



Data Sheet

CN333

North Bridge

*with Integrated UniChrome
Pro 3D / 2D Graphics
Controller*

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VIA TECHNOLOGIES, INC.

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Offices:

VIA Technologies Incorporated

Taiwan Office:

1st Floor, No. 531

Chung-Cheng Road, Hsin-Tien

Taipei, Taiwan ROC

Tel: (886-2) 2218-5452

Fax: (886-2) 2218-5453

Home page: <http://www.via.com.tw>

VIA Technologies Incorporated

USA Office:

940 Mission Court

Fremont, CA 94539

USA

Tel: (510) 683-3300

Fax: (510) 683-3301 or (510) 687-4654

Home Page: <http://www.viatech.com>

S3 Graphics Incorporated

USA Office:

1045 Mission Court

Fremont, CA 94539

USA

Tel: (510) 687-4900

Fax: (510) 687-4901

Home Page: <http://www.s3graphics.com>

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CN333 NORTH BRIDGE

133 / 100 MHz VIA C3 Front Side Bus
 Integrated UniChrome Pro 3D / 2D Graphics and Video Controllers
 Advanced DDR333 SDRAM Controller
 1 GB / Sec Ultra V-Link Interface

PRODUCT FEATURES

- **Defines Highly Integrated Solutions for Full Featured, Power Efficient PC Designs**
 - High Performance UMA North Bridge: Integrated VIA C3 North Bridge with 133 / 100 MHz FSB support and UniChrome Pro 3D / 2D Graphics and Video Controllers in a single chip
 - Advanced memory controller supporting DDR 333 / 266 / 200 SDRAM
 - Combines with VIA VT8235M-CE / VT8237R South Bridge for integrated 10/100 LAN, Audio, ATA133 IDE, LPC, USB 2.0 and Serial ATA (VT8237R)
 - “Lead-Free” 31 x 31mm HSBGA (Ball Grid Array with Heat Spreader) package with 681 balls and 1mm ball pitch
- **High Performance CPU Interface**
 - Supports 133 / 100 MHz FSB VIA C3 processors
 - Eight outstanding transactions (eight-level In-Order Queue (IOQ))
 - Built-in Phase Lock Loop circuitry for optimal skew control within and between clocking regions
- **Advanced High-Performance 64-Bit DDR SDRAM Controller**
 - Supports DDR333 / 266 memory types with 2.5V SSTL-2 DRAM interface
 - Supports mixed 64 / 128 / 256 / 512 / 1024Mb DDR SDRAMs in x8 and x16 configurations
 - Supports CL 2 / 2.5 for DDR266 / 333
 - Supports 2 unbuffered double-sided DIMMs and up to 4 GBytes of physical memory
 - Programmable timing / drive for memory address, data and control signals
 - DRAM interface pseudo-synchronous with host CPU for optimal memory performance
 - Concurrent CPU, internal graphics controller and V-Link access for minimum memory access latency
 - Rank interleave and up to 16-bank page interleave (i.e., 16 pages open simultaneously) based on LRU to effectively reduce memory access latency
 - Seamless DRAM command scheduling for maximum DRAM bus utilization
 - (e.g., precharge other banks while accessing the current bank)
 - CPU Read-Around-Write capability for non-stalled operation
 - Speculative DRAM read before snoop result to reduce PCI master memory read latency
 - Supports Burst Read and Write operations with burst length of 4 or 8
 - Eight cache lines (64 quadwords) of integrated CPU-to-DRAM write buffers and eight separate cache lines of CPU-to-DRAM read prefetch buffers
 - Optional dynamic Clock Enable (CKE) control for DRAM power reduction during normal system state (S0)
 - Supports self-refresh and CAS-before-RAS DRAM refresh with staggered RAS timing
- **High Bandwidth 1 GB / Sec 16-Bit “Ultra V-Link” Host Controller**
 - Supports 66 MHz, 4x and 8x transfer modes, Ultra V-Link Host interface with 1 GB / Sec total bandwidth
 - Full duplex transfers with separate command / strobe for 4x and 8x modes
 - Request / Data split transaction
 - Transaction assurance for V-Link Host-to-Client access eliminates V-Link Host-Client Retry cycles
 - Intelligent V-Link transaction protocol to minimize data wait-states, throttle transfer latency and avoid data overflow
 - Highly efficient V-Link arbitration with minimum overhead

- **Advanced System Power Management Support**

- ACPI 2.0 and PCI Bus Power Management 1.1 compliant
- Supports Suspend-to-DRAM (STR) and DRAM self-refresh
- Supports dynamic Clock Enable (CKE) control for DRAM power reduction during normal system state (S0)
- Supports SMI, SMM and STPCLK mechanisms
- Supports VIA PowerSaver™ Technology
- Low-leakage I/O pads

- **Integrated Graphics with 2D / 3D / Video Controllers**

- Optimized Unified Memory Architecture (UMA)
- Supports 16 / 32 / 64 MB Frame Buffer sizes
- 200 MHz Graphics Engine Clock
- Two independent 128-bit data paths between North Bridge and graphics core to improve video performance, one for frame buffer access and one for texture / command access
- PCI v2.2 Host Bus compliant
- AGP v3.0 compliant

2D Acceleration

- 128-bit 2D graphics engine
- Hardware 2D rotation
- Supports ROP3, 256 operations
- Supports 8bpp, 15/16bpp and 32bpp color depth modes
- BitBLT (Bit Block Transfer) functions including alpha BLTs
- True-color hardware cursor (64x64x32bpp) with 256-level blending effect
- Color expansion, source Color Key and destination Color Key
- Bresenham line drawing / style line function
- Transparency mode
- Window clipping
- Text function

3D Acceleration

3D Graphics Processor

- 128-bit 3D graphics engine
- Dual pixel rendering pipes and dual texture units
- Floating-point setup engine
- Internal full 32-bit ARGB format for high rendering quality
- 8K Texture Cache

Capability

- Supports ROP2
- Supports various texture formats including 16/32bpp ARGB, 8bpp Palletized (ARGB), YUV 422/420 and compressed texture (DXTC)
- Texture sizes up to 2048x2048 with Microsoft DirectX texture compression
- High quality texture filter for Nearest, Linear, Bi-linear, Tri-linear and Anisotropic modes
- Flat and Gouraud shading
- Vertex Fog and Fog Table
- Z-Bias, LOD-Bias, Polygon offset, Edge Anti-aliasing and Alpha Blending
- Bump mapping and cubic mapping
- Hardware back-face culling
- Specular lighting

Performance

- Two textures per pass
- Triangle rate up to 4.5 million triangles per second
- Pixel rate up to 200 million pixels per second for 2 textures each
- Texel bilinear fill rate up to 400 million texels per second
- High quality dithering

Video Acceleration

High Quality Video Processor

- RGB555, RGB565, RGB8888 and YUV422 video playback formats
- High quality 5-tap horizontal and 5-tap vertical scaler (up or down) for both horizontal and vertical scaling (linear interpolation for horizontal and vertical p-scaling and filtering for horizontal and vertical down-scaling)
- Independent graphics and video gamma tables
- 2 sets of Color and Chroma Key support
- Color enhancement for contrast, hue, saturation and brightness
- Display rotation in clockwise and counter-clockwise directions
- Bob, Weave, Median-filter and Adaptive de-interlacing modes
- 3:2 / 2:2 pull-down detection
- De-blocking mode support
- Combining of many special effects such as filter, scaling up or down, sub-picture blending, de-interlacing and deblocking to one pass process
- Tear-free double / triple buffer flipping
- Input video vertical blanking or line interrupt
- Video gamma correction

Video Overlay Engine

- Simultaneous graphics video playback overlay
- Supports video window overlays
- Supports 16 operations for Color and Chroma Key
- Hardware sub-picture blending

MPEG Video Playback

- MPEG-2 hardware VLD (Various Length Decode), iDCT, and motion compensation for full speed DVD and MPEG-2 playback at full D1 resolution
- High quality DVD and streaming video playback
- Video auto-flipping
- Hardware DVD sub-picture blending

DuoView+™ Dual Image Capability

- WinXP, WinME and Win98 multi-monitor, extended desktop support
- Two independent display engines, each of which can display completely different information at different resolutions, pixel depths and refresh rates (supports different images on different displays simultaneously)
- CRT, FPD and DVI monitor refresh rates are independently programmable for optimum image quality
- Improved display flexibility with simultaneous FPD / CRT, FPD, FPD / DVI and other combined operations

Full Software Support

- Microsoft DirectX 7.0, 8.0 and 9.0 compatible
- Microsoft DirectX Texture Compression (DXTC / S3TC)
- Supports OpenGL™
- Drivers for major operating systems and APIs: Windows® 9x / ME, Windows 2000, Windows XP, Direct3D™, DirectDraw™, DirectShow™ and OpenGL™ ICD for Windows 9x / ME and XP
- Windows NT 4.0 Standard VGA driver

- **Extensive Display Support for External Video Output**

- CRT display interface
- 12-bit Digital Video Port with support for external DVI transmitter
- 24-bit / Dual 12-Bit FPD interface to external LVDS transmitter

- **CRT Display**

- CRT display interface with 24-bit true-color RAMDAC up to 300 MHz pixel rate with gamma correction capability
 - Supports CRT resolutions up to 1920 x 1440

- **12-Bit DVI Transmitter Interface**

- 1.5V low-swing interface supports external DVI transmitter for a driving a DVI monitor
 - Double-data-rate data transfer with clock rates up to 165 MHz
 - Built-in digital phase adjuster to fine-tune signal timing between clock and data bus

- **24-Bit Flat Panel Display (FPD) Interface**

- Supports 18/24-bit FPD interface with external LVDS transmitter chip using single or double-data rate data transfer
 - Supports panel resolutions up to 1600x1200

- **Dual 12-Bit Flat Panel Display (FPD) Interface**

- Alternate operating mode of FPD interface with external LVDS transmitters
 - Single or separate sets of clock and sync signals
 - Supports panel resolutions up to 1600x1200

- **Advanced Graphics Power Management Support**

- Built-in reference voltage generator and monitor sense circuits
 - Automatic panel power sequencing and VESA DPMS (Display Power Management Signaling) CRT power-down
 - External I/O signal controls enabling of graphics accelerator into standby / suspend-off state
 - Dynamic clock gating for inactive functions to achieve maximum power saving
 - I²C Serial Bus and DDC / E-DDC Monitor Communications for Plug-and-Play configuration

CN333 SYSTEM OVERVIEW

The CN333 is a high performance, cost-effective and energy efficient UMA North Bridge with integrated UniChrome Pro graphics / video controller used for the implementation of mobile and desktop personal computer systems with 133 / 100 MHz CPU host bus (“Front Side Bus”) based on VIA C3 processors.

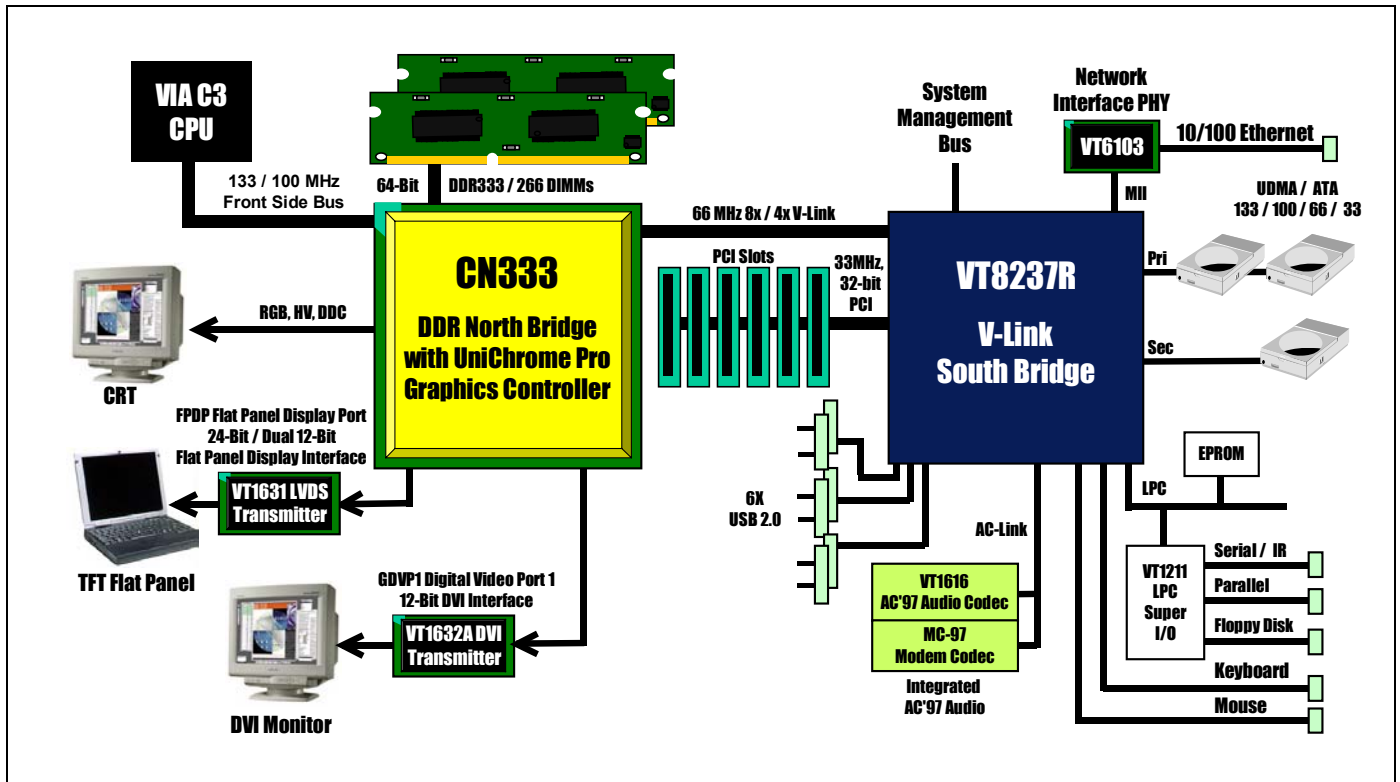


Figure 1. System Block Diagram

The complete chipset consists of the CN333 North Bridge and the VT8237R V-Link South Bridge. The CN333 integrates VIA’s most advanced system controller with a high-performance UniChrome Pro 3D / 2D graphics / video controller plus flat panel and DVI monitor. The CN333 provides superior performance between the CPU, DRAM, V-Link and integrated graphics controller with pipelined, burst and concurrent operation. The VT8237R is a highly integrated peripheral controller which includes V-Link-to-PCI / V-Link-to-LPC controllers, Ultra DMA IDE controller, USB2.0 host controller, 10/100Mb networking MAC, AC97 and system power management controllers.

VIA C3 Processor Interface

The CN333 supports 133 / 100 MHz FSB VIA C3 processors and implements an eight-deep In-Order-Queue. VIA PowerSaver technology is supported for VIA Antaur processors to reduce system power consumption while sustaining high processing power.

Memory Controller

The CN333 SDRAM controller supports up to two double-sided DDR333 / 266 DIMMs for 4 GB maximum physical memory. The DDR DRAM interface allows zero-wait-state data transfer bursting between the DRAM and the memory controller’s data buffers. The different banks of DRAM can be composed of an arbitrary mixture of 64 / 128 / 256 / 512 / 1024Mb DRAMs in x8 or x16 configurations. The DRAM controller can run either synchronous or pseudo-synchronous with the host CPU bus.

Ultra V-Link

The CN333 North Bridge interfaces to the South Bridge through a high speed (up to 1 GB / Sec) 8x, 66 MHz Data Transfer interconnect bus called “Ultra V-Link”. Deep pre-fetch and post-write buffers are included to allow for concurrent CPU and V-Link operation. The combined CN333 North Bridge and VT8237R South Bridge system 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 CPU write-back forward to PCI master and CPU 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.

System Power Management

For sophisticated power management, the CN333 supports dynamic CKE control to minimize DDR SDRAM power consumption during normal system state (S0). A separate suspend-well plane is implemented for the memory control logic for the Suspend-to-DRAM state. VIA PowerSaver™ Technology is supported to minimize CPU power consumption while sustaining processing power. The CN333 graphics accelerator implements automatic clock gating for each graphics engine to achieve power saving, moving to standby or suspend states to further reduce power consumption when idle. Automatic panel power sequencing and VESA DPMS (Display Power Management Signaling) CRT power-down are supported. Coupled with the VT8237R South Bridge chip, a complete power conscious PC main board can be implemented with no external glue logic.

3D Graphics Engine

Featuring an integrated 128-bit 3D graphics engine, the CN333 North Bridge utilizes a highly pipelined architecture that provides high performance along with superior image quality. Several new features enhance the 3D architecture, including two pixel rendering pipes, single-pass multitexturing, bump and cubic mapping, texture compression, edge anti-aliasing, vertex fog and fog table, hardware back-face culling, specular lighting, 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 CN333 North Bridge's advanced 128-bit 2D graphics engine delivers high-speed 2D acceleration for productivity applications. The enhanced 2D architecture with direct access frame buffer capability optimizes UMA performance and provides acceleration of all color depths.

MPEG Video Playback

The CN333 North Bridge provides the ideal architecture for high quality MPEG-2 based video applications. For MPEG playback, the integrated video accelerator offloads the CPU by performing planar-to-packed format conversion and motion video compensation tasks, while the enhanced scaling algorithm delivers incredible full-screen video playback.

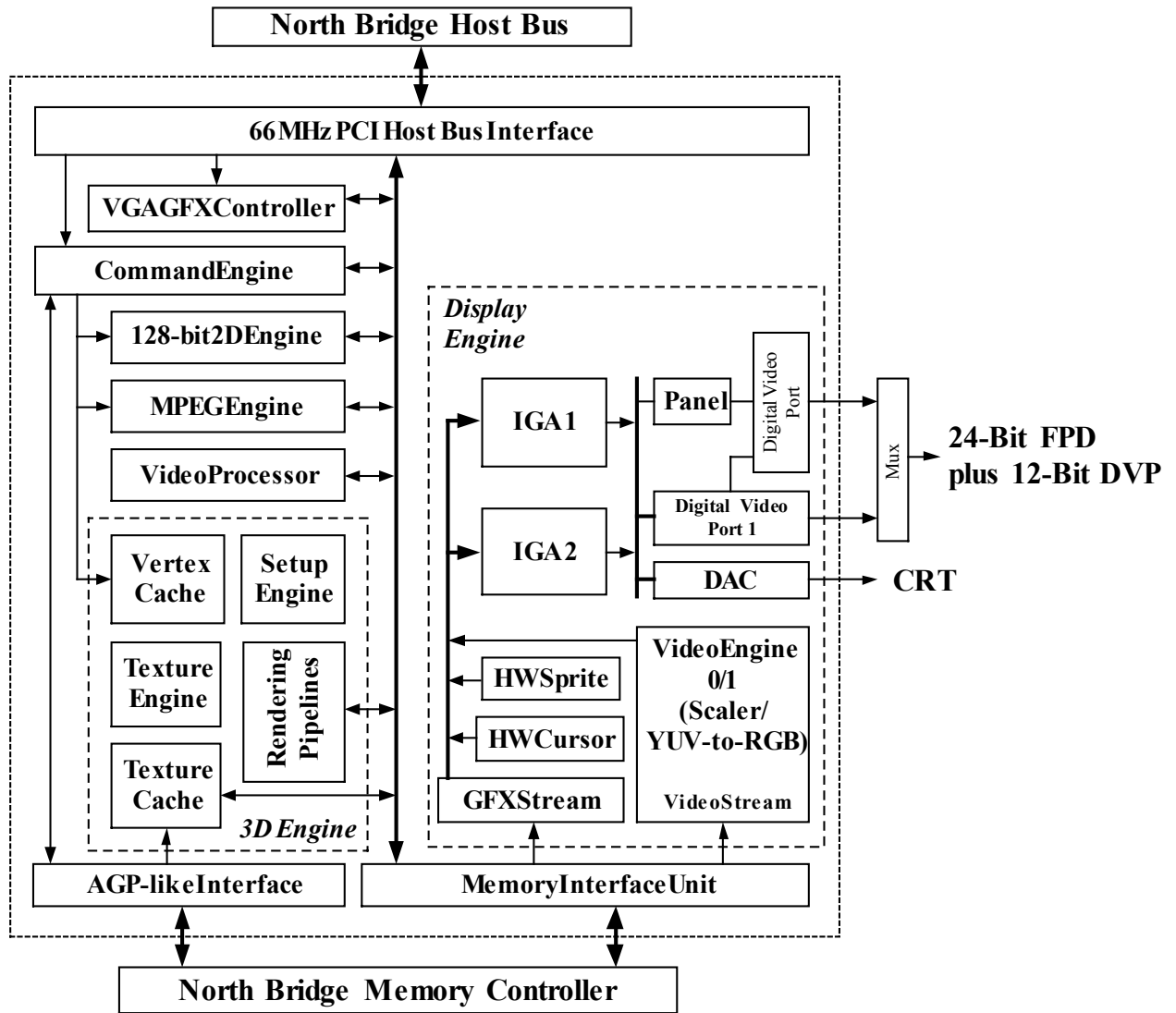


Figure 2. Integrated UniChrome Pro Graphics Controller Internal Block Diagram

LCD and DVI Monitor Support

The CN333 provides two “Digital Video Port” interfaces: FPDP and GDVP1. The Flat Panel Display Port (FPDP) implements a 24-bit / dual 12-bit interface which is designed to drive a Flat Panel Display via an external LVDS transmitter chip (such as the VIA VT1631 or NSC DS90C387R). The CN333 can be connected to the external LVDS transmitter chip in either 24-bit or dual-12-bit modes. A wide variety of LCD panels are supported including VGA, SVGA, XGA, SXGA+ and up to UXGA-resolution TFT color panels, in either SDR (1 pixel / clock) or DDR (2 pixels / clock) modes. UXGA and higher resolutions require dual-edge data transfer (DDR) mode which is supported by the VIA VT1631 LVDS transmitter chip. Digital Video Port 1 (GDVP1) is used to drive a DVI monitor via an external DVI transmitter chip (such as the VIA VT1632A).

The flexible display configurations of the CN333 allow support of a flat panel (LVDS interface) or flat panel monitor (DVI interface) and CRT display at the same time. Internally the CN333 North Bridge provides two separate display engines, so if two display devices are connected, each can display completely different information at different resolutions, pixel depths and refresh rates. If more than two display devices are connected, the additional displays must have the same resolution, pixel depth and refresh rate as one of the first two. The maximum display resolutions supported for one display device are listed in the table below. If more than one display is implemented (i.e., if both display engines are functioning at the same time), then available memory bandwidth may limit the display resolutions supported on one or both displays. This will be dependent on many factors including primarily clock rates and memory speeds (contact VIA for additional information).

Desktop Modes for Single Display

Resolution	BPP	CRT Maximum Refresh				
		60	75	85	100	120
640x480	8	√	√	√	√	√
	16	√	√	√	√	√
	32	√	√	√	√	√
800x600	8	√	√	√	√	√
	16	√	√	√	√	√
	32	√	√	√	√	√
1024x768	8	√	√	√	√	
	16	√	√	√	√	
	32	√	√	√	√	
1280x1024	8	√	√	√		
	16	√	√	√		
	32	√	√	√		
1400x1050	8	√				
	16	√				
	32	√				
1600x1200	8	√	√	√		
	16	√	√	√		
	32	√	√1	√2		
1920x1440	8	√	√			
	16	√	√			
	32	√	√			

Table 1. Supported CRT and Panel Screen Resolutions

Key for Desktop Mode

- √ = Supported: Mode available and Overlay available
- √1 = Supported, but DDR266: Mode available, overlay not available.
- √2 = Supported, but DDR266: Mode not available, overlay not available.

Note: LCD Single Display modes follow the 60Hz refresh column.

PINOUTS **Pin Diagrams** **Figure 3. Ball Diagram (Top View) – Flat Panel / Digital Video Output**

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	27	28	29	30		
A			HD 28#	HD 29#	HD 25#	HD 26#	HD 16#	HD 13#			GND	HD 5#	HD 15#	GND	HA 23#	HA 19#	GND			HA 11#	BNR#	NC	GND	DE FER#	HREQ 0#	GND	D RDY#	ADS#	GND			
B		HD 34#	GND	HD 31#	GND	HD 24#	HD 19#	GND			HD 10#	HD 17#	HD 4#	NC	HA 30#	HA 31#	HA 15#			GND	HA 4#	NC	B PRI#	HREQ 2#	HIT M#	D BSY#	RS2#	NC				
C	HD 43#	HD 38#	HD 22#	NC	HD 32#	NC	NC	HD 20#	HD 11#	HD 12#	NC	HD 8#	HD 6#	HA 29#	HA 27#	HA 22#	HA 10#	HA 13#	HA 3#	HA 9#	HA 8#	HREQ 1#	HREQ 4#	NC	RS1#	RS0#	BRFQ 0#	NC				
D	HD 37#	GND	HD 27#		GND	HD 33#	HD 21#	HD 30#	HD 14#	HD 18#	GND	HD 9#	HD 0#	GND	HA 20#	CPU RST#	GND	HA 12#	HA 5#	HA 6#	NC	HA 7#	GND	HREQ 3#	HT RDY#	GND	NC		GND			
E	NC	HD 39#	HD 36#			NC	HD 23#	GND	HD 2#		NC	NC	HD 1#	HA 26#	HA 24#	HA 21#	HA 28#	HA 16#	NC	GND		HA 14#	E	H LOCK#	HIT#				GND			
F	HD 42#	NC	HD 45#	HD 44#	HD 47#		HD 35#	HD 7#	HD 3#			HR COMP	HA 18#	HA 17#	HA 25#	GND	HA VREF0			HA VREF1			F			TEST IN#	DFT IN#	M CLKI	M CLKO			
G	HD 51#	GND	HD 49#	HD 41#	GND		GND		HD VREF0			HD VREF1	HCOMP VREF	GTL VREF	GND											GND	VCCA3 MCK	VCCA3 MCK	GND	MD 0		
H	HD 63#	HD 57#	HD 55#	HD 59#	HD 48#	HD 40#	7	H8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	H23	24	25	MEM VREF0	MD 4	MD 5	GND	MD 1		
J	HD 46#	NC	NC	HD 52#	NC		HD VREF3	J	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	J	GND	MD 6	MD 2	DQS 0#	DQM 0			
K	HD 53#	GND	HD 54#	HD 58#	GND	HD 50#	HD VREF2	K	VCC 15	VTT	VTT	VTT	VTT	VTT	VTT	VTT	VTT	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC 15	VCC 15	K		CKE 3	CKE 1	MD 3	MD 7			
L	HD 62#	HD 56#	HD 61#	NC		HD 60#		L	VCC 15	VTT	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	L	MEM VREF1	GND	MD 9	MD 12	GND	MD 8		
M	VCCA33 HCK1	GND	VCCA33 HCK1	VCCA33 GCK	VCCA33 HCK2	GND	GND	M	VCC 15	VTT	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	M		CKE 0	CKE 2	DQM 1	DQS 1#	MD 13		
N	VCCA15 PLL3	GND	VCCA15 PLL3	VCCA15 PLL1	GND	PLL1	H CLK+	H CLK-	T CLK	N	VCC 15	VTT	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	N		MA 12	MA 11	MD 15	MD 14			
P		DISP CLK1	DISP CLK0	VCCA15 PLL2	GND	PLL2	G CLK	G CLK	XIN	P	VCC 15	VTT	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	P		GND	MD 20	MD 11	GND	MD 10		
R			VCCA33 DAC1	GND	DAC1			R	VCC 15	VCC33 GFX	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	R	MEM VREF2	MA 9	MA 7	MD 21	MD 17	MD 16		
T	AB	AG	AR	GND	DAC2			T	VCC 15	VCC33 GFX	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	T		MA 5	MA 8	DQM 2	DQS 2#			
U			VCCA33 DAC2	GND	DAC3	NC	NC	U	VCC 15	VCC33 GFX	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	U		GND	MD 19	MD 22	GND	MD 18		
V	H SYNC	V SYNC	SP DAT2	R SET	INTA#	NC		V	VCC 15	VCC15 AGP	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	V		MA 4	MA 6	MD 28	MD 24	MD 23		
W		SP CLK2	NC	NC	NC			W	VCC 15	VCC15 AGP	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC25 MEM	VCC 15	W	MEM VREF3	MA 2	MA 3	MD 29	DQS 3#	MD 25		
Y		NC	NC	NC	NC			Y	VCC 15	VCC15 AGP	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC MEM25	VCC 15	Y	MA 0	GND	MD 30	MD 26	GND	DQM 3		
AA		NC	NC	NC	NC			AA	VCC 15	VCC15 AGP	VCC15 AGP	VCC15 AGP	VCC15 AGP	VCC15 VL	VCC15 VL	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC25 MEM	VCC 15	AA		MA 1	MD 33	MD 32	MD 31	MD 27		
AB		NC	NC	NC	NC			AB	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	VCC 15	GND	AB		BA 0	BA 1	MA 10	MD 37	MD 36			
AC	NC	GND	NC	NC	GND	6	7	AC8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	AC23	24	MEM VREF4	GND	MD 34	DQM 4	GND	DQS 4#		
AD	NC	NC	SBDDC DAT	SBDDC CLK	ENA VEE	AGP VREF1		AD															AD			MD 35	MD 39	MD 38				
AE	AGP COMPP	AGP COMPN	FP CLK#	ENA VDD	ENA BLT	NC		AE	FP CLK	FP D13	FP HS	FP1 VS	FP D10	FP D20	AGP VREF0	VL COMPP	VL VREF				AGP BUSY#	MEM VREF5		AE			MD 40	MD 44				
AF	GDVP1 DE	GND	GDVP1 VS	GDVP1 D0	GND	NC		AF	FP DE	GND	FP1 CLK#	FP1 DET	GND	FP D7	FP D9	V PAR	VD 4	DN STB+	DN STB-	VD 3	VD 7	GND	V SUS 15		GND	S WE#	GND	MD 45	MD 41	GND	DQS 5#	
AG	GDVP1 HS	GDVP1 D2	GDVP1 D1	GDVP1 D5	NC	NC		AG	FP D17	FP1 DE	FP D23	FP D22	FP D11	FP1 CLK	NC	GND	VD 1	V BE#	GND	DN CMD	UP CMD	VD 14	PWR OK		CS 3#	MD 61	CS 2#	S CAS#	S RAS#	MD 46	DQM 5	MD 42
AH	GDVP1 D3	GDVP1 CLK#	GDVP1 D6	GDVP1 D7	GDVP1 D10	GDVP1 D11		AH	FP D18	SBPL CLK	SBPL DAT	FP D1	FP D2	FP D6	NC	VD 8	VD 5	VD 0	UP STB+	VD 2	VD 6	VD 11	RE SET#	MD 59	MA 13	MD 57	CS 1#	CS 0#	MD 54	MD 48	MD 47	
AJ	GDVP1 CLK	GND	GDVP1 D9	FP DET	GND	FP D14		AJ	FP VS	GND	FP D21	FP D3	GND	FP D5	VD 12	VD 9		UP STB-					SUS ST#	MD 63	GND	DQS 7#	MD 60	GND	MD 50	MD 52	GND	MD 49
AK	GDVP1 D8	GDVP1 DET	GDVP1 D4	FP D12	FP D15	FP D16	FP D19	NC	FP D00	FP1 HS	FP D4	FP D8	FP D5	VD 13	GND								GND	MD 60	GND	DQM 7	MD 56	MD 51	MD 55	DQS 6#	DQM 6	MD 53

Pin Lists

Table 2. Pin List (Listed by Pin Number)

Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name
A03	IO HD28#	D03	IO HD27#	J01	IO HD46#	V05	O INTA#	AE10	O FPIVS	AH13	- NC		
A04	IO HD29#	D06	IO HD33#	J02	- NC	V06	- NC	AE11	O FPD10	AH14	IO VD08		
A05	IO HD25#	D07	IO HD21#	J03	- NC	V26	O MA04	AE12	O FPD20	AH15	IO VD05		
A06	IO HD26#	D08	IO HD30#	J04	IO HD52#	V27	O MA06	AE14	AI VLCOMP	AH16	IO VD00		
A07	IO HD16#	D09	IO HD14#	J05	- NC	V28	IO MD28	AE21	O AGPBUSY#	AH17	I UPSTB+		
A08	IO HD13#	D10	IO HD18#	J27	IO MD06	V29	IO MD24	AE27	IO MD40	AH18	IO VD02		
A12	IO HD05#	D12	IO HD09#	J28	IO MD02	V30	IO MD23	AE28	IO MD44	AH19	IO VD06		
A13	IO HD15#	D13	IO HD00#	J29	IO DQS0#	W02	IO SPCLK2	AF01	O GDVPIDE	AH20	IO VD11		
A15	IO HA23#	D15	IO HA20#	J30	O DQM0	W03	- NC	AF03	O GDVPIVS	AH21	I RESET#		
A16	IO HA19#	D16	O CPURST#	K01	IO HD53#	W04	- NC	AF04	O GDVPID00	AH22	IO MD59		
A20	IO HA11#	D18	IO HA12#	K03	IO HD54#	W05	- NC	AF06	- NC	AH23	O MA13		
A21	IO BNR#	D19	IO HA05#	K04	IO HD58#	W26	O MA02	AF07	O FPDE	AH24	IO MD57		
A22	- NC	D20	IO HA06#	K06	IO HD50#	W27	O MA03	AF09	O FPICLK#	AH25	O CS1#		
A24	IO DEFER#	D21	- NC	K27	O CKE3	W28	IO MD29	AF10	I FP1DET	AH26	O CS0#		
A25	IO HREQ0#	D22	IO HA07#	K28	O CKE1	W29	IO DQS3#	AF12	O FPD07	AH27	IO MD54		
A27	IO DRDY#	D24	IO HREQ3#	K29	IO MD03	W30	IO MD25	AF13	O FPD09	AH28	IO MD48		
A28	IO ADS#	D25	IO HTRDY#	K30	IO MD07	Y02	- NC	AF14	IO VPAR	AH29	IO MD43		
		D27	- NC	L01	IO HD62#	Y03	- NC	AF15	IO VD04	AH30	IO MD47		
B02	IO HD34#	E01	- NC	L02	IO HD56#	Y04	- NC	AF16	O DNSTB+	AJ01	O GDVPICLK		
B04	IO HD31#	E02	IO HD39#	L03	IO HD61#	Y05	- NC	AF17	O DNSTB-	AJ03	O GDVPID09		
B06	IO HD24#	E03	IO HD36#	L04	- NC	Y25	O MA00	AF18	IO VD03	AJ04	I FPDET		
B07	IO HD19#	E06	- NC	L06	IO HD60#	Y27	IO MD30	AF19	IO VD07	AJ06	O FPD14		
B11	IO HD10#	E07	IO HD23#	L27	IO MD09	Y28	IO MD26	AF25	O SWE#	AJ07	O FPVS		
B12	IO HD17#	E09	IO HD02#	L28	IO MD12	Y30	O DQM3	AF27	IO MD45	AJ09	O FPD21		
B13	IO HD04#	E11	- NC	L30	IO MD08	AA02	- NC	AF28	IO MD41	AJ10	O FPD03		
B14	- NC	E12	- NC	M26	O CKE0	AA03	- NC	AF30	IO DQS5#	AJ12	O FPD05		
B15	IO HA30#	E13	IO HD01#	M27	O CKE2	AA04	- NC	AG01	O GDVPIHS	AJ13	IO VD12		
B16	IO HA31#	E14	IO HA26#	M28	O DQM1	AA05	- NC	AG02	O GDVPID02	AJ14	IO VD09		
B17	IO HA15#	E15	IO HA24#	M29	IO DQS1#	AA26	O MA01	AG03	O GDVPID01	AJ17	I UPSTB-		
B21	IO HA04#	E16	IO HA21#	M30	IO MD13	AA27	IO MD33	AG04	O GDVPID05	AJ21	I SUSST#		
B22	- NC	E17	IO HA28#	N05	I HCLK+	AA28	IO MD32	AG05	- NC	AJ22	IO MD63		
B23	IO BPRI#	E18	IO HA16#	N06	I HCLK-	AA29	IO MD31	AG06	- NC	AJ24	IO DQS7#		
B24	IO HREQ2#	E19	- NC	N07	I TCLK	AA30	IO MD27	AG07	O FPD17/	AJ25	IO MD60		
B25	I HITM#	E22	IO HA14#	N27	O MA12	AB02	- NC	AG08	O FPIDE	AJ27	IO MD50		
B26	IO DBSY#	E24	I HLOCK#	N28	O MA11	AB03	- NC	AG09	O FPD23/	AJ28	IO MD52		
B27	IO RS2#	E25	IO HIT#	N29	IO MD15	AB04	- NC	AG10	O FPD22/	AJ30	IO MD49		
B28	- NC			N30	IO MD14	AB05	- NC	AG11	O FPD11	AK01	O GDVPID08		
C01	IO HD43#	F01	IO HD42#	P02	I DISPCLKI	AB26	O BA0	AG12	O FPICLK	AK02	I GDVPIDET		
C02	IO HD38#	F02	- NC	P03	O DISPCLKO	AB27	O BA1	AG13	- NC	AK03	O GDVPID04		
C03	IO HD22#	F04	IO HD44#	P06	I GCLK	AB28	O MA10	AG15	IO VD01	AK04	O FPD12		
C04	- NC	F05	IO HD47#	P07	I XIN	AB29	IO MD37	AG16	IO VBE#	AK05	O FPD15		
C05	IO HD32#	F07	IO HD35#	P27	IO MD20	AB30	IO MD36	AG18	O DNCMD	AK06	O FPD16		
C06	- NC	F08	IO HD07#	P28	IO MD11	AC01	- NC	AG19	I UPCMD	AK07	O FPD19		
C07	- NC	F09	IO HD03#	P30	IO MD10	AC03	- NC	AG20	IO VD14	AK08	- NC		
C08	IO HD20#	F13	AI HRCOMP	R26	O MA09	AC04	- NC	AG21	I PWROK	AK09	O FPD00		
C09	IO HD11#	F14	IO HA18#	R27	O MA07	AC27	IO MD34	AG23	O CS3#	AK10	O FPIHS		
C10	IO HD12#	F15	IO HA17#	R28	IO MD21	AC28	O DQM4	AG24	IO MD61	AK11	O FPD04		
C11	- NC	F16	IO HA25#	R29	IO MD17	AC30	IO DQS4#	AG25	O CS2#	AK12	O FPD08		
C12	IO HD08#	F27	I TESTIN#	R30	IO MD16	AD01	- NC	AG26	O SCAS#	AK13	IO VD13		
C13	IO HD06#	F28	I DFTIN#	T01	AO AB	AD02	- NC	AG27	O SRAS#	AK20	IO VD10		
C14	IO HA29#	F29	I MCLKI	T02	AO AG	AD03	IO SBDDCDAT	AG28	IO MD46	AK21	IO VD15		
C15	IO HA27#	F30	O MCLKO	T03	AO AR	AD04	IO SBDDCCLK	AG29	O DQM5	AK22	IO MD58		
C16	IO HA22#	G01	IO HD51#	T27	O MA05	AD05	O ENAVEE	AG30	IO MD42	AK23	IO MD62		
C17	IO HA10#	G03	IO HD49#	T28	O MA08	AD27	IO MD35	AH01	O GDVPID03	AK24	O DQM7		
C18	IO HA13#	G04	IO HD41#	T29	O DQM2	AD28	IO MD39	AH02	O GDVPICLK#	AK25	IO MD56		
C19	IO HA03#	G30	IO MD00	T30	IO DQS2#	AD29	IO MD38	AH03	O GDVPID06	AK26	IO MD51		
C20	IO HA09#	H01	IO HD63#	U06	- NC	AE01	AI AGPPCMP	AH04	O GDVPID07	AK27	IO MD55		
C21	IO HA08#	H02	IO HD57#	U07	- NC	AE02	AI AGPNCMP	AH05	O GDVPID10	AK28	IO DQS6#		
C22	IO HREQ1#	H03	IO HD55#	U27	IO MD19	AE03	O FPCLK#	AH06	O GDVPID11	AK29	O DQM6		
C23	IO HREQ4#	H04	IO HD59#	U28	IO MD22	AE04	O ENAVDD	AH07	O FPD18	AK30	IO MD53		
C24	- NC	H05	IO HD48#	U30	IO MD18	AE05	O ENABLT	AH08	IO SBPLCLK				
C25	IO RS1#	H06	IO HD40#	V01	O HSYNC	AE06	- NC	AH09	IO SBPLDAT				
C26	IO RS0#	H27	IO MD04	V02	O VSYNC	AE07	O FPCLK	AH10	O FPD01				
C27	O BREQ0#	H28	IO MD05	V03	IO SPDAT2	AE08	O FPD13	AH11	O FPD02				
C28	- NC	H30	IO MD01	V04	AI RSET	AE09	O FPHS	AH12	O FPD06				
D01	IO HD37#												

Table 3. Pin List (Listed by Pin Name)

Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name
T01	AO AB	AK12	O FPD08	C14	IO HA29#	L06	IO HD60#	AA27	IO MD33	AA04	- NC		
A28	IO ADS#	AF13	O FPD09	B15	IO HA30#	L03	IO HD61#	AC27	IO MD34	AA05	- NC		
T02	AO AG	AE11	O FPD10	B16	IO HA31#	L01	IO HD62#	AD27	IO MD35	AB04	- NC		
AE21	O AGPBUSY#	AG11	O FPD11	N05	I HCLK+	H01	IO HD63#	AB30	IO MD36	AB05	- NC		
AE02	AI AGPCOMP	AK04	O FPD12	N06	I HCLK-	E25	IO HIT#	AB29	IO MD37	AC01	- NC		
AE01	AI AGPCOMPP	AE08	O FPD13	D13	IO HD00#	B25	I HITM#	AD29	IO MD38	AC03	- NC		
T03	AO AR	AJ06	O FPD14	E13	IO HD01#	E24	I HLOCK#	AD28	IO MD39	AC04	- NC		
AB26	O BA0	AK05	O FPD15	E09	IO HD02#	F13	AI HRCOMP	AE27	IO MD40	AD01	- NC		
AB27	O BA1	AK06	O FPD16	F09	IO HD03#	A25	IO HREQ0#	AF28	IO MD41	AD02	- NC		
A21	IO BNR#	AG07	O FPD17	B13	IO HD04#	C22	IO HREQ1#	AG30	IO MD42	AE06	- NC		
B23	IO BPRI#	AH07	O FPD18	A12	IO HD05#	B24	IO HREQ2#	AH29	IO MD43	AF06	- NC		
C27	O BREQ0#	AK07	O FPD19	C13	IO HD06#	D24	IO HREQ3#	AE28	IO MD44	AG05	- NC		
M26	O CKE0	AE12	O FPD20	F08	IO HD07#	C23	IO HREQ4#	AF27	IO MD45	AG06	- NC		
K28	O CKE1	AJ09	O FPD21	C12	IO HD08#	V01	O HSYNC	AG28	IO MD46	AG13	- NC		
M27	O CKE2	AG10	O FPD22	D12	IO HD09#	D25	IO HTRDY#	AH30	IO MD47	AH13	- NC		
K27	O CKE3	AG09	O FPD23	B11	IO HD10#	V05	O INTA#	AH28	IO MD48	AK08	- NC		
D16	O CPURST#	AF07	O FPDE	C09	IO HD11#	Y25	O MA00	AJ30	IO MD49	AG21	I PWROK		
AH26	O CS0#	AJ04	I FPDET	C10	IO HD12#	AA26	O MA01	AJ27	IO MD50	AH21	I RESET#		
AH25	O CS1#	AE09	O FPHS	A08	IO HD13#	W26	O MA02	AK26	IO MD51	C26	IO RSO#		
AG25	O CS2#	AJ07	O FPVS	D09	IO HD14#	W27	O MA03	AJ28	IO MD52	C25	IO RSL#		
AG23	O CS3#	P06	I GCLK	A13	IO HD15#	V26	O MA04	AK30	IO MD53	B27	IO RS2#		
B26	IO DBSY#	AJ01	O GDVP1CLK	A07	IO HD16#	T27	O MA05	AH27	IO MD54	V04	AI RSET		
A24	IO DEFER#	AH02	O GDVP1CLK#	B12	IO HD17#	V27	O MA06	AK27	IO MD55	AD03	IO SBDDCDAT		
F28	I DFTIN#	AF04	O GDVP1D00	D10	IO HD18#	R27	O MA07	AK25	IO MD56	AD04	IO SBDDCLK		
P02	I DISPCLKI	AG03	O GDVP1D01	B07	IO HD19#	T28	O MA08	AH24	IO MD57	AH08	IO SBPLCLK		
P03	O DISPCLKO	AG02	O GDVP1D02	C08	IO HD20#	R26	O MA09	AK22	IO MD58	AH09	IO SBPLDAT		
AG18	O DNCMD	AH01	O GDVP1D03	D07	IO HD21#	AB28	O MA10	AH22	IO MD59	AG26	O SCAS#		
AF16	O DNSTB+	AK03	O GDVP1D04	C03	IO HD22#	N28	O MA11	AJ25	IO MD60	AB02	- NC		
AF17	O DNSTB-	AG04	O GDVP1D05	E07	IO HD23#	N27	O MA12	AG24	IO MD61	W02	IO SPCLK2		
J30	O DQM0	AH03	O GDVP1D06	B06	IO HD24#	AH23	O MA13	AK23	IO MD62	AB03	- NC		
M28	O DQM1	AH04	O GDVP1D07	A05	IO HD25#	F29	I MCLKI	AJ22	IO MD63	V03	IO SPDAT2		
T29	O DQM2	AK01	O GDVP1D08	A06	IO HD26#	F30	O MCLKO	A22	- NC	AG27	O SRAS#		
Y30	O DQM3	AJ03	O GDVP1D09	D03	IO HD27#	G30	IO MD00	B14	- NC	AJ21	I SUSST#		
AC28	O DQM4	AH05	O GDVP1D10	A03	IO HD28#	H30	IO MD01	B22	- NC	AF25	O SWE#		
AG29	O DQM5	AH06	O GDVP1D11	A04	IO HD29#	J28	IO MD02	B28	- NC	N07	I TCLK		
AK29	O DQM6	AF01	O GDVP1IDE	D08	IO HD30#	K29	IO MD03	C04	- NC	F27	I TESTIN#		
AK24	O DQM7	AK02	I GDVP1DET	B04	IO HD31#	H27	IO MD04	C06	- NC	AG19	I UPCMD		
J29	IO DQS0#	AG01	O GDVP1HS	C05	IO HD32#	H28	IO MD05	C07	- NC	AH17	I UPSTB+		
M29	IO DQS1#	AF03	O GDVP1VS	D06	IO HD33#	J27	IO MD06	C11	- NC	AJ17	I UPSTB-		
T30	IO DQS2#	C19	IO HA03#	B02	IO HD34#	K30	IO MD07	C24	- NC	AG16	IO VBE#		
W29	IO DQS3#	B21	IO HA04#	F07	IO HD35#	L30	IO MD08	C28	- NC	AH16	IO VD00		
AC30	IO DQS4#	D19	IO HA05#	E03	IO HD36#	L27	IO MD09	D21	- NC	AG15	IO VD01		
AF30	IO DQS5#	D20	IO HA06#	D01	IO HD37#	P30	IO MD10	D27	- NC	AH18	IO VD02		
AK28	IO DQS6#	D22	IO HA07#	C02	IO HD38#	P28	IO MD11	E01	- NC	AF18	IO VD03		
AJ24	IO DQS7#	C21	IO HA08#	E02	IO HD39#	L28	IO MD12	E06	- NC	AF15	IO VD04		
A27	IO DRDY#	C20	IO HA09#	H06	IO HD40#	M30	IO MD13	E11	- NC	AH15	IO VD05		
AE05	O ENABLT	C17	IO HA10#	G04	IO HD41#	N30	IO MD14	E12	- NC	AH19	IO VD06		
AE04	O ENAVDD	A20	IO HA11#	F01	IO HD42#	N29	IO MD15	E19	- NC	AF19	IO VD07		
AD05	O ENAVEE	D18	IO HA12#	C01	IO HD43#	R30	IO MD16	F02	- NC	AH14	IO VD08		
AG12	O FP1CLK	C18	IO HA13#	F04	IO HD44#	R29	IO MD17	J02	- NC	AJ14	IO VD09		
AF09	O FP1CLK#	E22	IO HA14#	F03	IO HD45#	U30	IO MD18	J03	- NC	AK20	IO VD10		
AG08	O FP1IDE	B17	IO HA15#	J01	IO HD46#	U27	IO MD19	J05	- NC	AH20	IO VD11		
AF10	I FP1DET	E18	IO HA16#	F05	IO HD47#	P27	IO MD20	L04	- NC	AJ13	IO VD12		
AK10	O FP1HS	F15	IO HA17#	H05	IO HD48#	R28	IO MD21	U06	- NC	AK13	IO VD13		
AE10	O FP1VS	F14	IO HA18#	G03	IO HD49#	U28	IO MD22	U07	- NC	AG20	IO VD14		
AE07	O FPCLK	A16	IO HA19#	K06	IO HD50#	V30	IO MD23	V06	- NC	AK21	IO VD15		
AE03	O FPCLK#	D15	IO HA20#	G01	IO HD51#	V29	IO MD24	W03	- NC	AE14	AI VLCOMPP		
AK09	O FPD00	E16	IO HA21#	J04	IO HD52#	W30	IO MD25	W04	- NC	AF14	IO VPAR		
AH10	O FPD01	C16	IO HA22#	K01	IO HD53#	Y28	IO MD26	W05	- NC	V02	O VSYNC		
AH11	O FPD02	A15	IO HA23#	K03	IO HD54#	AA30	IO MD27	Y02	- NC	P07	I XIN		
AJ10	O FPD03	E15	IO HA24#	H03	IO HD55#	V28	IO MD28	Y03	- NC				
AK11	O FPD04	F16	IO HA25#	L02	IO HD56#	W28	IO MD29	Y04	- NC				
AJ12	O FPD05	E14	IO HA26#	H02	IO HD57#	Y27	IO MD30	Y05	- NC				
AH12	O FPD06	C15	IO HA27#	K04	IO HD58#	AA29	IO MD31	AA02	- NC				
AF12	O FPD07	E17	IO HA28#	H04	IO HD59#	AA28	IO MD32	AA03	- NC				

Table 4. Power, Ground and Voltage Reference Pin List
Outer Ring Pins (Intermixed with Signal Pins)

AGPVREF[0:1]	(2 pins):	AE13, AD6
GTLVREF	(1 pin):	G15
HAVREF[0:1]	(2 pins):	F18,20
HDVREF[0:3]	(4 pins):	G10,13, K7, J7
HCOMPVREF	(1 pin):	G14
MEMVREF[0:5]	(6 pins):	H26, L25, R25, W25, AC25, AE22
VLVREF	(1 pin):	AE15
VCCA33HCK1	(1 pin):	M1
GNDAHCK1	(1 pin):	M2
VCCA33HCK2	(1 pin):	M4
GNDAHCK2	(1 pin):	M5
VCCA33GCK	(1 pin):	M3
GNDAGCK	(1 pin):	M6
VCCA33MCK	(1 pin):	G28
GNDAMCK	(1 pin):	G27
VCCA15PLL1	(1 pin):	N3
GNDAPLL1	(1 pin):	N4
VCCA15PLL2	(1 pin):	P4
GNDAPLL2	(1 pin):	P5
VCCA15PLL3	(1 pin):	N1
GNDAPLL3	(1 pin):	N2
VCCA33DAC[1:2]	(2 pins):	R4, U4
GNDADAC[1:3]	(3 pins):	R5, T4, U5
VSUS15	(1 pin):	AF21
GND	(63 pins):	A11,14,17,23,26,29, B3,5,8,20, D2,5,11,14,17,23,26,29, E8,20,30, F17, G2,5,8,16,29, H29, J26, K2,5, L26,29, P26,29, U26,29, Y26,29, AC2,5,26, 29, AF2,5,8,11,20,23,26,29, AG14,17, AJ2,5,8,11,20,23,26,29, AK14,17

Center Pins

VCC15	(51 pins):	J9-22, K9,22, L9,22, M9,22, N9,22, P9,22, R9,22, T9,22, U9,22, V9,22, W9,22, Y9,22, AA9,22, AB9-21
VCC25MEM	(20 pins):	K18-21, L21, M21, N21, P21, R21, T21, U21, V21, W21, Y21, AA16-21
VCC15AGP	(7 pins):	V10, W10, Y10, AA10-13
VCC15VL	(2 pins):	AA14-15
VCC33GFX	(3 pins):	R10, T10, U10
VTT	(12 pins):	K10-17, L10, M10, N10, P10
GND	(101 pins):	L11-20, M11-20, N11-20, P11-20, R11-20, T11-20, U11-20, V11-20, W11-20, Y11-20

Pin Descriptions

CPU Interface Pin Descriptions

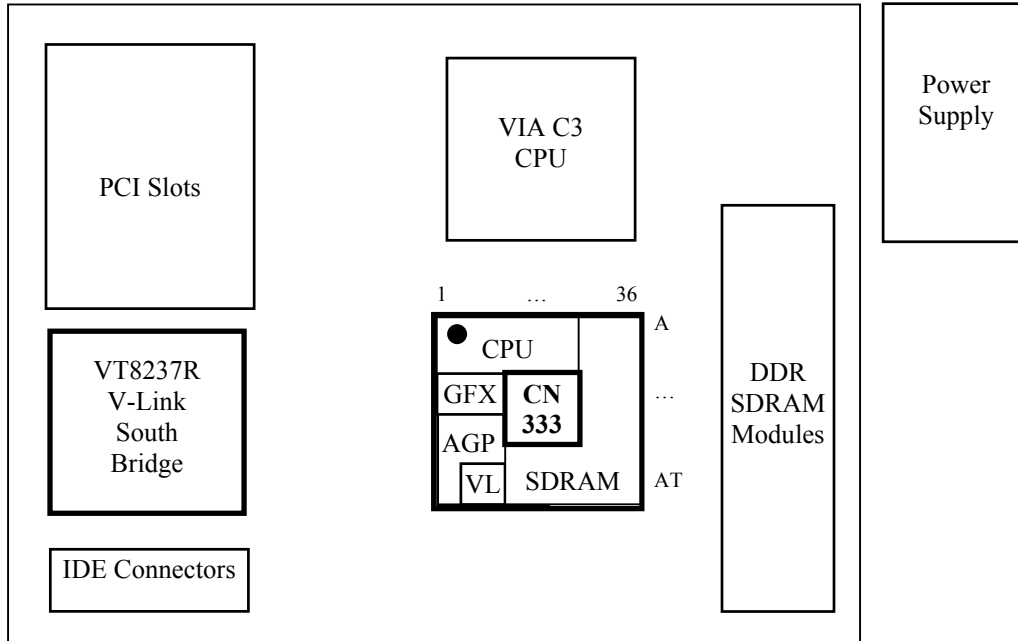
CPU Interface																					
Signal Name	Pin #	I/O	Signal Description																		
HA[31:3]#	(see pin list)	IO	Host Address Bus. HA[31:3] connect to the address bus of the host CPU. During CPU cycles HA[31:3] are inputs. These signals are driven by the North Bridge during cache snooping operations.																		
HD[63:0]#	(see pin list)	IO	Host CPU Data. These signals are connected to the CPU data bus.																		
ADS#	A28	IO	Address Strobe. The CPU asserts ADS# in T1 of the CPU bus cycle.																		
BNR#	A21	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#	B23	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 North Bridge drives this signal to gain control of the processor bus.																		
DBSY#	B26	IO	Data Bus Busy. Used by the data bus owner to hold the data bus for transfers requiring more than one cycle.																		
DEFER#	A24	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#	A27	IO	Data Ready. Asserted for each cycle that data is transferred.																		
HIT#	E25	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#	B25	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#	E24	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]#	C23, D24, B24, C22, A25	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#	D25	IO	Host Target Ready. Indicates that the target of the processor transaction is able to enter the data transfer phase.																		
RS[2:0]#	B27, C25, C26	IO	Response Signals. Indicates the type of response per the table below: <table border="0" style="margin-left: 20px;"> <tr> <td>RS[2:0]#</td> <td>Response type</td> </tr> <tr> <td>000</td> <td>Idle State</td> </tr> <tr> <td>001</td> <td>Retry Response</td> </tr> <tr> <td>010</td> <td>Defer Response</td> </tr> <tr> <td>011</td> <td>Reserved</td> </tr> <tr> <td>100</td> <td>Hard Failure</td> </tr> <tr> <td>101</td> <td>Normal Without Data</td> </tr> <tr> <td>110</td> <td>Implicit Writeback</td> </tr> <tr> <td>111</td> <td>Normal With Data</td> </tr> </table>	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
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#	D16	O	CPU Reset. Reset output to CPU. External pullup and filter capacitor to ground should be provided per CPU manufacturer's recommendations.																		
BREQ0#	C27	O	Bus Request 0. Connect to CPU bus request 0.																		

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

Note: I/O pads for the above pins are powered by VTT. Input voltage levels are referenced to HAVREF, HDVREF and GTLREF.

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.



DDR SDRAM Memory Controller Pin Descriptions

DDR DRAM Interface			
Signal Name	Pin #	I/O	Signal Description
MA[13:0]	(see pin lists)	O	Memory Address. Output drive strength may be set by Device 0 Function 3 Rx E8.
BA[1:0]	AB27, AB26	O	Bank Address. Output drive strength may be set by Device 0 Function 3 Rx E8.
SRAS#, SCAS#, SWE#	AG27, AG26, AF25	O	Row Address, Column Address and Write Enable Command Indicators. Output drive strength may be set by Device 0 Function 3 Rx E8.
MD[63:0]	(see pin lists)	IO	Memory Data. These signals are connected to the DRAM data bus. Output drive strength may be set by Device 0 Function 3 Rx E2.
DQM[7:0]	AK24, AK29, AG29, AC28, Y30, T29, M28, J30	O	Data Mask. Data mask of each byte lane. Output drive strength may be set by Device 0 Function 3 Rx E2.
DQS[7:0]#	AJ24, AK28, AF30, AC30, W29, T30, M29, J29	IO	DDR Data Strobe. Data strobe of each byte lane. Output drive strength may be set by Device 0 Function 3 Rx E0.
CS[3:0]#	AG23, AG25, AH25, AH26	O	Chip Select. Chip select of each bank. Output drive strength may be set by Device 0 Function 3 Rx E4.
CKE[3:0]	K27, M27, K28, M26	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.

Note: I/O pads for all pins on this page are powered by VCC25MEM. MD / DQS input voltage levels are referenced to MEMVREF.

Ultra V-Link Pin Descriptions

Ultra V-Link Interface			
Signal Name	Pin #	I/O	Signal Description
VD15	AK21	IO	V-Link Data Bus. During system initialization, VD[7:0] are used to transmit strap information from the South Bridge (the straps are not on the VD pins but are on the indicated pins of the South Bridge chip). Check the strap pin table for details.
VD14	AG20	IO	
VD13	AK13	IO	
VD12	AJ13	IO	
VD11	AH20	IO	
VD10	AK20	IO	
VD9	AJ14	IO	
VD8	AH14	IO	
VD7	AF19	IO	
VD6	AH19	IO	
VD5	AH15	IO	
VD4	AF15	IO	
VD3	AF18	IO	
VD2	AH18	IO	
VD1	AG15	IO	
VD0	AH16	IO	
VPAR	AF14	IO	V-Link Parity.
VBE#	AG16	IO	V-Link Byte Enable.
UPCMD	AG19	I	V-Link Command from Client (South Bridge) to Host (North Bridge).
UPSTB+	AH17	I	V-Link Strobe from Client to Host.
UPSTB-	AJ17	I	V-Link Complement Strobe from Client to Host.
DNCMD	AG18	O	V-Link Command from Host (North Bridge) to Client (South Bridge).
DNSTB+	AF16	O	V-Link Strobe from Host to Client.
DNSTB-	AF17	O	V-Link Complement Strobe from Host to Client.

Note: I/O pads for the pins in the above table are powered by VCC15VL. Input voltage levels are referenced to VLVREF.

CRT and Serial Bus Pin Descriptions

CRT Interface			
Signal Name	Pin #	I/O	Signal Description
AR	T3	AO	Analog Red. Analog red output to the CRT monitor.
AG	T2	AO	Analog Green. Analog green output to the CRT monitor.
AB	T1	AO	Analog Blue. Analog blue output to the CRT monitor.
HSYNC	V1	O	Horizontal Sync. Output to CRT.
VSYNC	V2	O	Vertical Sync. Output to CRT.
RSET	V4	AI	Reference Resistor. Tie to GNDDAC through an external 82Ω 1% resistor to control the RAMDAC full-scale current value.

I/O pads for the pins in the above table are powered by VCC33GFX (i.e., 3.3V I/O).

SMB / I2C Interface			
Signal Name	Pin #	I/O	Signal Description
SBPLCLK	AH8	IO	I2C Serial Bus Clock for Panel
SBPLDAT	AH9	IO	I2C Serial Bus Data for Panel
SBDDCCLK	AD4	IO	I2C Serial Bus Clock for CRT DDC
SBDDCDAT	AD3	IO	I2C Serial Bus Data for CRT DDC
SPCLK2 SPCLK1 / CAPD12 SPDAT2, SPDAT1 / CAPD13	W2, AB2 V3, AB3	IO	Serial Port (SMB/I2C) Clock and Data. The SPCLKn pins are the clocks for serial data transfer. The SPDATn pins are the data signals used for serial data transfer. SPxxx1 is typically used for DVI monitor communications and SPxxx2 is typically used for DDC for CRT monitor communications. These pins are programmed via “Sequencer” graphics registers (port 3C5) in the “Extended” VGA register space (see the UniChrome-II Graphics Registers document for additional details). The SPxxx1 registers are programmed via 3C5.31 (“IIC Serial Port Control 1”) and the SPxxx2 registers are programmed via 3C5.26 (“IIC Serial Port Control 0”). In both registers, the clock out state is programmed via bit-5 and the data out state via bit-4, clock in status may be read in bit-3 and data in status in bit-2 and the port may be enabled via bit-0.

I/O pads for SPCLK[2:1] / SPDAT[2:1] above are powered by VCC33GFX (i.e., 3.3V I/O).

All other pins in the above table are powered by VCC15AGP (i.e., 1.5V I/O).

Flat Panel Display Port (FPDP) Pin Descriptions

The FPDP can be configured as either an LVDS transmitter interface port (see the LVDS Transmitter Interface)

24-Bit / Dual 12-Bit Flat Panel Display Interface			
Signal Name	Pin #	I/O	Signal Description
FPD23 / FPD0D11	AG9	O	Flat Panel Data. For 24-bit or dual 12-bit flat panel display modes. Two FPD interface modes, 24-bit and dual 12-bit, are supported. Strap High (3C5.12[4]=1): 24-bit Strap Low (3C5.12[4]=0): Dual 12-bit In “24-bit” mode, only one set of control pins is required. However, in dual 12-bit mode, the CN333 provides two sets of control signals that are required for certain LVDS transmitter chips. In 24-bit mode, two operating modes are supported: <u>3C5.12[4]=1 & 3x5.88[2]=0 & 3x5.88[4]=0</u> Double data rate: each rising and falling clock edge transmits a complete 24-bit pixel. <u>3C5.12[4]=1 & 3x5.88[2]=0 & 3x5.88[4]=1</u> Single data rate: each clock rising edge transmits a complete 24-bit pixel. In dual 12-bit mode, <u>3C5.12[4]=0 & 3x5.88[2]=1</u> Double data rate: Each rising and falling clock edge transmits half (12 bits) of two 24-bit pixels.
FPD22 / FPD0D10	AG10		
FPD21 / FPD0D09	AJ9		
FPD20 / FPD0D08	AE12		
FPD19 / FPD0D07	AK7		
FPD18 / FPD0D06	AH7		
FPD17 / FPD0D05	AG7		
FPD16 / FPD0D04	AK6		
FPD15 / FPD0D03	AK5		
FPD14 / FPD0D02	AJ6		
FPD13 / FPD0D01	AE8		
FPD12 / FPD0D00	AK4,		
FPD11 / FPD1D11	AG11		
FPD10 / FPD1D10	AE11		
FPD09 / FPD1D09	AF13		
FPD08 / FPD1D08	AK12		
FPD07 / FPD1D07	AF12		
FPD06 / FPD1D06	AH12		
FPD05 / FPD1D05	AJ12		
FPD04 / FPD1D04	AK11		
FPD03 / FPD1D03	AJ10		
FPD02 / FPD1D02	AH11		
FPD01 / FPD1D01	AH10		
FPD00 / FPD1D00	AK9		
FPHS	AE9	O	Flat Panel Horizontal Sync. 24-bit mode or port 0 in dual 12-bit mode.
FPVS	AJ7	O	Flat Panel Vertical Sync. 24-bit mode or port 0 in dual 12-bit mode.
FPDE	AF7	O	Flat Panel Data Enable. 24-bit mode or port 0 in dual 12-bit mode.
FPDET	AJ4	I	Flat Panel Detect. 24-bit mode or port 0 in dual 12-bit mode.
FPCLK	AE7	O	Flat Panel Clock. 24-bit mode or port 0 in dual 12-bit mode.
FPCLK#	AE3	O	Flat Panel Clock Complement. 24-bit mode or port 0 in dual 12-bit mode. For double-data-rate data transfers.
FP1HS	AK10	O	Flat Panel Horizontal Sync. For port 1 in dual 12-bit mode.
FP1VS	AE10	O	Flat Panel Vertical Sync. For port 1 in dual 12-bit mode.
FP1DE	AG8	O	Flat Panel Data Enable. For port 1 in dual 12-bit mode.
FP1DET	AF10	I	Flat Panel Detect. For port 1 in dual 12-bit mode.
FP1CLK	AG12	O	Flat Panel Clock. For port 1 in dual 12-bit mode.
FP1CLK#	AF9	O	Flat Panel Clock Complement. For port 1 in dual 12-bit mode. For double-data-rate data transfers.

Flat Panel Power Control			
Signal Name	Pin #	I/O	Signal Description
ENAVDD	AE4	IO	Enable Panel VDD Power.
ENAVEE	AD5	IO	Enable Panel VEE Power.
ENABLT	AE5	IO	Enable Panel Back Light.

Note: I/O pads for all pins on this page are powered by VCC15AGP (i.e., 1.5V I/O).

Digital Video Port 1 (GDVP1) Pin Descriptions

GDVP1 can be configured as either a DVI transmitter interface port (see the DVI Transmitter Interface pin lists below for details).

Digital Video Port 1 (GDVP1) – DVI Interface			
Signal Name	Pin #	I/O	Signal Description
GDVP1D11	AH6	O	Data.
GDVP1D10	AH5		
GDVP1D9	AJ3		
GDVP1D8	AK1		
GDVP1D7	AH4		
GDVP1D6	AH3		
GDVP1D5	AG4		
GDVP1D4	AK3		
GDVP1D3	AH1		
GDVP1D2	AG2		
GDVP1D1	AG3		
GDVP1D0	AF4		
GDVP1HS	AG1	O	
GDVP1VS	AF3	O	Vertical Sync.
GDVP1DE	AF1	O	Data Enable.
GDVP1DET	AK2	I	Display Detect. If VGA register 3C5.3E[0] = 1, 3C5.1A[4] will read 1 if a display is connected. Tie to GND if not used.
GDVP1CLK	AJ1	O	Clock.
GDVP1CLK#	AH2	O	Clock Complement.

I/O pads for the pins on this page are powered by VCC15AGP (1.5V I/O).

Clock, Reset, Power Control, GPIO, Interrupt and Test Pin Descriptions

Clocks, Resets, Power Control, General Purpose I/O, Interrupts and Test				
Signal Name	Pin #	I/O	Signal Description	Power Plane
HCLK+	N5	I	Host Clock. This pin receives the host CPU clock (100 / 133 / 200 MHz). This clock is used by all CN333 logic that is in the host CPU domain.	VTT
HCLK-	N6	I	Host Clock Complement.	VTT
MCLKO	F30	O	Memory (SDRAM) Clock. Output from internal clock generator to the external clock buffer for memory interface.	VCC25MEM
MCLKI	F29	I	Memory (SDRAM) Clock Feedback. Input from MCLKO.	VCC25MEM
DISPCLKI	P2	I	Dot Clock (Pixel Clock) In. Used for external EMI reduction circuit if used. Connect to GND if external EMI reduction circuit not implemented.	VCC33GFX
DISPCLKO	P3	O	Dot Clock (Pixel Clock) Out. Used for external EMI reduction circuit if used. NC if external EMI reduction circuit not implemented.	VCC33GFX
GCLK	P6	I	AGP Clock. Clock for AGP logic.	VCC15AGP
XIN	P7	I	Reference Frequency Input. External 14.31818 MHz clock source. All internal graphics controller clocks are synthesized on chip using this frequency as a reference.	VCC33GFX
RESET#	AH21	I	Reset. Input from the South Bridge chip. When asserted, this signal resets the CN333 and sets all register bits to the default value. The rising edge of this signal is used to sample all power-up strap options	VSUS15
PWROK	AG21	I	Power OK. Connect to South Bridge and Power Good circuitry.	VSUS15
SUSST#	AJ21	I	Suspend Status. For implementation of the Suspend-to-DRAM feature. Connect to an external pull-up to disable.	VSUS15
AGPBUSY# / NMI	AE21	O	AGP Interface Busy. Connect to a South Bridge GPIO pin for monitoring the status of the internal AGP bus. See Design Guide for details. Pin function selectable with Device 0 Function 0 RxBE[7] (default = NMI).	VCC25MEM
GPOUT / CAPD14	U7	O	General Purpose Output. This pin reflects the state of SRD[0].	VCC33GFX
GPO0 / CAPD15	AA2	O	General Output Port. When SR1A[4] is cleared, this pin reflects the state of CR5C[0].	VCC33GFX
INTA#	V5	O	Interrupt. PCI interrupt output (handled by the interrupt controller in the South Bridge)	VCC33GFX
TCLK	N7	I	Test Clock. This pin is used for testing and must be connected to GND through a 1K-4.7K ohm resistor for all board designs.	VCC33GFX
TESTIN#	F27	I	Test In. This pin is used for testing and must be connected to VTT through a 1K-4.7K ohm resistor for all board designs.	VCC25MEM
DFTIN#	F28	I	DFT In. This pin is used for testing and must be connected to VTT through a 1K-4.7K ohm resistor for all board designs.	VCC25MEM
BISTIN / CAPAFD	U6	I	BIST In. This pin is used for testing and must be tied to GND with a 1K-4.7K ohm resistor on all board designs.	VCC33GFX

Compensation and Reference Voltage Pin Descriptions

Compensation				
Signal Name	Pin #	I/O	Signal Description	Power Plane
HRCOMP	F13	AI	Host CPU Compensation. Connect a 20.5 Ω 1% resistor to ground. Used for Host CPU interface I/O buffer calibration.	VTT
VLCOMP	AE14	AI	V-Link Compensation. Connect a 360 Ω 1% resistor to ground.	VCC15VL
AGPCOMP	AE2	AI	AGP N Compensation. Connect a 60.4 Ω 1% resistor to VCC15AGP.	VCC15AGP
AGPCOMP	AE1	AI	AGP P Compensation. Connect a 60.4 Ω 1% resistor to ground.	VCC15AGP

Reference Voltages				
Signal Name	Pin #	I/O	Signal Description	Power Plane
GTLVREF	G15	P	Host CPU Interface AGTL+ Voltage Reference. 2/3 VTT \pm 2% typically derived using a resistive voltage divider. See Design Guide.	VTT
HDVREF[0:1]	G10, G13, K7, J7	P	Host CPU Data Voltage Reference. 2/3 VTT \pm 2% typically derived using a resistive voltage divider. See Design Guide.	VTT
HAVREF[0:1]	F18, F20	P	Host CPU Address Voltage Reference. 2/3 VTT \pm 2% typically derived using a resistive voltage divider. See Design Guide.	VTT
HCOMPVREF	G14	P	Host CPU Compensation Voltage Reference. 1/3 VTT \pm 2% typically derived using a resistive voltage divider. See Design Guide.	VTT
MEMVREF[0:5]	H26, L25, R25, W25, AC25, AE22	P	Memory Voltage Reference. 0.5 VCC25MEM \pm 2% typically derived using a resistive voltage divider. See Design Guide.	VCC25MEM
VLVREF	AE15	P	V-Link Voltage Reference. 0.625V \pm 2% derived using a resistive voltage divider. See Design Guide.	VCC15VL
AGPVREF[0:1]	AE13, AD6	P	AGP Voltage Reference. 1/2 VCC15AGP (0.75V) for AGP 2.0 (4x transfer mode) and 0.23 VCC15AGP (0.35V) for AGP 3.0 (8x transfer mode). See the Design Guide for additional information and circuit implementation details..	VCC15AGP

Power Pin Descriptions

Analog Power / Ground			
Signal Name	Pin #	I/O	Signal Description
VCCA33HCK1	M1	P	Power for Host CPU Clock PLL 1 (3.3V ±5%). 400 MHz for CPU / DRAM frequencies of multiples of 100, 133 and 200 MHz.
GNDAHCK1	M2	P	Ground for Host CPU Clock PLL 1. Connect to main ground plane through a ferrite bead.
VCCA33HCK2	M4	P	Power for Host CPU Clock PLL 2 (3.3V ±5%). 500 MHz for CPU / DRAM frequencies of multiples of 166 MHz.
GNDAHCK2	M5	P	Ground for Host CPU Clock PLL 2. Connect to main ground plane through a ferrite bead.
VCCA33MCK	G28	P	Power for Memory Clock PLL (3.3V ±5%)
GNDAMCK	G27	P	Ground for Memory Clock PLL. Connect to main ground plane through a ferrite bead.
VCCA33GCK	M3	P	Power for AGP Clock PLL (3.3V ±5%)
GNDAGCK	M6	P	Ground for AGP Clock PLL. Connect to main ground plane through a ferrite bead.
VCCA15PLL1	N3	P	Power for Graphics Controller PLL1 (1.5V ±5%).
GNDAPLL1	N4	P	Ground for Graphics Controller PLL1. Connect to main ground plane through a ferrite bead.
VCCA15PLL2	P4	P	Power for Graphics Controller PLL2 (1.5V ±5%).
GNDAPLL2	P5	P	Ground for Graphics Controller PLL2. Connect to main ground plane through a ferrite bead.
VCCA15PLL3	N1	P	Power for Graphics Controller PLL3 (1.5V ±5%).
GNDAPLL3	N2	P	Ground for Graphics Controller PLL3. Connect to main ground plane through a ferrite bead.
VCCA33DAC[1:2]	R4, U4	P	Power for DAC. (3.3V ±5%)
GNDADAC[1:3]	R5, T4, U5	P	Ground for DAC. Connect to main ground plane through a ferrite bead.

Digital Power / Ground			
Signal Name	Pin #	I/O	Signal Description
VTT	(see pin lists)	P	Power for CPU I/O Interface Logic (12 Pins). Voltage is CPU dependent. See Design Guide for details.
VCC25MEM	(see pin lists)	P	Power for Memory I/O Interface Logic (20 Pins). 2.5V ±5%.
VCC15VL	AA14, AA15	P	Power for V-Link I/O Interface Logic (2 Pins). 1.5V ±5%
VCC15AGP	(see pin lists)	P	Power for AGP Bus I/O Interface Logic (7 Pins). 1.5V ±5%
VCC33GFX	R10, T10, U10	P	Power for Graphics I/O Logic (3 Pins). 3.3V ±5%
VCC15	(see pin lists)	P	Power for Internal Logic (51 Pins). 1.5V ±5%
VSUS15	AF21	P	Suspend Power (1 Pin). 1.5V ±5%
GND	(see pin lists)	P	Digital Ground (164 Pins). Connect to main ground plane.

Strap Pin Descriptions

Strap Pins				
(External pullup / pulldown straps are required to select “H” / “L”)				
Signal	Actual Strap Pin	Function	Description	Status Bit
VD7	VT8235M-CD: SDCS3# VT8235M-CE: SDCS3# VT8237R: PDCS3#	Number of processors installed	L: Single processor H: Dual processor VD7 is sampled during system initialization; the actual strapping pin is located on the South Bridge chip.	F2Rx50[6]
VD6	VT8235M-CD: SDA2 VT8235M-CE: SDA2 VT8237R: PDA2	Auto-Configure	L: Disable Auto-Configure H: Enable Auto-Configure VD6 is sampled during system initialization; the actual strapping pin is located on the South Bridge chip.	F2Rx76[2]
VD5	VT8235M-CD: SDA1 VT8235M-CE: SDA1 VT8237R: PDA1	-reserved-	Must be strapped high. VD5 is sampled during system initialization; the actual strapping pin is located on the South Bridge chip.	-
VD3	VT8235M-CD: SA19 VT8235M-CE: Strap_VD3 VT8237R: GPIOD	AGTL+ Pullups	L: Enable internal AGTL+ Pullups H: Disable internal AGTL+ Pullups VD3 is sampled during system initialization; the actual strapping pin is located on the South Bridge chip.	F2Rx52[5]
VD2	VT8235M-CD: SA18 VT8235M-CE: Strap_VD2 VT8237R: GPIOB	IOQ Depth	L: 8-Level deep H: 1-Level deep VD2 is sampled during system initialization; the actual strapping pin is located on the South Bridge chip.	F2Rx50[7]
VD4, VD1, VD0	VT8235M-CD: SDA0, SA17, SA16 VT8235M-CE: SDA0, Strap_VD1, Strap_VD0 VT8237R: PDA0, GPIOA, GPIOC	FSB Frequency	LLL: 100MHz LLH: 133MHz LHL: -reserved- LHH: -reserved- HLL: -reserved- HLH: -reserved- HHL: -reserved- HHH: Auto VD4, VD1 and VD0 are sampled during system initialization; the actual strapping pins are located on the South Bridge chip.	F2Rx54[7:5]

REGISTERS

Register Overview

The following tables summarize the configuration and I/O registers of the CN333 North Bridge. 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), RWC (or just WC) (Read / Write 1’s to Clear individual bits) and W1 (Write Once then Read / Only after that). 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.

The graphics registers are described in a separate document.

Table 5. Registers

I/O Ports

Port #	I/O Port	Default	Acc
22	PCI / AGP Arbiter Disable	00	RW
CFB-8	Configuration Address	0000 0000	RW
CFF-C	Configuration Data	0000 0000	RW

Device 0 Function 0 Registers – AGP
Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID	0259	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- (Cache Line Size)	00	—
D	Latency Timer	00	RW
E	Header Type	00 or 80	RO
F	-reserved- (Built In Self Test)	00	—
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	—
37-34	Capability Pointer	0000 0080	RO
38-3F	-reserved-	00	—

Device-Specific Registers

Offset	AGP Drive Control	Default	Acc
40-4D	-reserved-	00	—
4F	Multiple Function Control	00	RW

Offset	AGP Power Management Control	Default	Acc
50	Power Management Capability	01	RO
51	Power Management Next Pointer	00	RO
52	Power Management Capabilities I	02	RO
53	Power Management Capabilities II	00	RO
54	Power Management Control/Status	00	RW
55	Power Management Status	00	RO
56	PCI-to-PCI Bridge Support Extension	00	RO
57	Power Management Data	00	RO

Offset	Reserved	Default	Acc
58-7F	-reserved- (K8)	00	—

Device-Specific Registers

Offset	AGP Control	Default	Acc
80-CF	-reserved-	00	—

Offset	Reserved	Default	Acc
D0-DF	-reserved-	00	—
E0-EF	-reserved-	00	—
F0-FF	-reserved-	00	—

Device 0 Function 1 Registers – Error Reporting
Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID for Error Reporting	1259	RO
5-4	Command	0006	RW
7-6	Status	0200	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- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	-reserved- (Header Type)	00	—
F	-reserved- (Built In Self Test)	00	—
10-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	00	W1
2F-2E	Subsystem ID	00	W1
30-33	-reserved-	00	—
37-34	Capability Pointer	0000 0000	RO
38-3F	-reserved-	00	—

Device-Specific Registers

Offset	V-Link Error Control	Default	Acc
40-4F	-reserved-	00	—
50	NB Vlink Bus Error Status	00	WC
51-57	-reserved-	00	—
58	NB Vlink Bus Err Reporting Enable	00	RW
59-5F	-reserved-	00	—

Offset	Host CPU Error Control	Default	Acc
60-7F	-reserved-	00	—

Offset	DRAM Error Control	Default	Acc
80-CF	-reserved-	00	—

Offset	AGP Error Control	Default	Acc
D0-DF	-reserved-	00	—
E0	AGP Error Status 1	00	WC
E1	AGP Error Status 2	00	RO
E2-E7	-reserved-	00	—
E8	AGP Error Reporting Enable	00	RW
E9-FF	-reserved-	00	—

Device 0 Function 2 Registers – Host CPU
Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID for Host CPU Bus	2259	RO
5-4	Command	0006	RW
7-6	Status	0200	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- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	-reserved- (Header Type)	00	—
F	-reserved- (Built In Self Test)	00	—
10-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	00	W1
2F-2E	Subsystem ID	00	W1
30-33	-reserved-	00	—
37-34	Capability Pointer	0000 0000	RO
38-3F	-reserved-	00	—

Device-Specific Registers

Offset	Host CPU Protocol Control	Default	Acc
40-4F	-reserved-	00	—
50	CPU Interface Request Phase Control	00	RW
51	CPU Interface Basic Control	00	RW
52	CPU Interface Advanced Control	00	RW
53	CPU Interface Arbitration Control	00	RW
54	CPU Frequency	00	RW
55	CPU Miscellaneous Control	00	RW
56	Reorder Latency	00	RW
57	-reserved-	01	—
58	Delivery / Trigger Control	00	RW
59	IPI Control	00	RW
5A	Destination ID	00	RW
5B	Interrupt Vector	00	RW
5C	CPU Miscellaneous Control	00	RW
5D	Write Policy	00	RW
5E	Bandwidth Timer	00	RW
5F	Miscellaneous Control	00	RW
60	DRDY L Timing 1	00	RW
61	DRDY L Timing 2	00	RW
62	DRDY L Timing 3	00	RW
63	DRDY Q Timing 1	00	RW
64	DRDY Q Timing 2	00	RW
65	DRDY Q Timing 3	00	RW
66	Burst DRDY Timing 1	00	RW
67	Burst DRDY Timing 2	00	RW
68	Lowest Priority CPU ID #0	00	RW
69	Lowest Priority CPU ID #1	00	RW
6A	Lowest Priority CPU ID #2	00	RW
6B	Lowest Priority CPU ID #3	00	RW
6C	Lowest Priority CPU ID #4	00	RW
6D	Lowest Priority CPU ID #5	00	RW
6E	Lowest Priority CPU ID #6	00	RW
6F	Lowest Priority CPU ID #7	00	RW

Offset	Host CPU AGTL+ I/O Control	Default	Acc
70	Host Address (2x) Pullup Drive	00	RW
71	Host Address (2x) Pulldown Drive	00	RW
72	Host Data (1x) Pullup Drive	00	RW
73	Host Data (1x) Pulldown Drive	00	RW
74	AGTL+ Output Delay / Stagger Ctrl	00	RW
75	AGTL+ I/O Control	00	RW
76	AGTL+ Compensation Status	00	RW
77	AGTL+ AutoCompensation Offset	00	RW
78-FF	-reserved-	00	—

Device 0 Function 3 Registers – DRAM
Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID for DRAM Control	3259	RO
5-4	Command	0006	RW
7-6	Status	0200	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- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	-reserved- (Header Type)	00	—
F	-reserved- (Built In Self Test)	00	—
10-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	00	W1
2F-2E	Subsystem ID	00	W1
30-33	-reserved-	00	—
37-34	Capability Pointer	0000 0000	RO
38-3F	-reserved-	00	—

Device-Specific Registers

Offset	DRAM Control	Default	Acc
40-47	DRAM Row Ending Address:		
40	Bank 0 Ending (HA[32:25])	01	RW
41	Bank 1 Ending (HA[32:25])	01	RW
42	Bank 2 Ending (HA[32:25])	01	RW
43	Bank 3 Ending (HA[32:25])	01	RW
44	Bank 4 Ending (HA[32:25])	01	RW
45	Bank 5 Ending (HA[32:25])	01	RW
46	Bank 6 Ending (HA[32:25])	01	RW
47	Bank 7 Ending (HA[32:25])	01	RW
48	DRAM DIMM #0 Control	00	RW
49	DRAM DIMM #1 Control	00	RW
4A	DRAM DIMM #2 Control	00	RW
4B	DRAM DIMM #3 Control	00	RW
4C-4F	-reserved-	00	—
51-50	MA Map Type	2222	RW
52	DRAM Rank End Address Bit-33	00	RW
53	DRAM Rank Begin Address Bit-33	00	RW
54	DRAM Controller Internal Options	00	RW
55	DRAM Timing for All Banks I	00	RW
56	DRAM Timing for All Banks II	65	RW
57	DRAM Timing for All Banks III	01	RW
58-5F	-reserved-	00	—
60	DRAM Control	00	RW
61-64	-reserved-	00	—
65	DRAM Arbitration Timer	00	RW
66	DRAM Arbitration Control	00	RW
67	Reserved (Do Not Program)	00	RW
68	DRAM DDR Control	00	RW

Device-Specific Registers (continued)

Offset	Reserved	Default	Acc
69	DRAM Page Policy Control	00	RW
6A	DRAM Refresh Counter	00	RW
6B	DRAM Arbitration Control	10	RW
6C	DRAM Clock Control	00	RW
6D	-reserved-	00	—
6E	DRAM Control	00	RW
6F	-reserved-	00	—
70	DRAM DDR Control 1	00	RW
71	DRAM DDR Control 2	00	RW
72	DRAM DDR Control 3	00	RW
73	DRAM DDR Control 4	00	RW
74	DRAM DQS Input Delay	00	RW
75	-reserved-	00	—
76	DRAM Early Clock Select	00	RW
77	-reserved-	00	—
78	DRAM Timing Control	13	RW
79	DRAM DQS Output Control	01	RW
7A	DRAM DQS Capture Control Chan A	44	RW
7B	DRAM DQS Capture Control Chan B	04	RW
7C	DIMM0 DQS Input Delay Offset	00	RW
7D	DIMM1 DQS Input Delay Offset	00	RW
7E	DIMM2 DQS Input Delay Offset	00	RW
7F	DIMM3 DQS Input Delay Offset	00	RW

Offset	ROM Shadow	Default	Acc
80	C-ROM Shadow Control	00	RW
81	D-ROM Shadow Control	00	RW
82	F-ROM Shadow/MemHole/SMI Ctrl	00	RW
83	E-ROM Shadow Control	00	RW

Offset	DRAM Above 4G Control	Default	Acc
84	Low Top Address Low	00	RW
85	Low Top Address High	FF	RW
86	SMM / APIC Decoding	01	RW
87-9F	-reserved-	00	—

Offset	UMA Control	Default	Acc
A0	CPU Direct Access FB Base	00	RW
A1	CPU Direct Access FB Size	00	RW
A2	VGA Timer	00	RW
A3	Graphics Timer	00	RW
A4	Graphics Miscellaneous Control	00	RW
A5-AF	-reserved-	00	—

Device 0 Function 4 Registers – Power Management
Function 3 DRAM Device-Specific Registers (continued)

Offset	Graphics Control	Default	Acc
B0	Graphics Control 1	00	RW
B1	Graphics Control 2	00	RW
B2	Graphics Control 3	00	RW
B3	Graphics Control 4	00	RW
B4	Graphics Control 5	00	RW
B5-BF	-reserved-	00	—

Offset	AGP Controller Interface Control	Default	Acc
C0	AGP Controller Interface Control	00	RW
C1-DF	-reserved-	00	—

Offset	DRAM Drive Control	Default	Acc
E0	DRAM DQSA Drive	00	RW
E1	DRAM DQSB Drive	00	RW
E2	DRAM MDA / DQMA Drive	00	RW
E3	DRAM MDB / DQMB Drive	00	RW
E4	DRAM CS / CKE Drive	00	RW
E5	-reserved-	00	—
E6	DRAM S-Port Drive Control	00	RW
E7	-reserved-	00	—
E8	DRAM MAA / ScmdA Drive	00	RW
E9	-reserved-	00	—
EA	DRAM MAB / ScmdB Drive	00	RW
EB	-reserved-	00	—
EC	Channel A Duty Cycle Control	00	RW
ED	Channel B Duty Cycle Control	00	RW
EE	DDR CKG Duty Cycle Control 1	00	RW
EF	DDR CKG Duty Cycle Control 2	00	RW
F0-FF	-reserved-	00	—

Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID for Power Manager	4259	RO
5-4	Command	0006	RW
7-6	Status	0200	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- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	-reserved- (Header Type)	00	—
F	-reserved- (Built In Self Test)	00	—
10-3F	-reserved-	00	—

Device-Specific Registers

Offset	Reserved	Default	Acc
40-4F	-reserved-	00	—
50-5F	-reserved-	00	—
60-6F	-reserved-	00	—
70-7F	-reserved-	00	—
80-8F	-reserved-	00	—
90-9F	-reserved-	00	—

Offset	Power Management Control	Default	Acc
A0	Power Management Mode	00	RW
A1	DRAM Power Management	00	RW
A2	Dynamic Clock Stop	00	RW
A3	MA / SCMD Pad Toggle Reduction	00	RW
A4-AF	-reserved-	00	—

Offset	Reserved	Default	Acc
B0-BF	-reserved-	00	—
C0-CF	-reserved-	00	—

Offset	BIOS Scratch	Default	Acc
D0-EF	BIOS Scratch Registers	00	RW

Offset	Test	Default	Acc
F0-FF	Reserved (Do Not Program)	00	RW

Device 0 Function 7 Registers – V-Link / PCI
Header Registers

Offset	Configuration Space Header	Default	Acc
1-0	Vendor ID	1106	RO
3-2	Device ID for V-Link Control	7259	RO
5-4	Command	0006	RW
7-6	Status	0200	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- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	-reserved- (Header Type)	00	—
F	-reserved- (Built In Self Test)	00	—
10-2B	-reserved-	00	—
2D-2C	Subsystem Vendor ID	00	W1
2F-2E	Subsystem ID	00	W1
30-33	-reserved-	00	—
37-34	Capability Pointer	0000 0000	RO
38-3F	-reserved-	00	—

Device-Specific Registers

Offset	V-Link Control	Default	Acc
40	V-Link Revision ID	40	RO
41	V-Link NB Capability	39	RO
42	V-Link NB Downlink Command	88	RW
43	V-Link NB Uplink Max Req Depth	80	RW
44	V-Link NB Uplink Buffer Size	82	RW
45	V-Link NB Bus Timer	44	RW
46	V-Link NB Misc Control	00	RW
47	V-Link Control	00	RW
48	V-Link NB/SB Configuration	18	RW
49	V-Link SB Capability	19	WC
4A	V-Link SB Downlink Status	88	RO
4B	V-Link SB Uplink Max Req Depth	80	RW
4C	V-Link SB Uplink Buffer Size	82	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	Bank 7 End (same as F3Rx47)	Default	Acc
50-56	-reserved-	00	—
57	Bank 7 Ending Address (Sent to SB)	01	RO
58-5F	-reserved-	00	—
Offset	ROM Shadow (same as F3Rx80-82)	Default	Acc
60	-reserved-	00	—
61	C-ROM Shadow Control	00	RW
62	D-ROM Shadow Control	00	RW
63	F-ROM Shadow/MemHole/SMI Ctrl	00	RW
64	E-ROM Shadow Control	00	RW
65-6F	-reserved-	00	—

Device-Specific Registers (continued)

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

Offset	GART	Default	Acc
80-83	-reserved-	00	—
85-84	Graphics Aperture Size	0000	RW
86-87	-reserved-	00	—
88	GART Base Address	00	RW
89-8F	-reserved-	00	—

Offset	Reserved	Default	Acc
90-9F	-reserved-	00	—
A0-AF	-reserved-	00	—

Offset	V-Link Compensation / Drive Ctrl	Default	Acc
B0	V-Link CKG Control 1	00	RW
B1	V-Link CKG Control 2	00	RW
B2	-reserved-	00	—
B4	V-Link NB Compensation Control	00	RW
B5	V-Link NB Strobe Drive Control	00	RW
B6	V-Link NB Data Drive Control	00	RW
B7	V-Link NB Receive Strobe Delay	00	RW
B8	V-Link SB Compensation Control	00	RW
B9	V-Link SB Strobe Drive Control	00	RW
BA-BF	-reserved-	00	—

Offset	Reserved	Default	Acc
C0-CF	-reserved-	00	—
D0-DF	-reserved-	00	—

Offset	DRAM > 4G (same as F3Rx84-86)	Default	Acc
E0-E3	-reserved-	00	—
E4	Low Top Address Low	00	RW
E5	Low Top Address High	FF	RW
E6	SMM / APIC Decoding	01	RW
E7-EF	-reserved-	00	—

Offset	Reserved	Default	Acc
F0-FF	-reserved-	00	—

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	B198	RO
5-4	Command	0007	RW
7-6	Status	0230	WC
8	Revision ID	nn	RO
9	Program Interface	00	RO
A	Sub Class Code	04	RO
B	Base Class Code	06	RO
C	-reserved- (Cache Line Size)	00	—
D	-reserved- (Latency Timer)	00	—
E	Header Type	01	RO
F	-reserved- (Built In Self Test)	00	—
13-10	Graphics Aperture Base	0000 0008	RW
14-17	-reserved-	00	—
18	Primary Bus Number	00	RW
19	Secondary Bus Number	00	RW
1A	Subordinate Bus Number	00	RW
1B	-reserved-	00	—
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	70	RO
35-3F	-reserved-	00	—

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
48-6F	-reserved-	00	—

Offset	Power Management	Default	Acc
70	Capability ID	01	RO
71	Next Pointer	00	RO
72	Power Management Capabilities 1	02	RO
73	Power Management Capabilities 2	00	RO
74	Power Management Control / Status	00	RW
75	Power Management Status	00	RO
76	PCI-PCI Bridge Support Extensions	00	RO
77	Power Management Data	00	RO
78-FF	-reserved-	00	—

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.

Configuration Space I/O

All North Bridge registers (listed above) 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 (functions 0-4 and 7 are defined for device 0 but the function number is unused / ignored for Device 1).
- 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 Function 0 Registers – AGP

Device 0 Function 0 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, function number and device number equal to zero and function number equal to 0. (CN333 does not support external AGP port)

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

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

Offset 3-2 - Device ID (0259h)RO

15-0 ID Code (reads 0259h to identify the CN333 NB)

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
- 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 spacedefault
 - 1 Responds to I/O space

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 North Bridge 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

Offset 8 - Revision ID (0nh) RO

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

Offset 9 - Programming Interface (00h) RO

7-0 Interface Identifier always reads 00h

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

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

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

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

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 Rx75[6-4] (PCI Arbitration 1).

Device 0 Function 0 Header Registers (continued)

Offset E - Header Type (00h)RO

- 7-0 Header Type Code**
Rx4F[0]=0: reads 00h: single function
Rx4F[0]=1: reads 80h, multi function

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

- 7 BIST Supported**reads 0: no supported functions
- 6-0 Reserved** always reads 0

Offset 13-10 - Graphics Aperture Base (AGP 2.0) (00000008h)RW

This register is interpreted per the following definition if Rx4D[2]=0 (AGP 2.0 header at Rx80h).

- 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 AGP 2.0 Graphics Aperture Size register bit (Device 0 Function 0 Offset B4h) is 0.

27	26	25	24	23	22	21	20	(Base)
<u>7</u>	<u>6</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>0</u>	(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

- 19-4 Reserved** always reads 0
- 3 Prefetchable** **always reads 1**
Indicates that the locations in the address range defined by this register are prefetchable.
- 2-1 Type** always reads 0
Indicates the address range in the 32-bit address space.
- 0 Memory Space** always reads 0
Indicates the address range in the memory address space.

Offset 13-10 - Graphics Aperture Base (AGP 3.0) (00000008h) RW

This register is interpreted per the following definition if Rx4D[2]=1 (AGP 3.0 header at Rx80h).

- 31-22 Programmable Base Address Bits**..... def=0
These bits behave as if hardwired to 0 if the corresponding AGP 3.0 Graphics Aperture Size register bit (Device 0 Function 0 Offset 94h) is 0.

31	30	29	28	-	-	27	26	25	24	23	22	(Base)
<u>11</u>	<u>10</u>	<u>9</u>	<u>8</u>	<u>7</u>	<u>6</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>0</u>	(Size)
RW	RW	RW	RW	0	0	RW	RW	RW	RW	RW	RW	4M
RW	RW	RW	RW	0	0	RW	RW	RW	RW	RW	0	8M
RW	RW	RW	RW	0	0	RW	RW	RW	RW	0	0	16M
RW	RW	RW	RW	0	0	RW	RW	RW	0	0	0	32M
RW	RW	RW	RW	0	0	RW	RW	0	0	0	0	64M
RW	RW	RW	RW	0	0	RW	0	0	0	0	0	128M
RW	RW	RW	RW	0	0	0	0	0	0	0	0	256M
RW	RW	RW	0	0	0	0	0	0	0	0	0	512M
RW	RW	0	0	0	0	0	0	0	0	0	0	1G
RW	0	0	0	0	0	0	0	0	0	0	0	2G-max
0	0	0	0	0	0	0	0	0	0	0	0	4G

- 21-4 Reserved** always reads 0
- 3 Prefetchable** **always reads 1**
Indicates that the locations in the address range defined by this register are prefetchable.
- 2-1 Type** always reads 0
Indicates the address range in the 32-bit address space.
- 0 Memory Space** always reads 0
Indicates the address range in the memory address space.

Offset 2D-2C – Subsystem Vendor ID (0000h) R/W1

- 15-0 Subsystem Vendor ID** default = 0
This register may be written once and is then read only.

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

- 15-0 Subsystem ID** default = 0
This register may be written once and is then read only.

Offset 37-34 - Capability Pointer (CAPPTR)..... RO

Contains an offset from the start of configuration space.

- 31-0 AGP Capability List Ptr** ...always reads 0000 0080h

AGP Miscellaneous Control

Offset 4F – Multiple Function Control (00h).....RW

- 7-1 **Reserved** always reads 0
- 0 **Bridge Configuration Supports Multiple Functions**
- 0 Not supported, other functions 1, 2, 3, 4 and 7 cannot be seen and will return FFFFFFFFh when accessed.....default
- 1 Supported (this bit is reflected on Rx0E[7])

AGP Power Management Control

Offset 50 – Power Management Capability ID RO

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

Offset 51 – Power Management Next Pointer RO

- 7-0 **Next Pointer** always reads 00h (“Null” Pointer)

Offset 52 – Power Mgmt Capabilities I..... RO

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

Offset 53 – Power Mgmt Capabilities II..... RO

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

Offset 54 – 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

Offset 55 – Power Management Status..... RO

- 7-0 **Power Management Status**..... always reads 00h

Offset 56 – PCI-to-PCI Bridge Support Extensions RO

- 7-0 **P2P Bridge Support Extensions** always reads 00h

Offset 57 – Power Management Data RO

- 7-0 **Power Management Data** always reads 00h

AGP GART / Graphics Aperture

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 in the CN333.

This scheme is shown in the figure below.

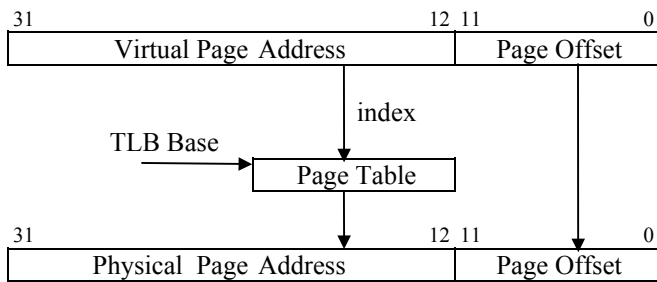


Figure 4. Graphics Aperture Address Translation

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 TLB in the CN333 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) for AGP 2.0 and 4MB to 2GB for AGP 3.0. 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 Device 0 Function 0 Rx10. The Graphics Aperture Size and TLB Table Base are defined in Rx94 and Rx98 along with various control bits.

Device 0 Function 1 Registers – Error Reporting

Device 0 Function 1 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 and device number equal to zero and function number equal to 1.

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

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

Offset 3-2 - Device ID for Error Reporting (1259h).....RO

15-0 ID Code (reads 1259h to identify CN333 NB virtual device function 1)

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
- 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 spacedefault
 - 1 Responds to I/O space

Offset 7-6 – Status (0200h)..... 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 1 to clear
- 14 Signaled Sys Err (SERR# Asserted) .always reads 0
- 13 Signaled Master Abort
 - 0 No abort received default
 - 1 Transaction aborted by master . write 1 to clear
- 12 Received Target Abort
 - 0 No abort received default
 - 1 Transaction aborted by target... write 1 to clear
- 11 Signaled Target Abortalways reads 0
 - 0 Target Abort never signaled
- 10-9 DEVSEL# Timing
 - 00 Fast
 - 01 Mediumalways 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 North Bridge was initiator of the operation in which the error occurred... write one to clear
- 7 Fast Back-to-Back Capablealways reads 0
- 6 User Definable Features.....always reads 0
- 5 66MHz Capable.....always reads 0
- 4 Supports New Capability list.....always reads 0
- 3-0 Reservedalways reads 0

Offset 8 - Revision ID (0nh) RO

8-0 Chip Revision Code.....always reads 0nh

Offset 9 - Programming Interface (00h) RO

7-0 Interface Identifieralways reads 00h

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

7-0 Sub Class Codereads 00 to indicate Host Bridge

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

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

Offset 2D-2C – Subsystem Vendor ID (0000h) W1 / RO

15-0 Subsystem Vendor ID default = 0

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

Offset 2F-2E – Subsystem ID (0000h)..... W1 / RO

15-0 Subsystem ID default = 0

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

Offset 37-34 - Capability Pointer (CAPPTR)..... RO

Contains an offset from the start of configuration space.

31-0 AGP Capability List Ptr ...always reads 0000 0000h

Device 0 Function 1 Device-Specific Registers

These registers are normally programmed once at system initialization time.

V-Link Error Reporting

Offset 50 – V-Link Error Status WC

- 7-1 **Reserved** always reads 0
- 0 **V-Link Parity Error Detected by NB..... WC**
 - 0 No V-Link Parity Error Detected default
 - 1 V-Link Parity Error Detected (write 1 to clear)

Offset 58 – V-Link Error Reporting Enable.....RW

- 7 **Parity Error or SERR# Reported via NMI**
 - 0 Disable default
 - 1 Enable
- 6 **Parity Error or SERR# Reported to SB via Vlink**
 - 0 Disable default
 - 1 Enable
- 5-1 **Reserved** always reads 0
- 0 **V-Link Parity Check Report**
 - 0 Disable default
 - 1 Enable

AGP Error Reporting

Offset E0 – AGP / PCI2 Error Status 1 (00h) RWC

- 7 **AGP Cycle Data Parity Error WC**
 - 0 Parity Error did not occur default
 - 1 Parity error occurred write 1 to clear
- 6 **PCI #2 GSERR Error WC**
 - 0 Parity Error did not occur default
 - 1 Parity error occurred write 1 to clear
- 5-0 **Reserved** always reads 0

Offset E1 – AGP / PCI2 Error Status 2 (00h) RO

- 7-2 **Reserved** always reads 0
- 1-0 **Isoch Error Code from Func 0 Rx8C[1:0] RO**

Offset E8 – AGP / PCI2 Error Reporting Enable (00h) RW

- 7-5 **Reserved** always reads 0
- 4 **Report Data Parity Errors on AGP Cycles**
 - 0 Disable default
 - 1 Enable
- 3-2 **Reserved** always reads 0
- 1 **Report Data Parity Errors on PCI2 Cycles**
 - 0 Disable default
 - 1 Enable
- 0 **Report Address Parity Errors on PCI2 Cycles**
 - 0 Disable default
 - 1 Enable

Device 0 Function 2 Registers – Host CPU

Device 0 Function 2 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 and device number equal to zero and function number equal to 2.

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

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

Offset 3-2 - Device ID (2259h).....RO

15-0 ID Code (reads 2259h to identify CN333 NB virtual device function 2)

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
- 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 spacedefault
 - 1 Responds to I/O space

Offset 7-6 – Status (0200h)..... 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 Sys Err (SERR# Asserted) .always reads 0
- 13 Signaled Master Abort
 - 0 No abort received default
 - 1 Transaction aborted by master . write 1 to clear
- 12 Received Target Abort
 - 0 No abort received default
 - 1 Transaction aborted by target... write 1 to clear
- 11 Signaled Target Abortalways reads 0
 - 0 Target Abort never signaled
- 10-9 DEVSEL# Timing
 - 00 Fast
 - 01 Mediumalways 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 North Bridge was initiator of the operation in which the error occurred... write one to clear
- 7 Fast Back-to-Back Capablealways reads 0
- 6 User Definable Features.....always reads 0
- 5 66MHz Capable.....always reads 0
- 4 Supports New Capability list.....always reads 0
- 3-0 Reservedalways reads 0

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

9-0 Chip Revision Code.....always reads 0nh

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

7-0 Interface Identifieralways reads 00h

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

7-0 Sub Class Codereads 00 to indicate Host Bridge

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

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

Offset 2D-2C – Subsystem Vendor ID (0000h) W1 / RO

15-0 Subsystem Vendor ID default = 0
This register may be written once and is then read only.

Offset 2F-2E – Subsystem ID (0000h)..... W1 / RO

15-0 Subsystem ID default = 0
This register may be written once and is then read only.

Offset 37-34 - Capability Pointer (CAPPTR)..... RO

Contains an offset from the start of configuration space.

31-0 AGP Capability List Ptr ...always reads 0000 0000h

Device 0 Function 2 Device-Specific Registers

These registers are normally programmed once at system initialization time.

Host CPU Control

Offset 50 – Request Phase Control (00h)RW

- 7 **CPU Hardwired IOQ (In Order Queue) Size**
Default set from the inverse of the VD2 strap. This register can be written 0 to restrict the chip to one level of IOQ.
0 1-Level (strap pulled high)
1 8-Level (strap pulled low)
- 6 **Dual CPU Support**
Default set from the VD7 strap (VT8237R South Bridge PDCS3# pin) or ROMSIP.
0 Single (SB strap pulled low)
1 Dual (SB strap pulled high)
- 5 **Fast DRAM Access**
0 Disabledefault
1 Enable
- 4-0 **Dynamic Defer Snoop Stall Count**
(granularity = 2T, normally set to 01000b)

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

- 7 **CPU Read DRAM Fast Ready**
0 Wait until all 8 QWs are received before DRDY is returneddefault
1 See Rx60-67 for DRDY timing
- 6 **Read Around Write**
0 Disabledefault
1 Enable
- 5 **DRQ Control**
0 Non pipelined similar to Pro266default
1 Pipelined
- 4 **CPU to PCI Read Defer**
0 Disabledefault
1 Enable
- 3 **Two Defer / Retry Entries**
0 Disabledefault
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 Disabledefault
1 Enable
- 0 **Reserved** always reads 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 High Priority**
0 Disable..... default
1 Enable
- 5 **AGTL+ Pullups**
Default set from the inverse of the VD3 strap.
0 Disable (strap pulled high)
1 Enable (strap pulled low)
- 4 **Reserved** always reads 0
- 3 **Write Retire Policy After 2 Writes**
0 Disable..... default
1 Enable
- 2 **2-Level Defer Queue with Lock**
0 Normal Operation..... default
1 Enhanced Operation (this bit should always be set to 1)
- 1 **Consecutive Speculative Read**
0 Disable..... default
1 Enable
- 0 **Speculative Read**
0 Disable..... default
1 Enable

Offset 53 – CPU Arbitration Control (00h)..... RW

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

Offset 54 – CPU Frequency (00h).....RW

- 7-5 CPU FSB Frequency.....Set from VD4,1,0 Straps**
 - 000 100 MHz (all three straps pulled low)
 - 001 133 MHz
 - 010 -reserved-
 - 011 -reserved-
 - 100 -reserved-
 - 101 -reserved-
 - 110 -reserved-
 - 111 Auto
- 4 SDRAM Burst Length of 8**
 - 0 Disabledefault
 - 1 Enable (must be set for 128-bit operation)
- 3 Fast Host Master Read Ready**
 - 0 Disable (normal)default
 - 1 Enable (1T early)
- 2 PCI Master 8QW Operation**
 - 0 Disabledefault
 - 1 Enable
- 1 Sync 1T Conversion**
 - 0 Transparentdefault
 - 1 Sync
- 0 VPX Mode**
 - 0 Disable (AGP Mode)default
 - 1 Enable (VPX Mode)

Offset 55 – CPU Miscellaneous Control (00h).....RW

- 7-6 Snoop Queue**
 - 00 12-leveldefault
 - 01 13-level
 - 1x 16-level
- 5 Reserved** always reads 0
- 4 Fast Command with 8QW Prefetch**
 - 0 Disabledefault
 - 1 Enable
- 3 Reserved** always reads 0
- 2 Medium Threshold for Write Policy**
 - 0 Disabledefault
 - 1 Enable
- 1 DRDY Early / Late Timing Select**
 - 0 2T Earlydefault
 - 1 2T Late
- 0 Reserved** always reads 0

Offset 56 – Reorder Latency (00h)..... RW

- 7-4 Medium Threshold for Write Policy to Improve Memory Read / Write Performance**
A setting of 2-4 is recommended default = 0h
- 3-0 Maximum Reorder Latency**
 - 0000 Disable (same as Rx55[0]=0) default
 - 0001 Reorder latency 1 (Rx55[0] must be 1)
 - 0010 Reorder latency 2 (Rx55[0] must be 1)
 -
 - 1100 Reorder latency 12 (Rx55[0] must be 1)
 - 1101 -reserved-
 - 1110 -reserved-
 - 1111 -reserved-

Offset 58 – Delivery / Trigger Control (00h)..... RW

- 7 Redirection Hint in Register-Triggered APIC**
 - 0 default
 - 1
- 6 Trigger Register**
 - 0 default
 - 1
- 5 Trigger Mode**
 - 0 default
 - 1
- 4 Delivery Status**
 - 0 default
 - 1
- 3 Destination Mode**
 - 0 default
 - 1
- 2-0 Delivery Mode**
 - 000 default
 - 001
 - 010
 - 011
 - 100
 - 101
 - 110
 - 111

Offset 59 – IPI Control (00h).....RW

- 7-1 **Reserved** always reads 0
- 0 **Lowest Priority IPI Support**
 - 0 Disabledefault
 - 1 Enable

Offset 5A – Destination ID (00h).....RW

- 7-0 **Destination ID in A[19:12]** default = 00h

Offset 5B – Interrupt Vector (00h).....RW

- 7-0 **Interrupt Vector in D[7:0]** default = 00h

Offset 5C – CPU Miscellaneous Control (00h).....RW

- 7 **Reserved** always reads 0
- 6 **Copy / Compare Performance Improvement**
 - 0 Disabledefault
 - 1 Enable
- 5 **CPU Bus Ownership**
 - 0 Disabledefault
 - 1 Enable
- 4 **Patch D11 in APIC Logic Mode**
 - 0 Disabledefault
 - 1 Enable
- 3 **Redirection Hint Information Obtained From**
 - 0 Address Fielddefault
 - 1 Data Field
- 2 **Destination Mode Information Obtained From**
 - 0 Address Fielddefault
 - 1 Data Field
- 1 **APIC Cluster Mode Support**
 - 0 Disabledefault
 - 1 Enable
- 0 **Reserved** always reads 0

Offset 5D – Write Policy (00h).....RW

- 7-4 **Write Request Limit** default = 0h
- 3-0 **Write Request Base**..... default = 0h

Offset 5E – Bandwidth Timer (00h).....RW

- 7-4 **Host CPU Bandwidth Timer**..... default = 0h
- 3-0 **DRAM Bandwidth Timer** default = 0h

Offset 5F – CPU Miscellaneous Control (00h)..... RW

- 7 **Same Bank But Different Sub-Bank Considered Off-Page**
 - 0 Disable..... default
 - 1 Enable (reduces post-write burst length and may increase performance)
- 6 **Back-to-Back Fast Read, Burst CPU-to-AGP Read and Burst CPU-to-Memory Read**
 - 0 Disable..... default
 - 1 Enable
- 5 **Machine Error Output**
 - 0 Disable..... default
 - 1 Enable
- 4 **Bus Initialization Output**
 - 0 Disable..... default
 - 1 Enable
- 3 **Pipeline APIC / Master Transactions**
 - 0 Disable..... default
 - 1 Enable
- 2 **Host CPU Bandwidth Limited**
 - 0 Disable..... default
 - 1 Enable
- 1 **DRAM Bandwidth Limited**
 - 0 Disable..... default
 - 1 Enable
- 0 **Improve CPU Access DRAM Read After Write**
 - 0 Disable..... default
 - 1 Enable

Offset 60 – DRDY L Timing Control 1 (00h).....RW

- 7-6 Phase 4 L Wait States default = 00b
- 5-4 Phase 3 L Wait States default = 00b
- 3-2 Phase 2 L Wait States default = 00b
- 1-0 Phase 1 L Wait States default = 00b

Offset 61 – DRDY L Timing Control 2 (00h).....RW

- 7-6 Phase 8 L Wait States default = 00b
- 5-4 Phase 7 L Wait States default = 00b
- 3-2 Phase 6 L Wait States default = 00b
- 1-0 Phase 5 L Wait States default = 00b

Offset 62 – DRDY L Timing Control 3 (00h).....RW

- 7-4 Reserved always reads 0
- 3-2 Phase 10 L Wait States default = 00b
- 1-0 Phase 9 L Wait States default = 00b

Offset 63 – DRDY Q Timing Control 1 (00h).....RW

- 7-6 Phase 4 Q Wait States default = 00b
- 5-4 Phase 3 Q Wait States default = 00b
- 3-2 Phase 2 Q Wait States default = 00b
- 1-0 Phase 1 Q Wait States default = 00b

Offset 64 – DRDY Q Timing Control 2 (00h).....RW

- 7-6 Phase 8 Q Wait States default = 00b
- 5-4 Phase 7 Q Wait States default = 00b
- 3-2 Phase 6 Q Wait States default = 00b
- 1-0 Phase 5 Q Wait States default = 00b

Offset 65 – DRDY Q Timing Control 3 (00h).....RW

- 7-4 Reserved always reads 0
- 3-2 Phase 10 Q Wait States default = 00b
- 1-0 Phase 9 Q Wait States default = 00b

Offset 66 – Burst DRDY Timing Control 1 (00h) RW

- 7 Burst DRDY Wait State #8
- 6 Burst DRDY Wait State #7
- 5 Burst DRDY Wait State #6
- 4 Burst DRDY Wait State #5
- 3 Burst DRDY Wait State #4
- 2 Burst DRDY Wait State #3
- 1 Burst DRDY Wait State #2
- 0 Burst DRDY Wait State #1
 - 0 0 ws DRDY Burst..... default
 - 1 1 ws DRDY Burst

Offset 67 – Burst DRDY Timing Control 2 (00h) RW

- 7-6 Reserved always reads 0
- 5-4 Burst DRDY Wait State #10-9
 - 0 Disable..... default
 - 1 Enable
- 3-0 Reserved always reads 0

Offset 68 – Lowest Priority CPU ID #0 (00h)..... RO

Offset 69 – Lowest Priority CPU ID #1 (00h)..... RO

Offset 6A – Lowest Priority CPU ID #2 (00h)..... RO

Offset 6B – Lowest Priority CPU ID #3 (00h)..... RO

Offset 6C – Lowest Priority CPU ID #4 (00h)..... RO

Offset 6D – Lowest Priority CPU ID #5 (00h)..... RO

Offset 6E – Lowest Priority CPU ID #6 (00h)..... RO

Offset 6F – Lowest Priority CPU ID #7 (00h)..... RO

Host CPU AGTL+ I/O Control

Offset 70 – Host Address (2x) Pullup Drive.....RW

- 7 Reserved always reads 0
- 6-4 Reserved (Do Not Program)..... default = 0
- 3 Reserved always reads 0
- 2-0 Address Pullup Drive (HA,HREQ#) default = 0

Offset 71 – Host Address (2x) Pulldown DriveRW

- 7 Reserved always reads 0
- 6-4 Reserved (Do Not Program)..... default = 0
- 3 Reserved always reads 0
- 2-0 Address Pulldown Drive (HA,HREQ#) . default = 0

Offset 72 – Host Data (1x) Pullup Drive.....RW

- 7 Reserved always reads 0
- 6-4 Reserved (Do Not Program)..... default = 0
- 3 Reserved always reads 0
- 2-0 Data Pullup Drive (HD)..... default = 0

Offset 73 – Host Data (1x) Pulldown Drive.....RW

- 7 Reserved always reads 0
- 6-4 Reserved (Do Not Program)..... default = 0
- 3 Reserved always reads 0
- 2-0 Data Pulldown Drive (HD)..... default = 0

Note: Refer to BIOS Porting Guide for recommended settings for these bits for typical system configurations.

Offset 74 – Output Delay / Stagger Control.....RW

- 7-6 Reserved always reads 0
- 5 HD[63:48, 31:16] Output Stagger
 - 0 No delay default
 - 1 1 nsec delay
- 4 HA[31:17] Output Stagger
 - 0 No delay default
 - 1 1 nsec delay
- 3-0 Reserved always reads 0

Offset 75 – AGTL+ I/O Control (00h) RW

- 7 AGTL+ 1x Input Increase Delay to Filter Noise
 - 0 Disable..... default
 - 1 Enable
- 6 AGTL+ 2x Input Increase Delay to Filter Noise
 - 0 Disable..... default
 - 1 Enable
- 5 AGTL+ Slew Rate Control
 - 0 Disable..... default
 - 1 Enable
- 4 Increase Delay for First HD Strobe
 - 0 Disable..... default
 - 1 Enable
- 3 Input Pullup
 - 0 Disable..... default
 - 1 Enable
- 2 AGTL+ Strobe Internal Termination Pullups
 - 0 Disable..... default
 - 1 Enable
- 1 AGTL+ Data Internal Termination Pullups
 - 0 Disable..... default
 - 1 Enable
- 0 AGTL+ Dynamic Compensation
 - 0 Disable..... default
 - 1 Enable

Offset 76 – AGTL+ Comp Status (00h) RW

- 7 Select AutoCompensation Drive
 - 0 Disable..... default
 - 1 Enable (RxD8-DB set automatically on-chip based on auto compensation results)
- 6-4 AGTL+ Compensation Result default = x
- 3 AGTL+ POS Function
 - 0 Inputs always powered default
 - 1 Inputs powered down when not in input mode
- 2 Auto Configure Set from VD6 Strap
 - 0 Disable (strap pulled low)
 - 1 Enable (strap pulled high). AGTL+ Drive settings and other chip configuration settings are stored in ROM, transferred from the South Bridge (via the V-Link bus) and loaded into the North Bridge automatically after system reset. Refer to the BIOS Porting Guide for layout of the AutoConfigure settings in ROM and for recommended bit settings.
- 1-0 Reserved (Do Not Program) default = 0

Offset 77 – AGTL+ Auto Comp Offset (00h) RW

- 7-4 AGTL+ Drive Offset to Comp Result for 2x Pad default = 0
- 3-0 AGTL+ Drive Offset to Comp Result for 1x Pad default = 0

Device 0 Function 3 Registers – DRAM

Device 0 Function 3 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 and device number equal to zero and function number equal to 3.

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

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

Offset 3-2 - Device ID (3259h).....RO

15-0 ID Code (reads 3259h to identify CN333 NB virtual device function 3)

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
- 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 spacedefault
 - 1 Responds to I/O space

Offset 7-6 – Status (0200h)..... 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 Sys Err (SERR# Asserted) .always reads 0
- 13 Signaled Master Abort
 - 0 No abort received default
 - 1 Transaction aborted by master . write 1 to clear
- 12 Received Target Abort
 - 0 No abort received default
 - 1 Transaction aborted by target... write 1 to clear
- 11 Signaled Target Abortalways reads 0
 - 0 Target Abort never signaled
- 10-9 DEVSEL# Timing
 - 00 Fast
 - 01 Mediumalways 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 North Bridge was initiator of the operation in which the error occurred... write one to clear
- 7 Fast Back-to-Back Capablealways reads 0
- 6 User Definable Features.....always reads 0
- 5 66MHz Capable.....always reads 0
- 4 Supports New Capability list.....always reads 0
- 3-0 Reservedalways reads 0

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

10-0 Chip Revision Code..... always reads 0nh

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

7-0 Interface Identifier always reads 00h

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

7-0 Sub Class Codereads 00 to indicate Host Bridge

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

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

Offset 2D-2C – Subsystem Vendor ID (0000h) W1 / RO

15-0 Subsystem Vendor ID default = 0
This register may be written once and is then read only.

Offset 2F-2E – Subsystem ID (0000h)..... W1 / RO

15-0 Subsystem ID default = 0
This register may be written once and is then read only.

Offset 37-34 - Capability Pointer (CAPPTR)..... RO

Contains an offset from the start of configuration space.

31-0 AGP Capability List Ptr ...always reads 0000 0000h

Device 0 Function 3 Device-Specific Registers

These registers are normally programmed once at system initialization time.

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 VIA Technologies CN333 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

Offset 40-47 – DRAM Row Ending Address:

- Offset 40 – Bank 0 Ending (HA[32:25]) (01h)RW**
- Offset 41 – Bank 1 Ending (HA[32:25]) (01h)RW**
- Offset 42 – Bank 2 Ending (HA[32:25]) (01h)RW**
- Offset 43 – Bank 3 Ending (HA[32:25]) (01h)RW**
- Offset 44 – Bank 4 Ending (HA[32:25]) (01h)RW**
- Offset 45 – Bank 5 Ending (HA[32:25]) (01h)RW**
- Offset 46 – Bank 6 Ending (HA[32:25]) (01h)RW**
- Offset 47 – Bank 7 Ending (HA[32:25]) (01h)RW**

Note : Refer to the BIOS Porting Guide or BIOS Porting Update Note for detailed programming information.

Offset 48 - DRAM DIMM #0 Control (00h)..... RW

- 7 Rank 1 Enable default = 0**
- 6 Rank 0 Enable default = 0**
- 5 Rank 1 Is Above 4GB..... default = 0**
- 4 Rank 0 Is Above 4GB..... default = 0**
- 3-0 MA Setting (see Table below)..... default = 0**

Offset 49 - DRAM DIMM #1 Control (00h)..... RW

- 7 Rank 3 Enable default = 0**
- 6 Rank 2 Enable default = 0**
- 5 Rank 3 Is Above 4GB..... default = 0**
- 4 Rank 2 Is Above 4GB..... default = 0**
- 3-0 MA Setting (see Table below)..... default = 0**

Offset 4A - DRAM DIMM #2 Control (00h)..... RW

- 7 Rank 5 Enable default = 0**
- 6 Rank 4 Enable default = 0**
- 5 Rank 5 Is Above 4GB..... default = 0**
- 4 Rank 4 Is Above 4GB..... default = 0**
- 3-0 MA Setting (see Table below)..... default = 0**

Offset 4B - DRAM DIMM #3 Control (00h) RW

- 7 Rank 7 Enable default = 0**
- 6 Rank 6 Enable default = 0**
- 5 Rank 7 Is Above 4GB..... default = 0**
- 4 Rank 6 Is Above 4GB..... default = 0**
- 3-0 MA Setting (see Table below)..... default = 0**

Table 7. DIMM MA Setting

Columns	12 Rows	13 Rows	14 Rows
8	0000 32 MB/Rank	—	—
9	0001 64 MB/Rank	0100 128 MB/Rank	—
10	0010 128 MB/Rank	0101 256 MB/Rank	1000 512 MB/Rank
11	0011 256 MB/Rank	0110 512 MB/Rank	1001 1 GB/Rank
12	—	0111 1 GB/Rank	1010 2 GB/Rank

Offset 51-50 - DRAM MA Map Type (2222h)RW

- 15-13 Bank 5/4 MA Map Type** (see Table below)
- 12 Bank 5/4 1T Command Rate**
 - 0 2T Commanddefault
 - 1 1T Command
- 11-9 Bank 7/6 MA Map Type** (see Table below)
- 8 Bank 7/6 1T Command Rate**
 - 0 2T Commanddefault
 - 1 1T Command
- 7-5 Bank 1/0 MA Map Type** (see Table below)
- 4 Bank 1/0 1T Command Rate**
 - 0 2T Commanddefault
 - 1 1T Command
- 3-1 Bank 3/2 MA Map Type** (see Table below)
- 0 Bank 3/2 1T Command Rate**
 - 0 2T Commanddefault
 - 1 1T Command

Table 8. MA Map Type Encoding

000	-	-reserved
001	<u>64/128Mb</u>	8 / 9-bit Column Address.....default
010	<u>64/128Mb</u>	9 / 10-bit Column Address
011	<u>64/128Mb</u>	10 / 11-bit Column Address
100	<u>1Gb</u>	10 / 11 / 12-bit Column Address
101	<u>256/512Mb</u>	8-bit Column Address
110	<u>256/512Mb</u>	9-bit Column Address
111	<u>256/512Mb</u>	10 / 11 / 12-bit Column Address

Offset 52 - DRAM Rank End Address Bit-33 (00h)RW

- 7-1 Reserved** always reads 0
- 0 Rank End Address Bit-33**..... default = 0

Offset 53 - DRAM Rank Begin Address Bit-33 (00h)RW

- 7-1 Reserved** always reads 0
- 0 Rank Begin Address Bit-33**..... default = 0

Offset 54 - DRAM Controller Internal Options (00h) ...RW

- 7-5 Reserved** always reads 0
- 4 Read-Modify-Write Option**
 - 0 Disabledefault
 - 1 Enable
- 3 Apply Same-Channel Constraints on Different Channels**
 - 0 Disabledefault
 - 1 Enable
- 2 Two SCMD Buses Are Exclusive & Cannot Operate Simultaneously**
 - 0 Disabledefault
 - 1 Enable
- 1-0 Reserved** always reads 0

Offset 55 - DRAM Rank Decode Address Config (00h) RW

- 7-2 Reserved**always reads 0
- 1-0 DRAM Rank Decode Address Configuration**
 - 00 default
 - 01
 - 10
 - 11

Offset 56 - DRAM Timing for All Banks I (65h) RW

- 7-6 Active Command to Precharge Command Period**
 - 00 TRAS = 6T
 - 01 TRAS = 7T default
 - 10 TRAS = 8T
 - 11 TRAS = 9T
- 5-4 CAS Latency**
 - 00 1.5T
 - 01 2T
 - 10 2.5T default
 - 11 3T
- 3-2 ACTIVE to CMD**
 - 00 TRCD = 2T
 - 01 TRCD = 3T default
 - 10 TRCD = 4T
 - 11 TRCD = 5T
- 1-0 Precharge Command to Active Command Period**
 - 00 TRP = 2T
 - 01 TRP = 3T default
 - 10 TRP = 4T
 - 11 TRP = 5T

Offset 57 - DRAM Timing for All Banks II (01h) RW

- 7-6 Reserved**always reads 0
- 5 Active (0) -> Active (1)**
 - 0 TRRD = 2T default
 - 1 TRRD = 3T
- 4 Write Recovery Time**
 - 0 2T default
 - 1 3T
- 3 TWTR**
 - 0 TWTR = 1T..... default
 - 1 TWTR = 2T
- 2 Increase TRFC For 1 Gbit DRAMs**
 - 0 Disable..... default
 - 1 Enable
- 1-0 TRFC (Refresh-to-Active or Refresh-to-Refresh)**

	<u>Bit-2=0</u>	<u>Bit-2=1</u>
00	12T	21T
01	13T	22T..... default
10	14T	23T
11	15T	24T

Offset 60 – DRAM Control (00h).....RW

- 7 **OWS Back-to-Back Write to Different DDR Bank**
 - 0 Disabledefault
 - 1 Enable
- 6 **Fast Read to Read Turnaround**
 - 0 Disabledefault
 - 1 Enable (DQS postamble overlap with preamble)
- 5 **Fast Read to Write Turnaround**
 - 0 Disabledefault
 - 1 Enable
- 4 **Fast Write to Read Turnaround**
 - 0 Disabledefault
 - 1 Enable
- 3 **DQSA Input Capture Extended Range Control**
 - 0default
 - 1
- 2 **DQSB Input Capture Extended Range Control**
 - 0default
 - 1
- 1-0 **DQS[7:4] Input Capture Extended Range Control for Channels A and B**
 - 00default
 - 01
 - 10
 - 11

Offset 65 - DRAM Arbitration Timer (00h)RW

- 7-4 **AGP Timer** (units of 4 DRAM clocks) default = 0
- 3-0 **CPU Timer** (units of 4 DRAM clocks)..... default = 0

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

- 7 **DRAM Controller Queue Greater Than 2**
 - 0 Disabledefault
 - 1 Enable
- 6 **DRAM Controller Queue Not Equal To 4**
 - 0 Disabledefault
 - 1 Enable
- 5-4 **Arbitration Parking Policy**
 - 00 Park at last bus ownerdefault
 - 01 Park at CPU
 - 10 Park at AGP
 - 11 -reserved-
- 3-0 **AGP / CPU Priority** (units of 4 DRAM clocks)

Offset 68 – DRAM DDR Control (00h)..... RW

- 7 **DRAM Access Timing**
 - 0 2T default
 - 1 3T
- 6 **Non-Burst Write-to-Write Can Be Closer in Non-DQM Mode**
 - 0 Disable..... default
 - 1 Enable
- 5 **Zero Delay DRAM Channel Switching for Read Cycles**
 - 0 Disable..... default
 - 1 Enable
- 4 **Zero Delay DRAM Channel Switching for Write Cycles**
 - 0 Disable..... default
 - 1 Enable
- 3-0 **DRAM Operating Frequency**
 - CPU / DRAM
 - 0000 133 / 133 (DDR-266) default
 - 0001 100 / 133 (DDR-266)
 - 133 / 166 (DDR-333)
 - 0101 100 / 166 (DDR-333)
 - 1001 -reserved-
 - 0010 -reserved-
 - 1010 -reserved-

All other combinations are reserved.

Offset 69 – DRAM Page Policy Control (00h).....RW

- 7-6 Bank Interleave**
 - 00 No Interleave.....default
 - 01 2-way
 - 10 4-way
 - 11 Reserved

For 16Mb DRAMs bank interleave is always 2-way
- 5 Reserved** always reads 0
- 4 Auto-Precharge for TLB Read or CPU Write-Back**
 - 0 Disabledefault
 - 1 Enable
- 3 DRAM 8K Page Enable**
 - 0 Disabledefault
 - 1 Enable
- 2 DRAM 4K Page Enable**
 - 0 Disabledefault
 - 1 Enable
- 1 Page Kept Active When Crossing Banks**
 - 0 Disabledefault
 - 1 Enable
- 0 Multiple Page Mode**
 - 0 Disabledefault
 - 1 Enable

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

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

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

Offset 6B - DRAM Arbitration Control (10h)..... RW

- 7 DQS Input DLL Adjust**
 - 0 Disable..... default
 - 1 Enable
- 6 DQS Output DLL Adjust**
 - 0 Disable..... default
 - 1 Enable
- 5 Burst Refresh**
 - 0 Disable..... default
 - 1 Enable
- 4 Reserved (Do Not Program)..... default = 1**
- 3 HA14 / HA22 Swap**
 - 0 Normal..... default
 - 1 Swap to improve performance
- 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 to Low DIMM
 - 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 MSR to High DIMM
 - 11x Reserved

Offset 6C – DRAM Clock Control (00h).....RW

- 7-5 **Reserved** always reads 0
- 4 **DQM Removal (Always Perform 4-Burst R/W)**
 - 0 Disabledefault
 - 1 Enable
- 3 **Reserved (Do Not Program)**..... default = 0
- 2 **DDR x4 Device Enable**
 - 0 Disabledefault
 - 1 Enable
- 1-0 **Reserved (Do Not Program)**..... default = 0

Offset 6E – DRAM Control (00h) RW

- 7 **Reserved**always reads 0
- 6 **DRAM Scrubber**
 - 0 Disable..... default
 - 1 Enable
- 5 **DRAM Scrubber Redirect**
 - 0 Disable..... default
 - 1 Enable
- 4-3 **Reserved**always reads 0
- 2 **For Double-Sided DIMMs, Interleave Using Address Bit-15**
 - 0 Disable..... default
 - 1 Enable
- 1 **Select Address Bit 19 Instead of 14 as Sub-Bank Address**
 - 0 Disable..... default
 - 1 Enable
- 0 **Select Address Bit 18 Instead of 13 as Sub-Bank Address**
 - 0 Disable..... default
 - 1 Enable

Note: Refer to the CN333 BIOS Porting Guide for SDRAM configuration algorithms and recommended settings for these bits for typical memory system configurations.

Offset 70 – DRAM DDR Control 1 (00h).....RW

7-0 Channel A DQS Output Delay
 00hdefault
 FFh

Offset 71 – DRAM DDR Control 2 (00h).....RW

7-0 Channel A MD Output Delay
 00hdefault
 FFh

Offset 72 – DRAM DDR Control 3 (00h).....RW

7-0 Channel B DQS Output Delay
 00hdefault
 FFh

Offset 73 – DRAM DDR Control 4 (00h).....RW

7-0 Channel B MD Output Delay
 00hdefault
 FFh

Offset 74 – DRAM DQS Input Delay (00h).....RW

7 DQS Input Delay Setting
 0 Autodefault
 1 Manual
6 Reserved always reads 0
5-0 DQS Input Delay
 (if bit-7 = 0, reads DLL calibration result)
 00hdefault
 FFh

Offset 76 – DRAM Early Clock Select (00h).....RW

7 Early Clock Select - Scmd/MA Bit-2 (see bits 3-2)
6 Early Clock Select - CS, CKE Bit-2 (see bits 1-0)
5-4 Reserved (Do Not Program)..... default = 0
3-2 Early Clock Select - Scmd/MA Bits 1-0 (see bit-7)
 000default
 001
 010
 011
 100
 101
 110
 111
1-0 Early Clock Select - CS, CKE Bits 1-0 (see bit-6)
 000default
 001
 010
 011
 100
 101
 110
 111

Offset 78 – DRAM Timing Control (13h)..... RW

7-6 Reserved (Do Not Program)..... default = 0
5-4 Write MD / DQS / CAS Timing Range Control
 00
 01 default
 10
 11
3-0 Reserved (Do Not Program)..... default = 3

Offset 79 – DRAM DQS Output Control (01h)..... RW

7-4 Reservedalways reads 0
3 DQS / MD Output Enable Gated with DQS Input Enable
 0 Disable..... default
 1 Enable
2 DQS Output Long Postamble
 0 Disable..... default
 1 Enable
1 DQS Output Long Preamble 2
 0 Disable..... default
 1 Enable
0 DQS Output Long Preamble
 0 Disable
 1 Enable..... default

Offset 7A – DRAM DQS Capture Ctrl Chan A (44h)....RW

7-6 MD Input Internal Timing Control
 00
 01default
 10
 11
 5 Process DQS Input as in QBM Mode
 0 Disabledefault
 1 Enable
 4-0 DQS Input Capture Range - Channel A
 00000
 00001
 00010
 00011
 00100default
 00101
 ...
 11111

Offset 7B – DRAM DQS Capture Ctrl Chan B (04h)....RW

7-5 Reserved (Do Not Program)..... default = 0
 4-0 DQS Input Capture Range - Channel B
 00000
 00001
 00010
 00011
 00100default
 00101
 ...
 11111

Offset 7C – DIMM #0 DQS Input Delay Offset (00h) ... RW

Values are programmed as two's-complement
 7-5 Rank 1 DQS Input 2nd-Order Delay Offset
 000 default
 ...
 111
 4-0 Rank 0 DQS Input Delay Offset
 00000 default
 ...
 11111

Offset 7D – DIMM #1 DQS Input Delay Offset (00h) ... RW

Values are programmed as two's-complement
 7-5 Rank 3 DQS Input 2nd-Order Delay Offset
 000 default
 ...
 111
 4-0 Rank 2 DQS Input Delay Offset
 00000 default
 ...
 11111

Offset 7E – DIMM #2 DQS Input Delay Offset (00h).... RW

Values are programmed as two's-complement
 7-5 Rank 5 DQS Input 2nd-Order Delay Offset
 000 default
 ...
 111
 4-0 Rank 4 DQS Input Delay Offset
 00000 default
 ...
 11111

Offset 7F – DIMM #3 DQS Input Delay Offset (00h).... RW

Values are programmed as two's-complement
 7-5 Rank 7 DQS Input 2nd-Order Delay Offset
 000 default
 ...
 111
 4-0 Rank 6 DQS Input Delay Offset
 00000 default
 ...
 11111

Table 9. 1x Bandwidth (64-Bit DDR) Memory Address Mapping Table

MA:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
<u>64/128Mb</u>																	x32 (14,8)
2K page	28	14	24	14	13	12	11	23	22	21	20	19	18	17	16	15	x16 (14,8)
001	31	28	27	14	13	PC	26	25	10	9	8	7	6	5	4	3	x8 (14,9)
4K page	28	14	25	14	13	12	24	23	22	21	20	19	18	17	16	15	x16 (14,9)
010	31	28	27	14	13	PC	26	11	10	9	8	7	6	5	4	3	x4 (14,10)
8K page	28	14	26	14	13	25	24	23	22	21	20	19	18	17	16	15	x8 (14,10)
011	31	28	27	14	13	PC	12	11	10	9	8	7	6	5	4	3	x4 (14,11)
<u>256/512Mb</u>																	
2K page	28	25	24	14	13	12	11	23	22	21	20	19	18	17	16	15	x32 (15,8)
101	31	29	28	14	13	PC	27	26	10	9	8	7	6	5	4	3	x16 (15,9)
4K page	28	26	25	14	13	12	24	23	22	21	20	19	18	17	16	15	x32 (15,9)
110	31	29	28	14	13	PC	27	11	10	9	8	7	6	5	4	3	x16 (15,9)
8K page	28	27	26	14	13	25	24	23	22	21	20	19	18	17	16	15	x16 (15,10)
111	31	29	28	14	13	PC	12	11	10	9	8	7	6	5	4	3	x8 (15,10)
																	x8 (15,11)
																	x4 (15,11)
																	x4 (15,12)
<u>1Gb</u>																	
8K page	28	27	26	14	13	25	24	23	22	21	20	19	18	17	16	15	x16 (16,10)
100	31	30	29	14	13	PC	12	11	10	9	8	7	6	5	4	3	x8 (16,11)
																	x4 (16,12)

ROM Shadow Control

Offset 80 – C-ROM Shadow Control (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

Offset 81 – D-ROM Shadow Control (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

Offset 82 – F-ROM Shadow /Memory Hole / SMI Control (00h)..... RW

- 7-6 **Reserved**always reads 0
- 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 **Disable A,BK SMRAM Direct Access**
- 0 **Enable A,BK DRAM Access**

SMI Mapping Control:

Bits	SMM		Non-SMM	
	Code	Data	Code	Data
1-0				
00	DRAM	DRAM	PCI	PCI
01	DRAM	DRAM	DRAM	DRAM
10	DRAM	PCI	PCI	PCI
11	DRAM	DRAM	DRAM	DRAM

Offset 83 – E-ROM Shadow Control (00h) RW

- 7-6 **EC000h-EFFFFh**
 - 00 Read/write disable default
 - 01 Write enable
 - 10 Read enable
 - 11 Read/write enable
- 5-4 **E8000h-EBFFFh**
 - 00 Read/write disable default
 - 01 Write enable
 - 10 Read enable
 - 11 Read/write enable
- 3-2 **E4000h-E7FFFh**
 - 00 Read/write disable default
 - 01 Write enable
 - 10 Read enable
 - 11 Read/write enable
- 1-0 **E0000h-E3FFFh**
 - 00 Read/write disable default
 - 01 Write enable
 - 10 Read enable
 - 11 Read/write enable

DRAM Above 4G Control

Offset 84 – Low Top Address Low (00h).....RW

- 7-4 **Low Top Address Low** default = 0
- 3-0 **DRAM Granularity**
 - 0 16M Total DRAM less than 4Gdefault
 - 1 32M Total DRAM less than 8G
 - 2 64M Total DRAM less than 16G
 - 3 128M Total DRAM less than 32G
 - 4 256M Total DRAM less than 64G
 - 5-7 -reserved-

Offset 85 – Low Top Address High (FFh).....RW

- 7-0 **Low Top Address High**..... default = FFh

Offset 86 – SMM / APIC Decoding (01h) RW

- 7-6 **Reserved**always reads 0
- 5 **APIC Lowest Interrupt Arbitration**
 - 0 Disable..... default
 - 1 Enable
- 4 **I/O APIC Decoding**
 - 0 FECxxxxx accesses go to PCI..... default
 - 1 FEC00000 to FEC7FFFF accesses go to PCI
FEC80000 to FECFFFFFF 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 **Reserved**always reads 0
- 0 **Compatible SMM**
 - 0 Disable
 - 1 Enable..... **default**

UMA Control

Offset A0 – CPU Direct Access FB Base Address (00h).RW

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

Offset A1 – CPU Direct Access FB Size (00h).....RW

- 7 VGA
 - 0 Disabledefault
 - 1 Enable
- 6-4 CPU Direct Access FB Size
 - 000 Nonedefault
 - 001 2MB†
 - 010 4MB†
 - 011 8MB†
 - 100 16MB
 - 101 32 MB
 - 110 64 MB
 - 111 -reserved-

†Microsoft WHQL DCT certification requires the frame buffer size to be a minimum of 16MB. Smaller frame buffer sizes are supported for non-Windows applications to reserve more available memory for the system.

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

Offset A2 – VGA Timer 1 (00h).....RW

- 7-4 VGA High Priority Timer def = 0
- 3-0 VGA Timer def = 0
(programmed in units of 16 dot clocks)

Offset A3 – VGA Timer 2 (00h).....RW

- 7-4 Timer to Promote Graphics Priority def = 0
(programmed in units of 16 dot clocks)
- 3-2 Reserved always reads 0
- 1-0 Reserved (Do Not Program)..... default = 0

Offset A4 – Graphics Miscellaneous Control (00h)..... RW

- 7-4 Reservedalways reads 0
- 3 AGP DIO (Pad) Clock
 - 0 Disable..... default
 - 1 Enable
- 2 Graphics Data Delay to Sync with Clock
 - 0 No sync..... default
 - 1 Sync with clock
- 1-0 Graphics DISPCLK Delay Control
 - 00 default
 - 01
 - 10
 - 11

Graphics Control

Offset B0 – Graphics Control 1 (00h).....RW

- 7-4 **Reserved** always reads 0
- 3 **Frame Buffer Rank Searching**
 - 0 Automatic.....default
 - 1 Select bank per bits 2-0
- 2-0 **Frame Buffer Rank Location**

Offset B1 – Graphics Control 2 (00h).....RW

- 7-4 **Current High Channel Granted (Normal Priority) and Request Pending Low Request Just Arrived ...** def = 0
- 3-0 **Current Low Channel Granted and Request Pending High Request Just Arrived.....** def = 0

Offset B2 – Graphics Control 3 (00h).....RW

- 7-4 **Lot Counter for High Channel to Extend Arbitration Slot to High Requests** def = 0
- 3-0 **Lot Counter for Low Channel to Extend Arbitration Slot to Low Requests** def = 0

Offset B3 – Graphics Control 4 (00h).....RW

- 7 **Reserved** always reads 0
- 6-4 **Graphics Write Queue Threshold** def = 0
- 3-0 **Graphics VM FIFO Threshold** def = 0

Offset B4 – Graphics Control 5 (00h).....RW

- 7-4 **Reserved** always reads 0
- 3 **Graphics Read / Write Order Control**
 - 0 R/W may be out of order.....default
 - 1 Keep original low channel R/W order as received from graphics controller
- 2 **Optimize Graphics Arbitration with DRAM Hit / Miss Consideration**
 - 0 Disabledefault
 - 1 Enable
- 1 **Qualify Length from Graphics Controller to Differentiate 2QW / 4QW Requests**
 - 0 Disabledefault
 - 1 Enable
- 0 **Alternate Arbitration to Low / High Channel Read When Both Hit**
 - 0 Disabledefault
 - 1 Enable

AGP Controller Interface Control

Offset C0 – AGP Controller Interface Control (00h).... RW

- 7-3 **Reserved**always reads 0
- 2 **Graphics AGP Read Data Delay**
 - 0 No delay default
 - 1 Delay 1 clock
- 1 **AGP Controller Interface Pipe Mode (Graphics)**
 - 0 Pipe default
 - 1 Pipe bypass
- 0 **AGP Controller Interface Pipe Mode (North Bridge)**
 - 0 Pipe default
 - 1 Pipe bypass

DRAM Drive Control

Offset E0 – DRAM DQSA Drive.....RW

- 7-4 **High Drive**
- 0000 Lowest.....default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest.....default
-
- 1111 Highest

Offset E1 – DRAM DQSB Drive.....RW

- 7-4 **High Drive**
- 0000 Lowest.....default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest.....default
-
- 1111 Highest

Offset E2 – DRAM MDA, DQMA Drive.....RW

- 7-4 **High Drive**
- 0000 Lowest.....default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest.....default
-
- 1111 Highest

Offset E3 – DRAM MDB, DQMB Drive.....RW

- 7-4 **High Drive**
- 0000 Lowest.....default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest.....default
-
- 1111 Highest

Offset E4 – DRAM CS / CKE Drive.....RW

- 7-4 **High Drive**
- 0000 Lowest.....default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest.....default
-
- 1111 Highest

Offset E6 – Drive Group S-Port Control (00h)..... RW

- 7 **DQ S-Port Control** default = 0
- 6 **CS S-Port Control** default = 0
- 5 **MAA S-Port Control** default = 0
- 4 **MAB S-Port Control** default = 0
- 3 **DQS S-Port Control** default = 0
- 2-1 **Reserved** always reads 0
- 0 **DQ / DQS / DQM Terminator**
- 0 Disable..... default
- 1 Enable

Offset E8 – MAA Drive (MAA, ScmdA) RW

- 7-4 **High Drive**
- 0000 Lowest default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest default
-
- 1111 Highest

Offset EA – MAB Drive (MAB, ScmdB) RW

- 7-4 **High Drive**
- 0000 Lowest default
-
- 1111 Highest
- 3-0 **Low Drive**
- 0000 Lowest default
-
- 1111 Highest

Offset EC – Channel A Duty Cycle Control..... RW

- 7-6 **DQS Duty Cycle Control – Falling** default = 0
- 5-4 **DQS Duty Cycle Control - Rising** default = 0
- 3-2 **DQ Duty Cycle Control – Falling** default = 0
- 1-0 **DQ Duty Cycle Control - Rising** default = 0

Offset ED – Channel B Duty Cycle Control..... RW

- 7-6 **DQS Duty Cycle Control – Falling** default = 0
- 5-4 **DQS Duty Cycle Control - Rising** default = 0
- 3-2 **DQ Duty Cycle Control – Falling** default = 0
- 1-0 **DQ Duty Cycle Control - Rising** default = 0

Offset EE – DDR CKG Duty Cycle Control 1..... RW

- 7-2 **Reserved** always reads 0
- 1-0 **DDR CKG Duty Cycle Control**..... default = 0

Offset EF – DDR CKG Duty Cycle Control 2..... RW

- 7-2 **Reserved** always reads 0
- 1-0 **DDR CKG Duty Cycle Control**..... default = 0

Device 0 Function 4 Registers – Power Management

Device 0 Function 4 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 and device number equal to zero and function number equal to 4.

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

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

Offset 3-2 - Device ID for Power Manager (4259h).....RO

15-0 ID Code (reads 4259h to identify CN333 NB virtual device function 4)

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
- 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 spacedefault
 - 1 Responds to I/O space

Offset 7-6 – Status (0200h)..... 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 North Bridge 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 0
- 3-0 Reserved always reads 0

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

11-0 Chip Revision Code..... always reads 0nh

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

7-0 Interface Identifier always reads 00h

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

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

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

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

Device 0 Function 4 Device-Specific Registers

These registers are normally programmed once at system initialization time.

Power Management Control

Offset A0 – Power Management Mode (00h).....RW

- 7 Dynamic Power Management**
 - 0 Disabledefault
 - 1 Enable
- 6 Halt / Shutdown Power Management**
 - 0 Disabledefault
 - 1 Enable
- 5 Stop Clock Power Management**
 - 0 Disabledefault
 - 1 Enable
- 4 Suspend Status Power Management**
 - 0 Disabledefault
 - 1 Enable
- 3-0 Reserved** always reads 0

Offset A1 – DRAM Power Management (00h).....RW

- 7 Reserved** always reads 0
- 6 Dynamic CKE when DRAM Idle**
 - 0 Disabledefault
 - 1 Enable
- 5 Dynamic DRAM I/O Pad Power Down (Float)**
 - 0 Disabledefault
 - 1 Enable
- 4-0 Reserved** always reads 0

Offset A2 – Dynamic Clock Stop Control (00h)..... RW

- 7 Host Interface Power Management**
 - 0 Disable..... default
 - 1 Enable
- 6 DRAM 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 PCI #2 Interface Power Management**
 - 0 Disable..... default
 - 1 Enable
- 2 Graphics Interface Power Management**
 - 0 Disable..... default
 - 1 Enable
- 1 Reserved** always reads 0
- 0 Host Fast Power Management (DADS Fast Timing)**
 - 0 Disable..... default
 - 1 Enable

Offset A3 – 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)
- 6-0 Reserved** always reads 0

BIOS Scratch

Offset D0-EF – BIOS Scratch Registers RW

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

Device 0 Function 7 Registers – V-Link

Device 0 Function 7 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 and device number equal to zero and function number equal to 7.

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

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

Offset 3-2 - Device ID for V-Link Control (7259h)RO

15-0 ID Code (reads 7259h to identify the CN333 North Bridge virtual device function 7)

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
- 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 spacedefault
 - 1 Responds to I/O space

Offset 7-6 – Status (0200h)..... 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 Sys Err (SERR# Asserted) .always reads 0
- 13 Signaled Master Abort
 - 0 No abort received default
 - 1 Transaction aborted by master . write 1 to clear
- 12 Received Target Abort
 - 0 No abort received default
 - 1 Transaction aborted by target... write 1 to clear
- 11 Signaled Target Abortalways reads 0
 - 0 Target Abort never signaled
- 10-9 DEVSEL# Timing
 - 00 Fast
 - 01 Mediumalways 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 North Bridge was initiator of the operation in which the error occurred... write one to clear
- 7 Fast Back-to-Back Capablealways reads 0
- 6 User Definable Features.....always reads 0
- 5 66MHz Capable.....always reads 0
- 4 Supports New Capability list.....always reads 0
- 3-0 Reservedalways reads 0

Offset 8 - Revision ID (0nh) RO

12-0 Chip Revision Code..... always reads 0nh

Offset 9 - Programming Interface (00h) RO

7-0 Interface Identifier always reads 00h

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

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

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

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

Offset 2D-2C – Subsystem Vendor ID (0000h) W1 / RO

15-0 Subsystem Vendor ID default = 0
This register may be written once and is then read only.

Offset 2F-2E – Subsystem ID (0000h)..... W1 / RO

15-0 Subsystem ID default = 0
This register may be written once and is then read only.

Offset 37-34 - Capability Pointer (CAPPTR)..... RO

Contains an offset from the start of configuration space.

31-0 AGP Capability List Ptr ...always reads 0000 0000h

Device 0 Function 7 Device-Specific Registers

These registers are normally programmed once at system initialization time.

V-Link Control

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

7-0 Specification Revision..... always reads 40

Offset 41 – NB V-Link Capability (39h).....RO

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

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

Offset 43 – NB Uplink Max Req Depth (80h).....RO

- 7-4 UpCmd Max Request Depth (0=1 UpCmd).. def = 8
Indicates the maximum allowable number of outstanding UPCMD requests
- 3-0 Reserved always reads 0

Offset 44 – NB Uplink Buffer Size (82h)RO

- 7-4 UpCmd P2C Write Buffer Size (max lines).. def = 8
- 3-0 UpCmd P2P Write Buffer Size (max lines).. def = 2

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
 - 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
 - 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

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

- 7 Downstream High Priority**
 - 0 Disable High Priority Down Commandsdef
 - 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 One 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 (ignore bit-1)
- 1 Read Around Write (ignored if bit-3 = 1)**
 - 0 Reads always pass writesdefault
 - 1 8RAW
- 0 Reserved** always reads 0

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

- 7-6 Reserved** always reads 0
- 5 C2P Read L1 Ready Return Timing**
 - 0 V-Link bus decodes C2P Read Ack cmddef
 - 1 Wait till previous P2C write cycles all flushed
- 4 Reserved** always reads 0
- 3 Down Strobe Dynamic Stop**
 - 0 Disabledefault
 - 1 Enable
- 2 Auto-Disconnect**
 - 0 Disabledefault
 - 1 Enable
- 1 V-Link Disconnect Cycle for STPGNT Cycle**
 - 0 Disabledefault
 - 1 Enable
- 0 V-Link Disconnect Cycle for HALT Cycle**
 - 0 Disabledefault
 - 1 Enable

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

- 7 V-Link Parity Check**
 - 0 Disable..... default
 - 1 Enable
- 6 Reserved** always reads 0
- 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 Reserved** always reads 0
- 1 V-Link Split Bus**
 - 0 Disable..... default
 - 1 Enable
- 0 8x Rate Supported**
 - 0 Not Supported..... default
 - 1 Supported

Transfers

V-Link Mode	Per 66MHz		Bus Usage	Rx48		
	Cycle	Bits		Bit-4	Bit-5	Bit-1
0	4x	8	Bidirectional	0	0	0
1	8x	4+4	Split	1	0	1
2	8x	8	Bidirectional	1	0	0
3	4x	16	Bidirectional	0	1	0
4	8x	8+8	Split	1	1	1

Offset 49 – SB V-Link Capability (19h)..... WC

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

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

Offset 4B – SB Uplink Command (80h)RW

- 7-4 UpCmd Max Request Depth (0=1 UpCmd).. def = 8
Indicates the maximum allowable number of outstanding UPCMD requests
- 3-0 Reserved always reads 0

Offset 4C – SB Uplink Command (82h)RW

- 7-4 UpCmd P2C Write Buffer Size (max lines).. def = 8
- 3-0 UpCmd P2P Write Buffer Size (max lines).. def = 2

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

- 7-4 **Timer for Normal Priority Requests from NB**
 - 0000 Immediate
 - 0001 1*4 VCLKs
 - 0010 2*4 VCLKs
 - 0011 3*4 VCLKs
 - 0100 4*4 VCLKsdefault
 - 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 NB**
 - 0000 Immediate
 - 0001 1*2 VCLKs
 - 0010 2*2 VCLKs
 - 0011 3*2 VCLKs
 - 0100 4*2 VCLKsdefault
 - 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

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

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
- 6-4 **Reserved** always reads 0
- 3 **Up Strobe Dynamic Stop**
 - 0 Disable..... default
 - 1 Enable
- 2-1 **Reserved** always reads 0
- 0 **Down Cycle Wait for Up Cycle Write Flush (Except Down Cycle Post Write)**
 - 0 Disable..... default
 - 1 Enable

Offset 57 – Bank 7 Ending (01h) RO

DRAM Bank 7 Ending Address High (HA[31:24]) sent to the South Bridge. (See also Function 3 Rx47).

Offset 61 – C-ROM Shadow (00h) RW

(same as Function 3 Rx80)

Offset 62 – D-ROM Shadow (00h) RW

(same as Function 3 Rx81)

Offset 63 – F-ROM Shadow / Mem Hole / SMI (00h) ... RW

(same as Function 3 Rx82)

Offset 64 – E-ROM Shadow (00h)..... RW

(same as Function 3 Rx83)

PCI Bus Control

These registers are normally programmed once at system initialization time.

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

- 7 CPU to PCI Post-Write**
 - 0 Disabledefault
 - 1 Enable
- 6 Reserved** always reads 0
- 5-4 PCI Master to DRAM Prefetch**
 - 00 Always prefetchdefault
 - x1 Never prefetch
 - 10 Prefetch only for Enhance command
- 3 Reserved** always reads 0
- 2 PCI Master Read Buffering**
 - 0 Disabledefault
 - 1 Enable
- 1 Delay Transaction**
 - 0 Disabledefault
 - 1 Enable
- 0 Reserved** always reads 0

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

- 7 Retry Status.....RWC**
 - 0 No retry occurreddefault
 - 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 CPUdefault
 - 01 Retry 16 times
 - 10 Retry 4 times
 - 11 Retry 64 times
- 3 PCI Burst**
 - 0 Disable
 - 1 Enabledefault
- 2 Reserved** always reads 0
- 1 Compatible Type#1 Configuration Cycles**
 - 0 Disable (fixed AD31).....default
 - 1 Enable
- 0 IDSEL Control**
 - 0 AD11, AD12default
 - 1 AD30, AD31

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.

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 CPU Latency**
- 3 Reserved** always reads 0
- 2-0 PCI Master Bus Time-Out**
(force into arbitration after a period of time)
 - 000 Disabledefault
 - 001 1x16 PCICLKs
 - 010 2x16 PCICLKs
 - 011 3x16 PCICLKs
 - 100 4x16 PCICLKs
 -
 - 111 7x16 PCICLKs

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

Graphics Aperture Control

Offset 85-84 – Graphics Aperture Size (0000h).....RW

- 15-12 **Reserved** always reads 0
 - 11-0 **Graphics Aperture Size [31:20]** default = 00h
 - 111100111111 4MB
 - 111100111110 8MB
 - 111100111100 16MB
 - 111100111000 32MB
 - 111100110000 64MB
 - 111100100000 128MB
 - 111100000000 256MB
 - 111000000000 512MB
 - 110000000000 1GB
 - 100000000000 2GB <= Max supported
 - 000000000000 4GB <= Do not program
- In AGP 2.0 mode, only 4MB - 256MB are supported

Offset 88 – GART Base (00h).....RW

- 7-2 **Reserved** always reads 0
- 1 **GART Window Access**
 - 0 Disable default
 - 1 Enable
- 0 **Reserved** always reads 0

V-Link CKG Control

Offset B0 – V-Link CKG Control 1 (00h) RW

- 7 **Rise Time Duty Cycle Control - V-Link #1 R-Port**
- 6 **Rise Time Duty Cycle Control - V-Link #0 R-Port**
- 5 **Fall Time Duty Cycle Control - V-Link #1 R-Port**
- 4 **Fall Time Duty Cycle Control - V-Link #0 R-Port**
- 3 **Rise Time Duty Cycle Control - V-Link #1 S-Port**
- 2 **Rise Time Duty Cycle Control - V-Link #0 S-Port**
- 1 **Fall Time Duty Cycle Control - V-Link #1 S-Port**
- 0 **Fall Time Duty Cycle Control - V-Link #0 S-Port**

Offset B1 – V-Link CKG Control 2 (00h) RW

- 7-4 **Reserved** always reads 0
- 3 **Rise Time Duty Cycle Control - V-Link #1 D-Port**
- 2 **Rise Time Duty Cycle Control - V-Link #0 D-Port**
- 1 **Fall Time Duty Cycle Control - V-Link #1 D-Port**
- 0 **Fall Time Duty Cycle Control - V-Link #0 D-Port**

V-Link Compensation / Drive Control

Offset B4 – V-Link NB Compensation Control (00h)....RW

- 7-5 V-Link Autocomp Output Value – High Drive .RO
- 4 Reserved always reads 0
- 3-1 V-Link Autocomp Output Value – Low Drive..RO
- 0 Compensation Select
 - 0 Auto Comp (use values in bits 7-5, 3-1) default
 - 1 Manual Comp (use values in RxB5, B6)

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

- 7-5 V-Link Strobe Pullup Manual Setting (High)
- 4 Reserved always reads 0
- 3-1 V-Link Strobe Pulldown Manual Setting (Low)
- 0 Reserved always reads 0

Offset B6 – V-Link NB Data Drive Control (00h).....RW

- 7-5 V-Link Data Pullup Manual Setting (High)
- 4 Reserved always reads 0
- 3-1 V-Link Data Pulldown Manual Setting (Low)
- 0 Reserved always reads 0

Offset B7 – V-Link NB Receive Strobe Delay (00h).....RW

- 7-2 Reserved always reads 0
- 1-0 NB V-Link Strobe Delay for Receiving
 - 00 150 psec earlydefault
 - 01 No delay
 - 10 150 psec late
 - 11 300 psec late

VT8237R South Bridge:

Offset B8 – V-Link SB Compensation Control (00h).... RW

- 7-5 V-Link Autocomp Output Value – High Drive .RO
- 4-1 Reservedalways reads 0
- 0 Compensation Select
 - 0 Auto Comp (use values in bits 7-5)..... default
 - 1 Manual Comp (use values in RxB9)

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

- 7-5 V-Link Strobe Pullup Manual Setting (High)
- 4 Reservedalways reads 0
- 3-1 V-Link Strobe Pulldown Manual Setting (Low)
- 0 Reservedalways reads 0

VT8233 South Bridge (VT8233, VT8233A):

Offset B8 – V-Link SB Compensation Control (00h).... RW

- 7-6 V-Link Autocomp Output Valuealways 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

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 Reservedalways reads 0
- 0 SB V-Link Slew Rate Control
 - 0 Disable..... default
 - 1 Enable

DRAM Above 4G Support

Offset E4 – Low Top Address Low (00h)..... RW

(same as Function 3 Rx84)

Offset E5 – Low Top Address High (FFh)..... RW

(same as Function 3 Rx85)

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

(same as Function 3 Rx86)

Device 1 Registers – PCI-to-PCI Bridge

Device 1 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 (B198h).....RO

15-0 ID Code (reads B198h to identify the North Bridge 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
- 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 interfacedefault
- 1 Memory Space..... RW
 - 0 Does not respond to memory space
 - 1 Enable memory space accessdefault
- 0 I/O Space RW
 - 0 Does not respond to I/O space
 - 1 Enable I/O space accessdefault

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

- 15 Detected Parity Erroralways 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 Abortalways reads 0
- 10-9 DEVSEL# Timing
 - 00 Fast
 - 01 Mediumalways reads 01
 - 10 Slow
 - 11 Reserved
- 8 Data Parity Error Detectedalways reads 0
- 7 Fast Back-to-Back Capablealways 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 Reservedalways reads 0

Device 1 Offset 8 - Revision ID (00h)..... RO

7-0 Chip Revision Code (00=First Silicon)

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 Identifieralways 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 E - Header Type (01h)..... RO

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

Device 1 Offset 13-10 – Graphics Aperture Base (0000 0008h).....RW

This register is interpreted per the following definition if RxFD[1]=1 (AGP 2.0 registers enabled).

31-22 Programmable Base Address Bits def=0
 These bits behave as if hardwired to 0 if the corresponding AGP 3.0 Graphics Aperture Size register bit (Device 0 Function 0 Offset 94h) is 0.

31	30	29	28	-	-	27	26	25	24	23	22	(Base)
11	10	9	8	7	6	5	4	3	2	1	0	(Size)
RW	RW	RW	RW	0	0	RW	RW	RW	RW	RW	RW	4M
RW	RW	RW	RW	0	0	RW	RW	RW	RW	RW	0	8M
RW	RW	RW	RW	0	0	RW	RW	RW	RW	0	0	16M
RW	RW	RW	RW	0	0	RW	RW	RW	0	0	0	32M
RW	RW	RW	RW	0	0	RW	RW	0	0	0	0	64M
RW	RW	RW	RW	0	0	RW	0	0	0	0	0	128M
RW	RW	RW	RW	0	0	0	0	0	0	0	0	256M
RW	RW	RW	0	0	0	0	0	0	0	0	0	512M
RW	RW	0	0	0	0	0	0	0	0	0	0	1G
RW	0	0	0	0	0	0	0	0	0	0	0	2G-max
0	0	0	0	0	0	0	0	0	0	0	0	4G

- 21-4 Reserved always reads 0
- 3 Prefetchable..... always reads 1
- 2-1 Type always reads 0
- 0 Memory Space..... always reads 0

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 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 Mem Base (FFF0h) RW

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

3-0 Reserved always reads 0

Device 1 Offset 34 - Capability Pointer (70h)..... RO

Contains an offset from the start of configuration space.

7-0 AGP Capability List Pointer always reads 70h

Device 1 Device-Specific Registers

AGP Bus Control

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

- 7 CPU-AGP Post Write**
 - 0 Disabledefault
 - 1 Enable
- 6 CPU-AGP One Wait State Burst Write**
 - 0 Disabledefault
 - 1 Enable
- 5-4 Read Prefetch Control**
 - 00 Always prefetchdefault
 - x1 Never prefetch
 - 10 Prefetch only for Enhance command
- 3 Reserved** always reads 0
- 2 MDA Present on AGP**
 - 0 Forward MDA accesses to AGPdefault
 - 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 Disabledefault
 - 1 Enable
- 0 AGP Delay Transaction**
 - 0 Disabledefault
 - 1 Enable

Table 10. VGA/MDA Memory/IO Redirection

3E[3]	40[2]	VGA	MDA	Axxxx,	B0000	3Cx,	
VGA	MDA	is	is	B8xxx	-B7FFF	3Dx	3Bx
Pres.	Pres.	on	on	Access	Access	I/O	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 Reserved** always reads 0

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

- 7 Reserved (Must Be Programmed to 1)** def = 0
 When this bit is set, the North Bridge will automatically resolve the problem of AGP master cycles being blocked by PCI Master Cycles.
- 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 Reserved** always reads 0
- 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 Snoop Write Enable 2T Rate, Support Host Side 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 GCLKsdefault
 -
 - F 128 GCLKs
- 3-0 AGP Master Time Slot**
 - 0 Disable (no timer)
 - 1 16 GCLKs
 - 2 32 GCLKsdefault
 -
 - F 128 GCLKs

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

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

Power Management

Device 1 Offset 70 – Capability ID (01h) RO

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

Device 1 Offset 71 – Next Pointer (00h)..... RO

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

Device 1 Offset 72 – Power Mgmt Capabilities 1 (02h).. RO

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

Device 1 Offset 73 – Power Mgmt Capabilities 2 (00h).. RO

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

Device 1 Offset 74 – 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 75 – Power Mgmt Status (00h)..... RO

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

Device 1 Offset 76 – P2P Br. Support Extensions (00h). RO

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

Device 1 Offset 77 – Power Management Data (00h) RO

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

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 voltage is CPU dependent. AGP is 1.5V (4x transfer mode) or 0.8V (8x transfer mode). V-Link is 1.5V. Memory is 2.5V. Graphics / Display is 3.3V.

DC Characteristics

T_C = 0-85°C, V_{RAIL} = V_{CC} ±5%, V_{CORE} = 1.5V ±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}

MECHANICAL SPECIFICATIONS

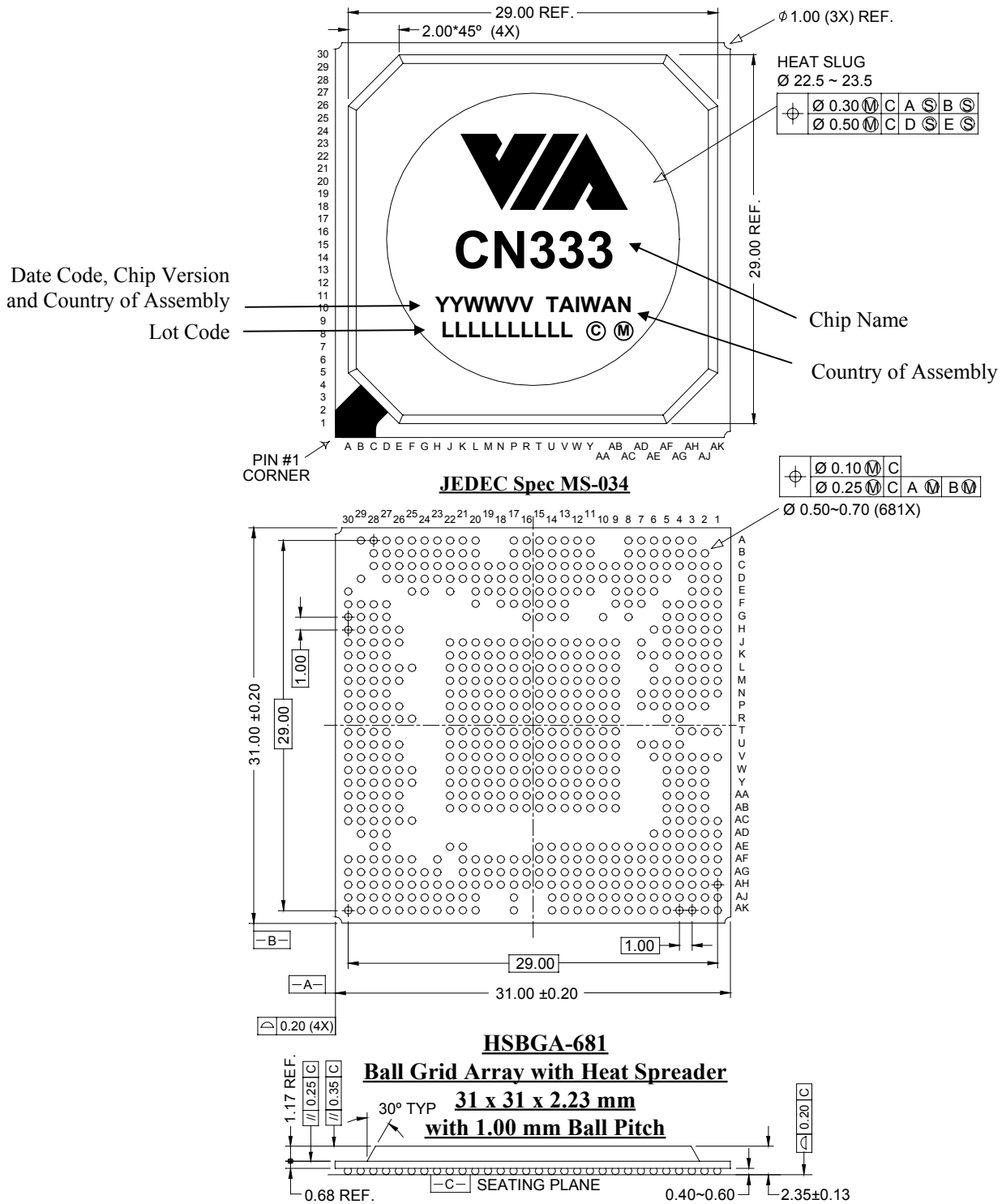


Figure 5. Mechanical Specifications – 681-Pin HSBGA Ball Grid Array Package with Heat Spreader

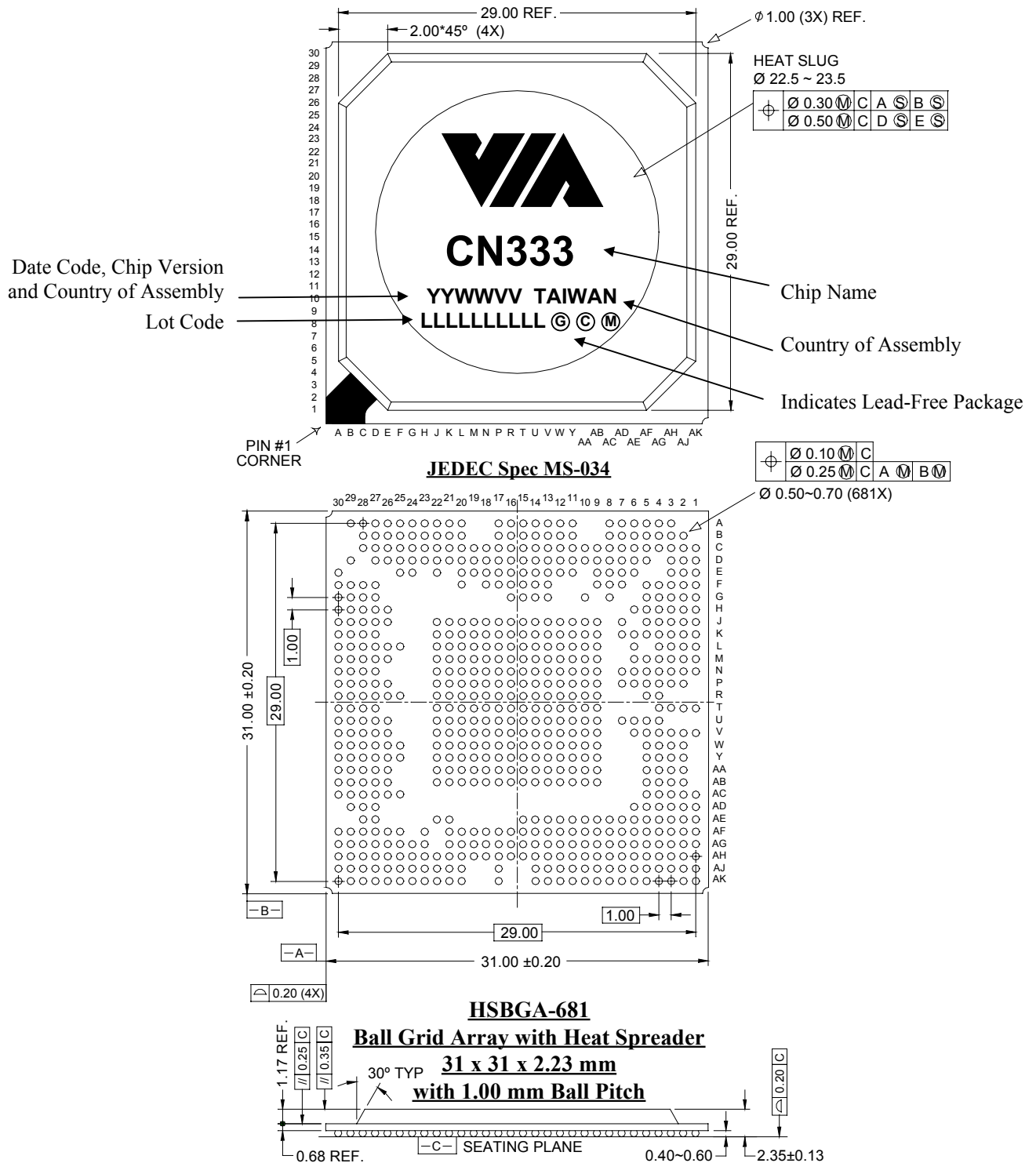


Figure 6. Lead-Free Mechanical Specifications – 681-Pin HSBGA Ball Grid Array Package with Heat Spreader