Direct Access FB Base (00h) RW

7-1 CPU Direct Access FB Base Address[27:21] . def=0

0 CPU Direct Access Frame Buffer

0 Disable .....default

1 Enable

Device 0 Offset E1 – CPU Direct Access FB Size (00h).. RW

7 Internal VGA

0 Disable .....default

1 Enable

6-4 Frame Buffer Size

000 None .....default

001 2M

010 4M

011 8MB

100 16MB

101 32MB

110 64MB

111 -reserved-

3-0 CPU Direct Access FB Base Address[31:28] . def=0

Device 0 Offset E2 – VGA Arbitration Timer 1 (00h) ...RW

7-4 Timer for Promoted High Priority Display Requests ..... def = 0

3-0 Timer for Promoted High Priority Display . def = 0

The fields above are defined in units of 16 memory (DRAM) clocks. (See also note under VGA Timer 2 description).

Device 0 Offset E3 – UMA Control (00h).....RW

7-5 Reserved ..... always reads 0

4 Frame Buffer Address Conversion

0 Disable .....default

1 Enable

Setting this bit further optimizes the MA table for VGA frame buffer accesses according to the DRAM page size in use. Setting this bit should improve VGA performance especially in tiling address mode. This but cannot be used at the same time as CPU Direct Access FB mode. If used, this bit must be set before enabling the internal VGA to prevent display corruption.

3-2 Reserved ..... always reads 0

1-0 Frame Buffer Bank

Device 0 Offset E6 – SMM / APIC Decoding (01h) ..... RW

7-6 Reserved .....always reads 0

5 Reserved (Do Not Program)..... default = 0

4 I/O APIC Decoding

0 FECxxxxx accesses go to PCI..... default

1 FEC00000 to FEC7FFFF accesses go to PCI
FEC80000 to FECFFFFF accesses go to AGP

3 MSI (Processor Message) Support

0 Disable (master access to FEExxxxx will go to PCI) ..... default

1 Enable (master access to FEExxxxx will be passed to host side to do snoop)

2 Top SMM

0 Disable..... default

1 Enable

1 High SMM

0 Disable..... default

1 Enable

0 Compatible SMM

0 Disable

1 Enable..... **default**

Device 0 Offset E8 – VGA Arbitration Timer 2 (40h)... RW

7-4 Timer for Promoted Low Priority Display Requests .....**default = 0100b**

3-0 Timer for Promoted Low Priority Display .. def = 0

The fields above are defined in units of 16 memory (DRAM) clocks.

VGA timers 1 and 2 are access arbitration timers between the display engine and the graphics engine. Normally the display engine has lower priority than the graphics engine unless the display buffer is below the threshold level where display requests become high priority. The VGA Timers provide the ability to override this deault behavior. These bits should be set prior to turning on the VGA.

BIOS Scratch

Device 0 Offset F7-F0 – BIOS Scratch Registers..... RW

7-0 No hardware function ..... default = 0

Device 1 Register Descriptions

Device 1 PCI-to-PCI Bridge Header Registers

All registers are located in PCI configuration space. They should be programmed using PCI configuration mechanism 1 through CF8 / CFC with bus number of 0 and function number equal to 0 and device number equal to one.

Device 1 Offset 1-0 - Vendor ID (1106h) ..... RO

15-0 ID Code (reads 1106h to identify VIA Technologies)

Device 1 Offset 3-2 - Device ID (B091h) ..... RO

15-0 ID Code (reads B091h to identify the on-chip PCI-to-PCI Bridge device)

Device 1 Offset 5-4 – Command (0007h) ..... RW

15-10 Reserved ..... always reads 0

9 Fast Back-to-Back Cycle Enable ..... **RO**
- 0 Fast back-to-back transactions only allowed to the same agent ..... default
- 1 Fast back-to-back transactions allowed to different agents

8 SERR# Enable ..... **RO**
- 0 SERR# driver disabled ..... default
- 1 SERR# driver enabled

(SERR# is used to report ECC errors)

7 Address / Data Stepping ..... **RO**
- 0 Device never does stepping ..... default
- 1 Device always does stepping

6 Parity Error Response ..... RW
- 0 Ignore parity errors & continue ..... default
- 1 Take normal action on detected parity errors

5 Reserved ..... always reads 0

4 Memory Write and Invalidate Command ..... **RO**
- 0 Bus masters must use Mem Write ..... default
- 1 Bus masters may generate Mem Write & Inval

3 Special Cycle Monitoring ..... **RO**
- 0 Does not monitor special cycles ..... default
- 1 Monitors special cycles

2 Bus Master ..... RW
- 0 Never behaves as a bus master
- 1 Enable to operate as a bus master on the primary interface on behalf of a master on the secondary interface ..... **default**

1 Memory Space ..... RW
- 0 Does not respond to memory space
- 1 Enable memory space access ..... **default**

0 I/O Space ..... RW
- 0 Does not respond to I/O space
- 1 Enable I/O space access ..... **default**

Device 1 Offset 7-6 - Status (Primary Bus) (0230h) .....RWC

15 Detected Parity Error ..... always reads 0

14 Signaled System Error (SERR#) ..... always reads 0

13 Signaled Master Abort
- 0 No abort received ..... default
- 1 Transaction aborted by the master with Master-Abort (except Special Cycles) ..... **write 1 to clear**

12 Received Target Abort
- 0 No abort received ..... default
- 1 Transaction aborted by the target with Target-Abort ..... **write 1 to clear**

11 Signaled Target Abort ..... always reads 0

10-9 DEVSEL# Timing
- 00 Fast
- 01 Medium ..... **always reads 01**
- 10 Slow
- 11 Reserved

8 Data Parity Error Detected ..... always reads 0

7 Fast Back-to-Back Capable ..... always reads 0

6 User Definable Features ..... always reads 0

5 66MHz Capable ..... **always reads 1**

4 Supports New Capability list ..... **always reads 1**

3-0 Reserved ..... always reads 0

Device 1 Offset 8 - Revision ID (0nh) ..... RO

7-0 Chip Revision Code ..... always reads 0nh

Device 1 Offset 9 - Programming Interface (00h) ..... RO

This register is defined in different ways for each Base/Sub-Class Code value and is undefined for this type of device.

7-0 Interface Identifier ..... always reads 00

Device 1 Offset A - Sub Class Code (04h) ..... RO

7-0 Sub Class Code .reads 04 to indicate PCI-PCI Bridge

Device 1 Offset B - Base Class Code (06h) ..... RO

7-0 Base Class Code .. reads 06 to indicate Bridge Device

Device 1 Offset D - Latency Timer (00h) ..... RO

7-0 Reserved ..... always reads 0

Device 1 Offset E - Header Type (01h) ..... RO

7-0 Header Type Code ..... reads 01: PCI-PCI Bridge

Device 1 Offset 18 - Primary Bus Number (00h).....RW

7-0 Primary Bus Number ..... default = 0

This register is read write, but internally the chip always uses bus 0 as the primary.

Device 1 Offset 19 - Secondary Bus Number (00h) .....RW

7-0 Secondary Bus Number..... default = 0

Note: AGP must use these bits to convert Type 1 to Type 0.

Device 1 Offset 1A - Subordinate Bus Number (00h) ....RW

7-0 Primary Bus Number ..... default = 0

Note: AGP must use these bits to decide if Type 1 to Type 1 command passing is allowed.

Device 1 Offset 1B – Secondary Latency Timer (00h) ....RO

7-0 Reserved ..... always reads 0

Device 1 Offset 1C - I/O Base (F0h).....RW

7-4 I/O Base AD[15:12]..... **default = 1111b**

3-0 I/O Addressing Capability ..... default = 0

Device 1 Offset 1D - I/O Limit (00h).....RW

7-4 I/O Limit AD[15:12] ..... default = 0

3-0 I/O Addressing Capability ..... default = 0

Device 1 Offset 1F-1E - Secondary Status.....RO

15-0 Secondary Status

Rx44[4] = 0: these bits read back 0000h

Rx44[4] = 1: these bits read back same as Rx7-6

Device 1 Offset 21-20 - Memory Base (FFF0h).....RW

15-4 Memory Base AD[31:20]..... **default = FFFh**

3-0 Reserved ..... always reads 0

Device 1 Offset 23-22 - Memory Limit (Inclusive) (0000h) RW

15-4 Memory Limit AD[31:20] ..... default = 0

3-0 Reserved ..... always reads 0

Device 1 Offset 25-24 - Prefetchable Memory Base (FFF0h) .....RW

15-4 Prefetchable Memory Base AD[31:20]..def = FFFh

3-0 Reserved ..... always reads 0

Device 1 Offset 27-26 - Prefetchable Memory Limit (0000h) .....RW

15-4 Prefetchable Memory Limit AD[31:20] ..... def = 0

3-0 Reserved ..... always reads 0

Device 1 Offset 34 - Capability Pointer (80h)..... RO

Contains a byte offset from the start of configuration space.

7-0 AGP Capability List Pointer ..... **always reads 80h**

Device 1 Offset 3F-3E – PCI-to-PCI Bridge Control (0000h) ..... RW

15-4 Reserved .....always reads 0

3 VGA-Compatible I/O and Memory Addresses

0 Do not forward VGA accesses ..... default

1 Forward VGA accesses

Note: VGA addresses are memory A0000-BFFFFh and I/O addresses 3B0-3BBh, 3C0-3CFh and 3D0-3DFh (10-bit decode). "Mono" text mode uses B0000-B7FFFh and "Color" Text Mode uses B8000-BFFFFh. Graphics modes use Axxxxh. Mono VGA uses I/O addresses 3Bx-3Cxh and Color VGA uses 3Cx-3Dxh. If an MDA is present, a VGA will not use the 3Bxh I/O addresses and B0000-B7FFFh memory space; if not, the VGA will use those addresses to emulate MDA modes.

2 Block / Forward ISA I/O Addresses

0 Forward all I/O accesses to the AGP bus if they are in the range defined by the I/O Base and I/O Limit registers (device 1 offset 1C-1D)

..... default

1 Do not forward I/O accesses to the AGP bus that are in the 100-3FFh address range even if they are in the range defined by the I/O Base and I/O Limit registers.

1-0 Reserved .....always reads 0

Device 1 PCI-to-PCI Bridge Device-Specific Registers

Internal AGP Bus Control

Device 1 Offset 40 - CPU-to-AGP Flow Control 1 (00h) RW

7 CPU-AGP Post Write
- 0 Disable .....default
- 1 Enable

6 Reserved ..... always reads 0

5 CPU-AGP One Wait State Burst Write
- 0 Disable .....default
- 1 Enable

4-3 Read Prefetch Control
- 00 Always prefetch .....default
- 10 Prefetch only for "Enhance" command
- x1 Prefetch Disable

2 MDA Present on AGP
- 0 Forward MDA accesses to AGP .....default
- 1 Forward MDA accesses to PCI

Note: Forward despite IO / Memory Base / Limit

Note: MDA (Monochrome Display Adapter) addresses are memory addresses B0000h-B7FFFh and I/O addresses 3B4-3B5h, 3B8-3BAh, and 3BFh (10-bit decode). 3BC-3BE are reserved for printers.

Note: If Rx3E bit-3 is 0, this bit is a don't care (MDA accesses are forwarded to the PCI bus).

1 AGP Master Read Caching
- 0 Disable .....default
- 1 Enable

0 AGP Delay Transaction
- 0 Disable .....default
- 1 Enable

Table 9. VGA / MDA Memory / IO Redirection

3E[3] VGA Pres.	40[2] MDA Pres.	VGA is on	MDA is on	Axxxx, B8xxx Access	B0000 -B7FFF Access	3Cx, 3Dx I/O	3Bx I/O
0	-	PCI	PCI	PCI	PCI	PCI	PCI
1	0	AGP	AGP	AGP	AGP	AGP	AGP
1	1	AGP	PCI	AGP	PCI	AGP	PCI

Device 1 Offset 41 - CPU-to-AGP Flow Control 2 (08h) RW

7 Retry Status
- 0 No retry occurred..... default
- 1 Retry Occurred .....**write 1 to clear**

6 Retry Timeout Action
- 0 No action taken except to record status ..... def
- 1 Flush buffer for write or return all 1s for read

5-4 Retry Count
- 00 Retry 2, backoff CPU ..... default
- 01 Retry 4, backoff CPU
- 10 Retry 16, backoff CPU
- 11 Retry 64, backoff CPU

3 CPU-to-AGP Bursting Timeout
- 0 Disable
- 1 Enable**..... default**

2 Reserved .....always reads 0

1 CPU-to-PCI/AGP Cycles Invalidate PCI/AGP Buffered Read Data
- 0 Disable..... default
- 1 Enable

0 AGP Read Bursting
- 0 Disable..... default
- 1 Enable

Device 1 Offset 42 - AGP Master Control (00h) ..... RW

7 AGP Performance Enhancement
- 0 Disable ..... default
- 1 Enable

6 AGP Master One Wait State Write
- 0 Disable ..... default
- 1 Enable

5 AGP Master One Wait State Read
- 0 Disable ..... default
- 1 Enable

4 Break Consecutive PCI Master Accesses
- 0 Disable ..... default
- 1 Enable

3 Dynamic AGP Mem Read Ready Head-Tail Select
- 0 Disable (use tail to return data) ..... default
- 1 Enable (dynamically use head or tail to return data)

2 Claim I/O R/W and Memory Read Cycles
- 0 Disable ..... default
- 1 Enable

1 Claim Local APIC FEEx xxxx Cycles
- 0 Disable ..... default
- 1 Enable

0 Support Host CPU Snoop Cycles at 2T Rate
- 0 Disable ..... default
- 1 Enable

Device 1 Offset 43 - AGP Master Latency Timer (22h) RW

7-4 Host to AGP Time slot
- 0 Disable (no timer)
- 1 16 GCLKs
- 2 32 GCLKs ..... **default**
- … …
- F 240 GCLKs

3-0 AGP Master Time Slot
- 0 Disable (no timer)
- 1 16 GCLKs
- 2 32 GCLKs ..... **default**
- … …
- F 240 GCLKs

Device 1 Offset 45 – Fast Write Control (72h) ..... RW

7 Force Fast Write Cycle to be QW Aligned (if Rx45[6] = 0)
- 0 Disable ..... default
- 1 Enable

6 Merge Multiple CPU Transactions Into One Fast Write Burst Transaction
- 0 Disable
- 1 Enable ..... **default**

5 Merge Multiple CPU Write Cycles To Memory Offset 23-20 Into Fast Write Burst Cycles (if Rx45[6] = 0)
- 0 Disable
- 1 Enable ..... **default**

4 Merge Multiple CPU Write Cycles To Prefetchable Memory Offset 27-24 Into Fast Write Burst Cycles (if Rx45[6] = 0)
- 0 Disable
- 1 Enable ..... **default**

3 Reserved ..... always reads 0

2 Fast Write Burst 4T Max (No Slave Flow Control)
- 0 Disable ..... default
- 1 Enable

1 Fast Write Fast Back to Back
- 0 Disable
- 1 Enable ..... **default**

0 Fast Write Initial Block 1 Wait State
- 0 Disable ..... default
- 1 Enable

Rx45 Bits 7-4	CPU Write Address in Mem1	CPU Write Address in Mem2	Fast Write Cycle Alignment
x1xx	-	-	QW aligned, burstable
0000	-	-	DW aligned, nonburstable
x010	0	0	n/a
0010	0	1	DW aligned, non-burstable
x010	1	-	QW aligned, burstable
x001	0	0	n/a
x001	-	1	QW aligned, burstable
0001	1	0	DW aligned, non-burstable
x011	0	0	n/a
x011	1	-	QW aligned, burstable
x011	0	1	QW aligned, burstable
1000	-	-	QW aligned, non-burstable
1010	0	1	QW aligned, non-burstable
1001	1	0	QW aligned, non-burstable

Device 1 Offset 47-46 – PCI-to-PCI Bridge Device ID... RW

15-0 PCI-to-PCI Bridge Device ID ..... default = 0000

Device 1 Offset 48 – AGP Parity Error Control..... RW

7-2 Reserved ..... always reads 0

1 Pass AGP Data Parity Error to V-Link

0 Disable ..... default

1 Enable

0 Pass AGP Address Parity Error to V-Link

0 Disable ..... default

1 Enable

Power Management

Device 1 Offset 80 – Capability ID (01h) ..... RO

7-0 Capability ID ..... always reads 01h

Device 1 Offset 81 – Next Pointer (00h)..... RO

7-0 Next Pointer: Null ..... always reads 00h

Device 1 Offset 82 – Power Mgmt Capabilities 1 (02h).. RO

7-0 Power Mgmt Capabilities ..... always reads 02h

Device 1 Offset 83 – Power Mgmt Capabilities 2 (00h).. RO

7-0 Power Mgmt Capabilities ..... always reads 00h

Device 1 Offset 84 – Power Mgmt Ctrl/Status (00h)..... RW

7-2 Reserved ..... always reads 0

1-0 Power State

00 D0 ..... default

01 -reserved-

10 -reserved-

11 D3 Hot

Device 1 Offset 85 – Power Mgmt Status (00h)..... RO

7-0 Power Mgmt Status ..... default = 00

Device 1 Offset 86 – P2P Br. Support Extensions (00h). RO

7-0 P2P Bridge Support Extensions ..... default = 00

Device 1 Offset 87 – Power Management Data (00h) ..... RO

7-0 Power Management Data ..... default = 00

FUNCTIONAL DESCRIPTION

Integrated Graphics Controller

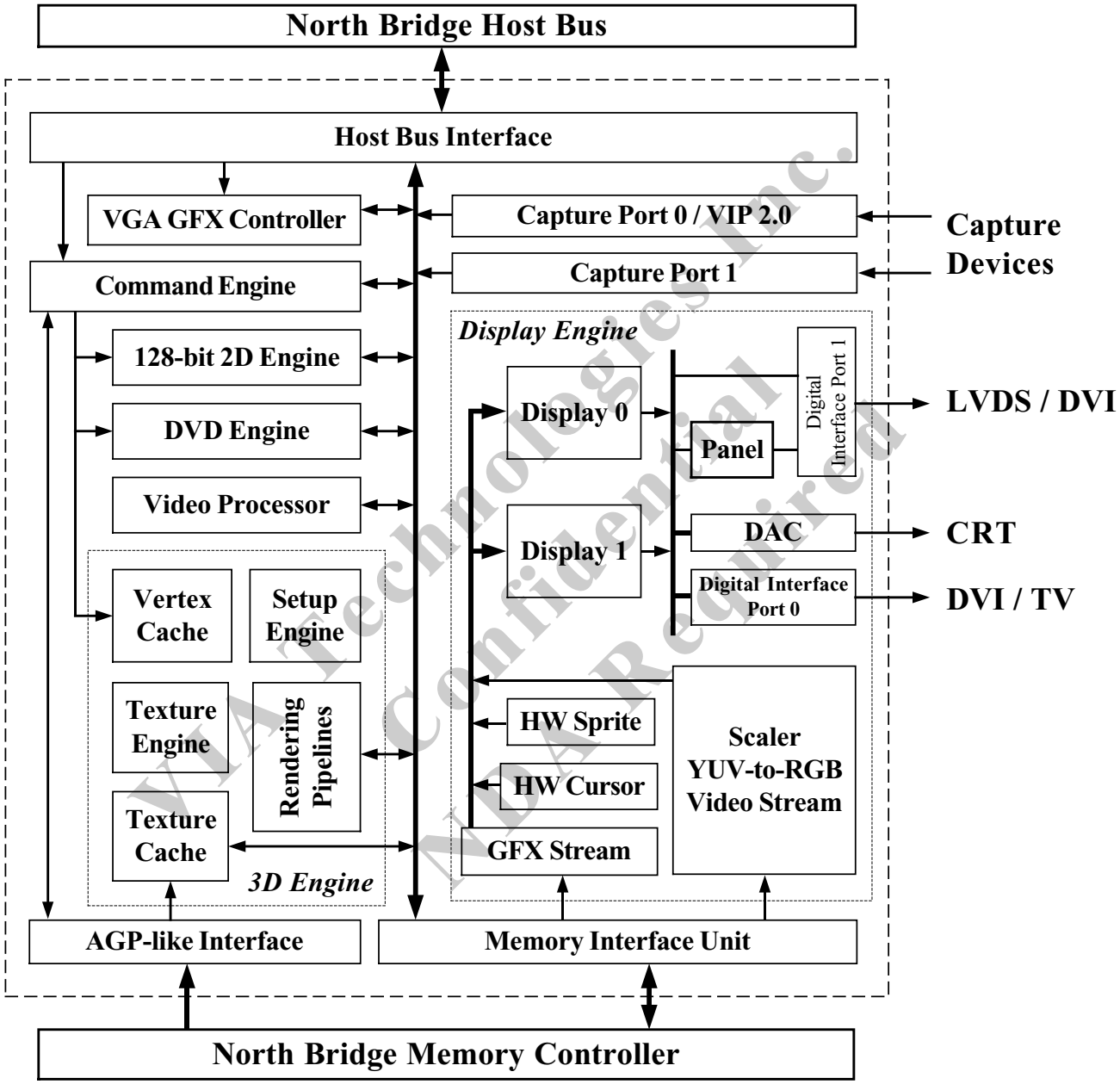


Figure 4. Graphics Controller Internal Block Diagram

Internal Architecture

A high-level block diagram of the integrated graphics controller core is shown in Figure 4 above. This diagram is intended to be used for gaining an understanding of chip features and programming. It shows logical structure but is not intended to show actual internal implementation details.

Graphics Modes

Mode support is influenced by:

- Amount, speed and bus width of video memory
- Display resolution and color depth
- Maximum refresh capability detected for the display devices
- Panel Size
- Single IGA or Dual IGA setting
- SAMM setting

Desktop Modes - Single Display

LCD Single Display modes follow the 60Hz refresh column in the table below.

Resolution	Bpp	CRT Maximum Refresh				
		60	75	85	100	120
640x480	8	√	√	√	√	√
	16	√	√	√	√	√
	32	√	√	√	√	√
800x600	8	√	√	√	√	√
	16	√	√	√	√	√
	32	√	√	√	√	
1024x768	8	√	√	√	√1	
	16	√	√	√1	√1	
	32	√	√	√1		
1152x864	8	√	√			
	16	√	√			
	32	√	√			
1280x1024	8	√	√	√		
	16	√	√	√		
	32	√	√	√3		
1400x1050**	8	√	√	√		
	16	√	√	√1		
	32	√	√3	√4		
1600x1200	8	√	√	√		
	16	√	√1	√1		
	32	√3				

Figure 5. Desktop Graphics Modes – Single Display

Key for Desktop Modes

** = Mode available for systems where this LCD panel size is detected

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**

√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.

√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.

√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.

√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.

Desktop Modes - LCD VGA 640x480 Multiple Display

CRT Resolution	BPP	LCD 8BPP CRT Maximum Refresh					LCD 16BPP CRT Maximum Refresh					LCD 32BPP CRT Maximum Refresh				
		60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	32	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
800x600	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√1
	32	√	√	√	√		√	√	√	√		√	√	√	√1	
1024x768	8	√	√	√	√		√	√	√	√		√	√	√	√1	
	16	√	√	√	√1		√	√	√	√1		√	√	√1	√2	
	32	√	√	√1			√	√	√1			√	√	√1		
1152x864	8	√	√				√	√				√	√			
	16	√	√				√	√				√	√1			
	32	√	√1				√	√1				√	√1			
1280x1024	8	√	√1	√1			√	√1	√1			√	√1	√2		
	16	√	√1	√1			√	√1	√1			√1	√1	√2		
	32	√	√1	√4			√	√1	√4			√1	√2	√4		
1600x1200	8	√1	√2				√1	√2				√2	√2			
	16	√2	√2				√2	√2				√2	√2			
	32	√4					√4					√4				

Figure 6. Desktop Graphics Modes – LCD VGA 640x480 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**
√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.
√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.
√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.
√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.
√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Desktop Modes - LCD SVGA 800x600 Multiple Display

CRT Resolution	BPP	LCD 8BPP CRT Maximum Refresh					LCD 16BPP CRT Maximum Refresh					LCD 32BPP CRT Maximum Refresh				
		60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	32	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
800x600	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√1
	32	√	√	√	√		√	√	√	√		√	√	√	√1	
1024x768	8	√	√	√	√		√	√	√	√		√	√	√	√1	
	16	√	√	√	√1		√	√	√	√1		√	√	√1	√2	
	32	√	√	√1			√	√	√1			√	√	√1		
1152x864	8	√	√				√	√				√	√			
	16	√	√1				√	√1				√	√1			
	32	√	√1				√	√1				√	√1			
1280x1024	8	√	√1	√1			√	√1	√1			√	√2	√2		
	16	√	√1	√1			√	√1	√1			√1	√2	√2		
	32	√	√1	√4			√	√1	√4			√1	√4	√4		
1600x1200	8	√2	√2				√2	√2				√2	√2			
	16	√2	√2				√2	√2				√2	√2			
	32	√4					√4					√4				

Figure 7. Desktop Graphics Modes – LCD SVGA 800x600 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**
√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.
√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.
√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.
√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.
√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Desktop Modes - LCD XGA 1024x768 Multiple Display

CRT Resolution	BPP	LCD 8BPP CRT Maximum Refresh					LCD 16BPP CRT Maximum Refresh					LCD 32BPP CRT Maximum Refresh				
		60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	32	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
800x600	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√1
	32	√	√	√	√		√	√	√	√		√	√	√	√1	
1024x768	8	√	√	√	√		√	√	√	√		√	√	√	√1	
	16	√	√	√	√1		√	√	√	√1		√	√1	√1	√2	
	32	√	√	√1			√	√	√1			√1	√1	√1		
1152x864	8	√	√				√	√				√	√1			
	16	√	√1				√	√1				√1	√1			
	32	√	√1				√	√1				√1	√1			
1280x1024	8	√	√1	√1			√	√1	√1			√1	√2	√2		
	16	√1	√1	√1			√1	√1	√1			√1	√2	√2		
	32	√1	√1	√4			√1	√1	√4			√1	√2	√4		
1600x1200	8	√2	√2				√2	√2				√2	√2			
	16	√2	√2				√2	√2				√2	√2			
	32	√4					√4					√4				

Figure 8. Desktop Graphics Modes – LCD XGA 1024x768 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**
√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.
√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.
√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.
√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.
√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Desktop Modes - LCD SXGA 1280x1024 Multiple Display

CRT Resolution	BPP	LCD 8BPP					LCD 16BPP					LCD 32BPP				
		CRT Maximum Refresh					CRT Maximum Refresh					CRT Maximum Refresh				
		60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√	√	√	√	√	√	√	√	√	√	√1	√1	√1	√1	√1
	16	√	√	√	√	√	√	√	√	√	√	√1	√1	√1	√3	√4
	32	√	√	√	√	√	√	√	√	√	√	√3	√3	√3	√4	√4
800x600	8	√	√	√	√	√	√	√	√	√	√	√1	√1	√1	√3	√2
	16	√	√	√	√	√1	√	√	√	√	√1	√3	√4	√4	√4	√4
	32	√	√	√	√1		√	√	√	√1		√3	√4	√4	√4	
1024x768	8	√	√	√	√1		√	√	√	√1		√1	√1	√2	√4	
	16	√	√1	√1	√1		√	√1	√1	√1		√4	√4	√4	√4	
	32	√1	√1	√2			√1	√1	√2			√4	√4	√4		
1152x864	8	√	√1				√	√1				√2	√2			
	16	√1	√1				√1	√1				√4	√4			
	32	√1	√2				√1	√2				√4	√4			
1280x1024	8	√1	√1	√2			√1	√1	√2			√4	√4	√4		
	16	√1	√2	√2			√1	√2	√2			√4	√4	√4		
	32	√2	√2	√4			√2	√2	√4			√4				
1600x1200	8	√2	√2				√2	√2				√4	√4			
	16	√2	√2				√2	√2				√4	√4			
	32	√4					√4									

Figure 9. Desktop Graphics Modes – LCD SXGA 1280x1024 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**

√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.

√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.

√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.

√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.

√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Desktop Modes - LCD SXGA+ 1400x1050 Multiple Display

Note: LCD at 32bpp is not supported with SXGA+ panels.

		LCD 8BPP					LCD 16BPP					LCD 32BPP[5]				
		CRT MAXIMUM REFRESH					CRT MAXIMUM REFRESH					CRT MAXIMUM REFRESH				
CRT RESOLUTION	BPP	60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√	√	√	√	√	√	√	√	√	√					
	16	√	√	√	√	√	√	√	√	√	√					
	32	√	√	√	√	√	√	√	√	√	√					
800x600	8	√	√	√	√	√	√	√	√	√	√					
	16	√	√	√	√	√1	√	√	√	√	√1					
	32	√	√	√	√1		√	√	√	√1						
1024x768	8	√	√	√	√1		√	√	√	√1						
	16	√	√1	√1	√2		√	√1	√1	√2						
	32	√1	√2	√2			√1	√2	√2							
1152x864	8	√	√1				√	√1								
	16	√1	√1				√1	√1								
	32	√1	√2				√1	√2								
1280x1024	8	√1	√1	√2			√1	√1	√2							
	16	√1	√2	√2			√1	√2	√2							
	32	√2	√2	√4			√2	√2	√4							
1400x1050	8	√2	√2				√2	√2								
	16	√2	√2				√2	√2								
	32	√4	√4				√4	√4								
1600x1200	8	√2	√2				√2	√2								
	16	√2	√2				√2	√2								
	32	√4					√4									

Figure 10. Desktop Graphics Modes – LCD SXGA+ 1400x1050 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**
√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.
√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.
√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.
√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.
√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Desktop Modes - LCD UXGA 1600x1200 Multiple Display

Note: LCD at 32bpp is not supported with UXGA panels.

		LCD 8BPP					LCD 16BPP					LCD 32BPP[5]				
		CRT MAXIMUM REFRESH					CRT MAXIMUM REFRESH					CRT MAXIMUM REFRESH				
CRT RESOLUTION	BPP	60	75	85	100	120	60	75	85	100	120	60	75	85	100	120
640x480	8	√1	√1	√1	√1	√1	√1	√1	√1	√1	√1					
	16	√1	√1	√1	√1	√1	√1	√1	√1	√1	√1					
	32	√1	√1	√1	√1	√1	√1	√1	√1	√1	√1					
800x600	8	√1	√1	√1	√1	√1	√1	√1	√1	√1	√1					
	16	√1	√1	√1	√1	√1	√1	√1	√1	√1	√1					
	32	√1	√1	√1	√1		√1	√1	√1	√1						
1024x768	8	√1	√1	√1	√1		√1	√1	√1	√1						
	16	√1	√1	√1	√2		√1	√1	√1	√2						
	32	√1	√2	√2			√1	√2	√2							
1152x864	8	√1	√1				√1	√1								
	16	√1	√2				√1	√2								
	32	√2	√4				√2	√4								
1280x1024	8	√1	√2	√2			√1	√2	√2							
	16	√2	√2	√2			√2	√2	√2							
	32	√4	√4	√4			√4	√4	√4							
1600x1200	8	√2	√2				√2	√2								
	16	√2	√4				√2	√4								
	32	√4					√4									

Figure 11. Desktop Graphics Modes – LCD UXGA 1600x1200 Multiple Display

Key for Desktop Modes

√ = Supported with DDR200 or DDR266: **Mode available and Overlay available**

√1 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available, overlay available**.

√2 = DDR200: **Mode available**, overlay not available. DDR266: **Mode available**, overlay not available.

√3 = DDR200: Mode not available, overlay not available. DDR266: **Mode available, overlay available**.

√4 = DDR200: Mode not available, overlay not available. DDR266: **Mode available**, overlay not available.

√5 = Mode and Motion Compensation available with LCD in standalone configuration only

Graphics Modes That Allow LCD Centering and Expansion

When the LCD resolution is smaller than the panel's native resolution, software and hardware may activate centering or expansion depending on the display setting, using the high quality interpolated scaler.

	LCD NATIVE RESOLUTION			
RESOLUTION	LCD XGA 1024x768	LCD WXGA 1280x1024	LCD SXGA+ 1400x1050	LCD UXGA 1600x1200
640x480	CE	CE	CE	CE
800x600	CE	CE	CE	CE
1024x768		CE	CE	CE
1280x1024			CE	CE
1400x1050				
1600x1200				

Figure 12. Graphics Modes That Allow LCD Centering and Expansion

C = Centered
CE = Centering and Expansion possible for LCD

VGA Graphics Modes

Legacy VGA modes may be supported by BIOS and DOS, but most are not enabled for drivers.

Resolution	Bpp	Colors	Memory	Mode	CRT Refresh				
					60	70	75	85	100
40x25	c	16	text	0,1		√			
80x25	c	16	text	2,3		√			
320x200	2	4	2-bit planar	4,5		√			
640x200	1	2	1-bit planar	6		√			
80x25	bw	mono	text	7		√			
320x200	4	16	4-bit planar	0D		√			
640x200	4	16	4-bit planar	0E		√			
640x350	bw	mono	1-bit planar	0F		√			
640x350	4	16	4-bit planar	10		√			
640x480	1	2	2-bit planar	11	√				
640x480	4	16	4-bit planar	12	√				
320x200*	8	256	8-bit packed	13		√			
800x600**	4	16	4-bit planar	102	√		√	√	√

Figure 13. VGA Graphics Modes

√ = Supported
* = Legacy VGA Mode 13, 320x200x8 is used by DirectDraw
** = Legacy VESA Mode 102, 800x600x4 is used by Windows XP
bw = Black and White
c = Color

Direct Draw Graphics Modes

Overlay is enabled for all the Direct Draw modes listed below.

Resolution	Bpp	Mode	CRT Refresh 85
320x200	8	13	√
	16	10E	√
	32	10F	√
320x240	8	131	√
	16	133	√
	32	134	√
400x300	8	141	√
	16	143	√
	32	144	√
512x384	8	151	√
	16	153	√
	32	154	√
640x400	8	100	√
	16	11D	√
	32	11E	√

Figure 14. Direct Draw Graphics Modes

√ = Supported

Graphics Modes for TV Display

Modes supported on TV using an external TV encoder:

		VT1621		VT1622		CH7009/ CH7010		SAA7108/ SAA7109	
RESOLUTION	BPP	NTSC	PAL	NTSC	PAL	NTSC	PAL	NTSC	PAL
40x25_TEXT	c	√	√	√	√	√	√	√	√
	c	√	√	√	√	√	√	√	√
80x25_TEXT	c	√	√	√	√	√	√	√	√
	c	√	√	√	√	√	√	√	√
	bw	√	√	√	√	√	√	√	√
320x200	8	√	√	√	√	√	√	√	√
640x480	4	√	√	√	√	√	√	√	√
	8	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√
	32	√	√	√	√	√	√	√	√
800x600	8	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√
	32	√	√	√	√	√	√	√	√
1024x768	8			√	√	√	√	√	√
	16			√	√	√	√	√	√
	32			√	√	√	√	√	√

Figure 15. Graphics Modes for TV Display

√ = Supported
bw = Black and White
c = Color

Additional Graphics Modes for IA Devices

These modes will be available for use in IA devices, but are not supported for PC configurations.

Resolution	Bpp	Mode	CRT Refresh 60	CRT Refresh 75
720x480	8	171	√	√
	16	173	√	√
	32	175	√	√
720x576	8	17C	√	√
	16	17E	√	√
	32	17F	√	√
848x480	8	15C	√	√
	16	15D	√	√
	32	15F	√	√
1024x512	8	1A9	√	√
	16	1AA	√	√
	32	1AB	√	√

Figure 16. Additional Graphics Modes for IA Devices

√ = Supported

Flat Panel Display RGB Mapping

Table 10. FPD RGB Mapping

	18Bit	24Bit
Pin	**RGB**	**RGB**
FPD0		B0
FPD1		B1
FPD2	B2	B2
FPD3	B3	B3
FPD4	B4	B4
FPD5	B5	B5
FPD6	B6	B6
FPD7	B7	B7
FPD8		G0
FPD9		G1
FPD10	G2	G2
FPD11	G3	G3
FPD12	G4	G4
FPD13	G5	G5
FPD14	G6	G6
FPD15	G7	G7
FPD16		R0
FPD17		R1
FPD18	R2	R2
FPD19	R3	R3
FPD20	R4	R4
FPD21	R5	R5
FPD22	R6	R6
FPD23	R7	R7

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Table 11. Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit	Notes
T_C	Case operating temperature	0	85	°C	1
T_S	Storage temperature	–55	125	°C	1
V_{IN}	Input voltage	–0.5	V_{RAIL} + 10%	Volts	1, 2
V_{OUT}	Output voltage	–0.5	V_{RAIL} + 10%	Volts	1, 2

Note 1. Stress above the conditions listed may cause permanent damage to the device. Functional operation of this device should be restricted to the conditions described under operating conditions.

Note 2. V_{RAIL} is defined as the V_{CC} level of the respective rail. The CPU interface can be 3.3V or 2.5V. Memory can be 3.3V only. PCI can be 3.3V or 5.0V. Video can be 3.3V or 5.0V. Flat Panel can be 3.3V only. AGP can be 1.5V (4x transfer mode) or 3.3V (2x transfer mode).

DC Characteristics

T_C = 0-85°C, V_{RAIL} = V_{CC} ±5%, V_{CORE} = 2.5V ±5%, GND=0V

Table 12. DC Characteristics

Symbol	Parameter	Min	Max	Unit	Condition
V_{IL}	Input Low Voltage	–0.50	0.8	V	
V_{IH}	Input High Voltage	2.0	V_{CC}+0.5	V	
V_{OL}	Output Low Voltage	–	0.55	V	I_{OL} = 4.0mA
V_{OH}	Output High Voltage	2.4	–	V	I_{OH} = –1.0mA
I_{IL}	Input Leakage Current	–	±10	uA	0 < V_{IN} < V_{CC}
I_{OZ}	Tristate Leakage Current	–	±20	uA	0.55 < V_{OUT} < V_{CC}

Power Characteristics

T_C = 0-85°C, V_{RAIL} = V_{CC} ±5%, V_{CORE} = 2.5V ±5%, GND=0V

Table 13. Power Characteristics – Internal and Interface Digital Logic

Symbol	Parameter	Typ	Max	Unit	Condition
I_{TT}	Power Supply Current – VTT			mA	Full-On Operation
I_{TTPOS}	Power Supply Current – VTT			mA	POS
I_{TTSTR}	Power Supply Current – VTT			mA	STR
I_{TTSOF}	Power Supply Current – VTT			mA	Soft-Off
I_{CCG}	Power Supply Current – VCCG			mA	Full-On Operation
I_{CCGPOS}	Power Supply Current – VCCG			mA	POS
I_{CCGSTR}	Power Supply Current – VCCG			mA	STR
I_{CCGSOF}	Power Supply Current – VCCG			mA	Soft-Off
I_{CCV}	Power Supply Current – VCCVL			mA	Full-On Operation
I_{CCVPOS}	Power Supply Current – VCCVL			mA	POS
I_{CCVSTR}	Power Supply Current – VCCVL			mA	STR
I_{CCVSOF}	Power Supply Current – VCCVL			mA	Soft-Off
I_{CCM}	Power Supply Current – VCCM			mA	Full-On Operation
I_{CCMPOS}	Power Supply Current – VCCM			mA	POS
I_{CCMSTR}	Power Supply Current – VCCM			mA	STR
I_{CCMSOF}	Power Supply Current – VCCM			mA	Soft-Off
I_{CC25}	Power Supply Current – VCC25			mA	Full-On Operation
$I_{CC25POS}$	Power Supply Current – VCC25			mA	POS
$I_{CC25STR}$	Power Supply Current – VCC25			mA	STR
$I_{CC25SOF}$	Power Supply Current – VCC25			mA	Soft-Off
I_{SUS25}	Power Supply Current – VSUS25			mA	Full-On Operation
$I_{SUS25POS}$	Power Supply Current – VSUS25			mA	POS
$I_{SUS25STR}$	Power Supply Current – VSUS25			mA	STR
$I_{SUS25SOF}$	Power Supply Current – VSUS25			mA	Soft-Off
I_{CCDAC}	Power Supply Current – VCCDAC			mA	Max operating frequency
P_D	Power Dissipation			W	Max operating frequency

Table 14. Power Characteristics – Analog and Reference Voltages

Symbol	Parameter	Typ	Max	Unit	Condition
I_{CCGTL}	Power Supply Current – GTLVREF			mA	Max operating frequency
I_{CCMREF}	Power Supply Current – MEMVREF			mA	Max operating frequency
$I_{CCVLREF}$	Power Supply Current – VLVREF			mA	Max operating frequency
I_{CCHCK}	Power Supply Current – VCCHCK			mA	Max operating frequency
I_{CCMCK}	Power Supply Current – VCCMCK			mA	Max operating frequency
I_{CCMDLL}	Power Supply Current – VCCMDLL			mA	Max operating frequency
I_{CCRGB}	Power Supply Current – VCCRGB			mA	Max operating frequency
I_{CCPLL1}	Power Supply Current – VCCPLL1			mA	Max operating frequency
I_{CCPLL2}	Power Supply Current – VCCPLL2			mA	Max operating frequency
$I_{CCALPLL}$	Power Supply Current – VCCALPLL			mA	Max operating frequency
$I_{CCALVDS}$	Power Supply Current – VCCALVDS			mA	Max operating frequency

AC Timing Specifications

AC timing specifications provided are based on external zero-pf capacitance load. Min/max cases are based on the following table:

Table 15. AC Timing Min / Max Conditions

Parameter	Min	Max	Unit
5.0V Power	4.75	5.25	Volts
3.3V Power (I/O Pads, VCCQ for 2x transfer mode)	3.135	3.465	Volts
2.5V Power (Internal Logic)	2.375	2.625	Volts
1.5V Power (VCCQ for 4x transfer mode)	1.425	1.575	Volts
Case Temperature	0	85	°C

Drive strength for selected output pins is programmable. See Rx6D for details.

Table 16. AC Timing – CPU Interface

Signal	Setup	Hold	Min Delay	Max Delay	Unit
HD Bus					ns
HA Bus					ns
ADS#					ns
DBSY#					ns
DRDY#					ns
BNR#					ns
HIT#					ns
HITM#					ns
HLOCK#					ns
HREQ0#					ns
HREQ1#					ns
HREQ2#					ns
HREQ3#					ns
HREQ4#					ns
BPRI#					ns
DEFER#					ns
HTRDY#					ns
RS[2:0]#					ns

Table 17. AC Timing – Memory Interface

Signal	Rx67[6:5] MD Bus Read Delay	Setup	Hold	Weak Drive		Strong Drive		Unit
				Min Delay	Max Delay	Min Delay	Max Delay	
MD Bus	00 (0.0 ns)							ns
MD Bus	01 (0.5 ns)			–	–	–	–	ns
MD Bus	10 (1.0 ns)			–	–	–	–	ns
MD Bus	11 (1.5 ns)			–	–	–	–	ns
MA Bus	–	–	–					ns
SRAS# Bus	–	–	–					ns
SCAS# Bus	–	–	–					ns
SWE# Bus	–	–	–					ns
CS# Bus	–	–	–					ns
DQM Bus	–	–	–					ns

MECHANICAL SPECIFICATIONS

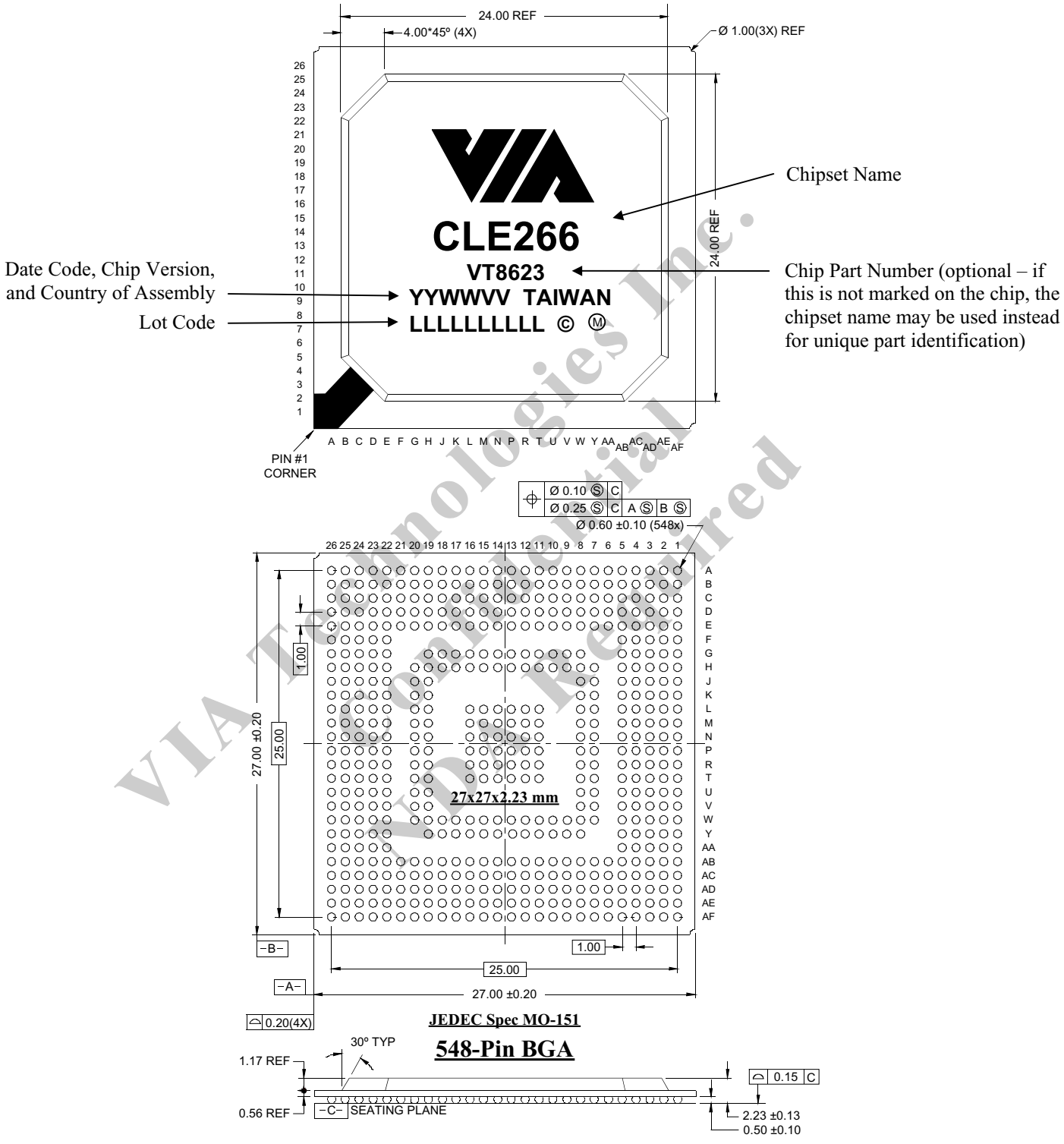


Figure 17. Mechanical Specifications – 548-Pin 27x27mm Ball Grid Array Package with 1mm Ball Pitch