VIA VT8237 South Bridge

White Paper

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Introduction: Bringing Serial ATA and RAID to the Mainstream

The new VIA VT8237 South Bridge brings for the first time the latest high performance storage technologies to the Mainstream PC. Previously confined to the niche enthusiast and enterprise segments, Serial ATA and Serial RAID can now be enabled on a complete range of VIA core logic chipset platforms supporting the full spectrum of Intel® Pentium® 4, AMD Athlon™ XP, AMD Opteron™, and VIA C3™/Eden™ ESP processors.

Featuring the new VIA DriveStation™ Controller Suite, the VT8237 enables multiple drive connectivity options and native support for Serial ATA and Serial RAID, alongside more traditional South Bridge functions such as IDE and PCI. In addition, the VT8237 delivers exceptional surround sound capabilities through its support for VIA Vinyl and high-resolution VIA Vinyl Gold Audio, and also offers a host of high-bandwidth connectivity options, including support for up to eight high-speed USB 2.0 ports and high-throughput 10/100Mb/s Ethernet.

Based on VIA's unique V-MAP (VIA Modular Architecture Platform) architecture, the VT8237 features the new Ultra V-Link bus, which delivers data throughput speeds of up to 1066MB/sec from the South Bridge to the emerging new generation of high performance VIA North Bridge solutions. Through its support for the 8X V-Link interface, the VT8237 is also fully compatible with existing VIA North Bridge solutions such as the KT600 and PT800, giving OEMs and motherboard manufacturers unprecedented flexibility in integrating new levels of advanced I/O functionality into platform design.

The VT8237 South Bridge has been designed to meet the increasing demands of today's software programs while providing all the necessary headroom for the data-intensive applications of tomorrow. It consists of four key components, as shown in Figure 1 and listed below.

Figure 1: VIA VT8237 South Bridge Architecture

- **VIA DriveStation™ Controller Suite**
  - o Serial ATA
    - ▪ Built-in full-duplex high performance 150MB/s Dual Channel Serial ATA interface
    - ▪ Support for additional two full-duplex Serial ATA devices through a single SATALite™ PHY
  - o V-RAID
    - ▪ Serial RAID controller
    - ▪ RAID 0, RAID 1, RAID 0+1 and JBOD
    - ▪ User-friendly Windows-based V-RAID software interface
  - o Parallel ATA 133
    - ▪ Supports up to four PATA devices

- **VIA Advanced Connectivity Suite**
  - o USB 2.0 Controller
    - ▪ Support for 8 USB 2.0/1.1 ports
  - o Network Controller
    - ▪ Enterprise Class 10/100Mb/s Fast Ethernet MAC
  - o PCI & LPC bus controllers

- **VIA Vinyl™ Multichannel Audio Suite**
  - o VIA Vinyl Audio integrated 5.1 surround sound
    - ▪ AC '97 audio
    - ▪ VIA Six-TRAC codec
  - o VIA Vinyl Gold Audio onboard 7.1 surround sound
    - ▪ 24/96 resolution audio
    - ▪ VIA Envy24PT + VIA Six-TRAC Codec + additional DAC
  - o VIA Stylus Audio Driver
    - ▪ Integrated Sensaura technology
    - ▪ Full 3D gaming support

- **VIA V-MAP Architecture**
  - o Ultra V-Link
    - ▪ High throughput 1GB/s South Bridge/North Bridge interconnect supporting the new generation of high performance VIA North Bridge solutions across all processor platforms
  - o 8X V-Link
    - ▪ High speed 533MB/s South Bridge/North Bridge interconnect supporting current VIA North Bridge solutions across all processor platforms
  - o VIA Hyperion 4in1 Unified Drivers
    - ▪ Optimized system performance and stability

VIA DriveStation™ Controller Suite

The VIA DriveStation™ Controller Suite in the VIA VT8237 provides the most comprehensive set of high-performance integrated storage interface technologies available on the market today. It not only enables high-speed 150MB/s dual channel connections to new generation Serial ATA Hard Drives while retaining support for today's Parallel ATA-133 devices, but also combines exceptionally fast disk data transfer rates and optimal data integrity with easy installation and manageability through V-RAID, the first native RAID controller integrated into a South Bridge supporting multiple RAID configurations.

Serial ATA Explained

Serial ATA is in the process of succeeding Parallel ATA to become the standard drive interface for all desktop and notebook PCs, and is projected to represent over 90 percent of total desktop and mobile PC hard disk drive shipments by 2005. Serial ATA will also enable high-performance desktop-class drives to displace SCSI drives in entry-level server environments. Parallel ATA has been the storage interface in PCs for over 10 years, debuting at 3.3 MB/s and, culminating in 133MB/s with the ATA-133 standard, it has reached its performance limit. The key advantages of Serial ATA can be summarized as follows:

- **Higher Performance:** With transfer speeds debuting at 150MB/s full-duplex, compared with a maximum of 133MB/s half-duplex for Parallel ATA, Serial ATA delivers all the bandwidth necessary to deal with the increasingly demanding requirements of today's and tomorrow's digital media applications, as well as offering improved data integrity.

- **Easier Configuration:** Using the appropriate controller driver, Serial ATA devices can be instantly recognized by the operating system, and can even be plugged in 'on the fly' while the system is running. Any Serial ATA device will be detected as a 'Master' only, meaning that no fiddling about with Master/Slave configurations is required. To enable a smooth migration path from Parallel to Serial ATA, Serial ATA is backward compatible with software that was originally designed to work with Parallel ATA.

- **System Design Innovation**: As the industry moves towards smaller form factor designs, Serial ATA brings a number of benefits to system designers. The significantly reduced size of Serial ATA cable (see Figure 2) allows for easier installation and improved airflow within the system case, which is particularly important in a more compact chassis. Serial ATA also enables a reduced connector pin count, with only seven pins versus the forty pins required for an IDE interface. This smaller connector size means less consumption of valuable board layout space, which will be a welcome benefit to motherboard designers. Serial ATA also brings a reduction in controller chip power consumption compared to Parallel ATA, thus lowering the voltage interface-signaling requirement and enabling reduced die size. Furthermore, Serial ATA cables can be up to one meter in length, more

than double the length of Parallel ATA cables (see Figure 2), again allowing for greater flexibility in system design.

Figure 2: SATA vs PATA Cable Comparison

SATA cabling (left) vs. PATA cabling (right)

The migration towards Serial ATA as the standard drive interface for all desktop and notebook PCs is part of a general move within the PC industry and consumer electronics industries towards serial architectures for buses and interfaces. VIA has been at the forefront of developing high-performance solutions that support and enable these standards, as summarized in Table 1.

Table 1: High Performance Serial Technologies

Technology	Maximum Data Rate	Availability
USB 1.1	12Mb/s	Now
Fast Ethernet	10/100 Mb/s	Now
1394A	400Mb/s	Now
USB 2.0	480Mb/s	Now
Gigabit Ethernet	1Gb/s	Now
Serial ATA	1.5Gb/s	Now
PCI Express	2.5Gb/s	2004

VIA DriveStation™ Serial ATA Controller

With the integrated VIA DriveStation™ Dual Channel Serial ATA controller, the VT8237 South Bridge delivers a number of significant benefits to mainstream PC users:
- Superior Hard Disk Drive Performance
- Quick & Easy Set-Up
- Hot Plug Capabilities
- SATALite Interface

VIA DriveStation™ Serial ATA Controller Performance

By integrating the Serial ATA controller in the South Bridge, the VT8237 not only delivers superior data transfer rates of up to 150 MB/s per SATA device compared to a maximum of 133MB/s for Parallel ATA devices, but also eliminates the 132MB/s bottleneck on the PCI bus that has significantly inhibited the performance of discrete Serial ATA controllers.

As shown in Figure 3, the integrated VIA DriveStation™ Serial ATA Controller delivers an increase of over 25% in data transfer speeds compared to a discrete Promise PDC20376 Serial ATA controller using the popular HD Tach Burst Speed benchmark over a single Serial ATA drive. HD Tach Burst Speed measures the speed in which data from the HDD's cache is transferred to the system, and represents the theoretical peak of the system's data transfer.

Figure 3: Serial ATA Performance: HD Tach Burst Speed Benchmark
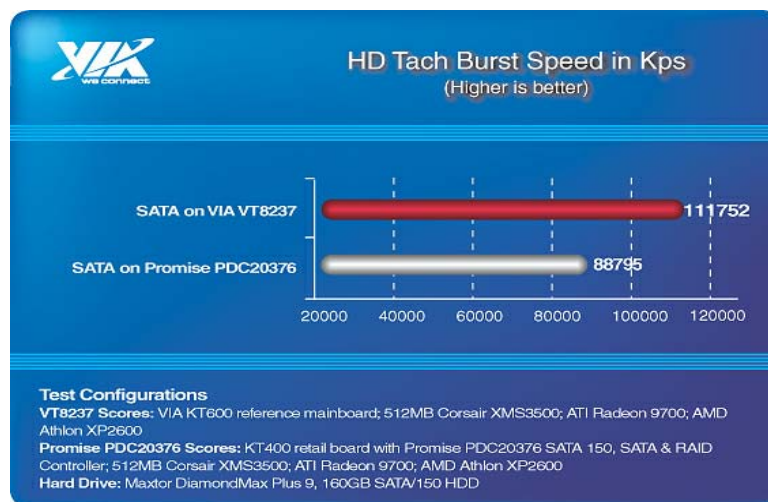
## Quick and Easy Set Up, & Hot Plug Capabilities

Setting up a Serial ATA Drive using the VIA DriveStation™ Serial ATA Controller is intuitive and straightforward. In addition, no configuration at all is necessary when installing an additional Serial ATA drive because there is no need for jumpers to determine master/slave settings. The VIA DriveStation™ Serial ATA Controller also supports hot-plug capabilities when the appropriate BIOS and OS support is enabled.

VIA DriveStation™ SATALite Interface

In its default configuration, the VIA DriveStation™ Serial ATA Controller supports up to two Serial ATA devices and four Parallel ATA 133 devices directly. Two extra Serial ATA ports can be supported through the implementation of the SATALite interface with a single external PHY on the secondary Parallel-ATA interface, replacing one Parallel ATA channel, as shown in Figure 4. Unlike IDE-to-SATA bridge solutions, that are limited by the 133MB/s and half-duplex speed of the IDE bus, the SATALite interface enables the two additional Serial ATA ports to be operated simultaneously at full-duplex at up to 150MB/s speed.

Figure 4: The SATALite Interface
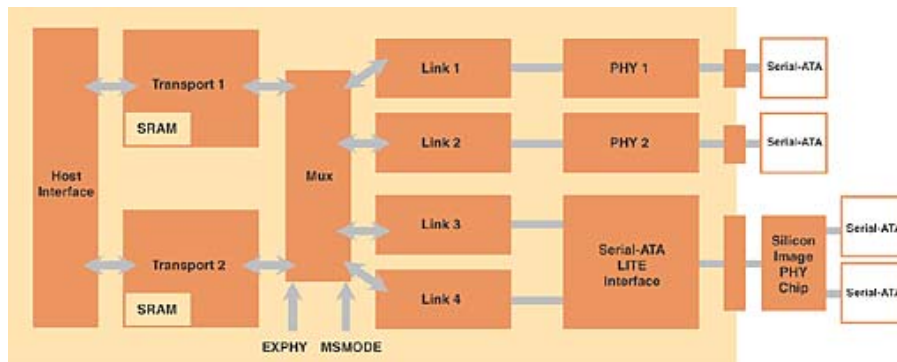
VIA DriveStation™ Parallel ATA-133 Controller

The VIA DriveStation™ Controller Suite also includes an enhanced IDE controller with a dual channel DMA engine and interlaced dual channel commands, allowing for full backwards compatibility with up to four Parallel ATA 133/100/66 devices delivering data transfer rates of up to 133 MB/s.

RAID Explained

RAID (Redundant Array of Independent Disks) is a technology that harnesses the power of multiple hard drives working together, and uses advanced data striping and mirroring techniques to improve data integrity and access speed. Disk arrays are groups of disk drives that work together to achieve higher data-transfer and I/O rates than those provided by single large drives. An array is a set of multiple disk drives plus a specialized controller (an array controller) that keeps track of how data is distributed across the drives. In Striping, data for a particular file is written in segments to the different drives in the array rather than being written to a single drive.

Arrays can also provide Mirroring so that no data is lost if a single drive (physical disk) in the array should fail. Different RAID 'levels' offer varying benefits to users, for example RAID Level 0 significantly increases hard drive read/write speeds, while RAID Level 1 provides rock solid data integrity, albeit with a performance trade off compared to RAID Level 0. The key benefits of each RAID Level are summarized below:

> **RAID Level 0** – A RAID 0 or 'striping' array organizes data in such a way that it is striped across the multiple drives, enabling the system to access data from multiple drives at the same time. The high-speed data access speeds are especially beneficial for retrieving very large files, such as digital video files, since they can be spread out effectively across multiple drives and accessed in more manageable fragments or 'stripes'. The downside to using RAID Level 0 configurations is that it sacrifices fault tolerance, as no room is made available to store redundant data.

> **RAID Level 1** - RAID Level 1 uses a process called disk mirroring to ensure data reliability, and can also enhance HDD read performance. In a RAID Level

1 configuration, data is copied or mirrored and stored on different disks within the array, meaning that should a drive fail the data will still be available somewhere else. The improved performance and fault tolerance of RAID Level 1 are at the expense of available capacity in the drives used. For example, if you have 2 x 60GB drives in a RAID 1 configuration, the array size will be 60GB.

RAID Level 0+1 - RAID 0+1 provides users with the best of both worlds: replicating the performance benefits of RAID level 0 with all the data integrity benefits of RAID level 1. A RAID 0+1 configuration would consist of two RAID 0 disks, and a further two disks to mirror between them, meaning a minimum of four disks is required.

JBOD - JBOD (Just a Bunch of Disks) combines multiple drives into one larger logical one, which is recognized by the operating system as a single drive. Although it doesn't deliver any of the performance or data integrity advantages of RAID levels 0 and 1, it can be useful for users dealing with extremely large file sizes such as animation and digital editing files.

VIA DriveStation™ V-RAID Controller

The advanced VIA DriveStation™ V-RAID Controller implemented in the VIA VT8237 South Bridge is the first full-featured native Serial RAID solution to be integrated into PC chipset architecture. It enables users to benefit from all the enhanced performance and rock solid data security benefits of a high-end RAID system, but without the complicated setup procedures that are normally found in server and workstation products and at a much more affordable price.

With digital media applications such as digital video creation and editing, and digital audio storage and playback becoming increasingly popular, the demands on hard disk drive throughput are growing at a dramatic rate. But although memory, processor, and Front Side Bus technologies have improved in recent years, significantly enhancing the performance of desktop systems, storage performance has not scaled at the same rate. V-RAID overcomes this bottleneck by delivering a significant boost in desktop storage performance.

V-RAID is the first native RAID controller to support a complete range of RAID Level 0, RAID Level 1, RAID Level 0+1[1], and JBOD configurations (shown in the table below), giving the user maximum flexibility in tuning their disk array to achieve the optimum balance of performance and data integrity depending on their requirements.

Table 2: RAID Configurations Supported by V-RAID

| RAID Level	Effect	Capacity	Performance	Fault Tolerance
0	Striping	100 %	High	Low
1	Mirroring	50 %	Medium/High	High
0+1[1]	Mirroring & Striping	50 %	High	High
JBOD	None	100 %	Normal	Low

Based on VIA's ground breaking DriveThru™ technology, V-RAID also enables 'on-the-fly' upgrades to RAID configurations, and an exceptionally user friendly software interface for V-RAID installation and management. Its key benefits are described in more detail below.

V-RAID Performance

V-RAID optimizes hard disk data transfer rates by utilizing the integrated VIA DriveStation™ Dual Channel Serial ATA Controller to deliver a maximum theoretical transfer rate of 300MB/s under a RAID Level 0 configuration. Since V-RAID is integrated into the VT8237 South Bridge, as opposed to implementing a discrete RAID controller on the PCI bus that has a shared 132MB/s peak bandwidth limitation, V-RAID is the only solution available that can deliver the full benefit of Serial ATA RAID without having to adopt expensive server/workstation platforms such as PCI-X or PCI Express.

The inherent performance advantages that the native V-RAID implementation offers over using a third party onboard RAID controller or PCI card RAID controller by comparing HD Tach Burst speeds, are clearly shown in Figure 5, where V-RAID performs over 50% faster than the Promise PDC20376 discrete controller. HD Tach Burst represents the theoretical peak of the system's data transfer speed.

Figure 5: V-RAID Performance: HD Tach Burst Speed Benchmark
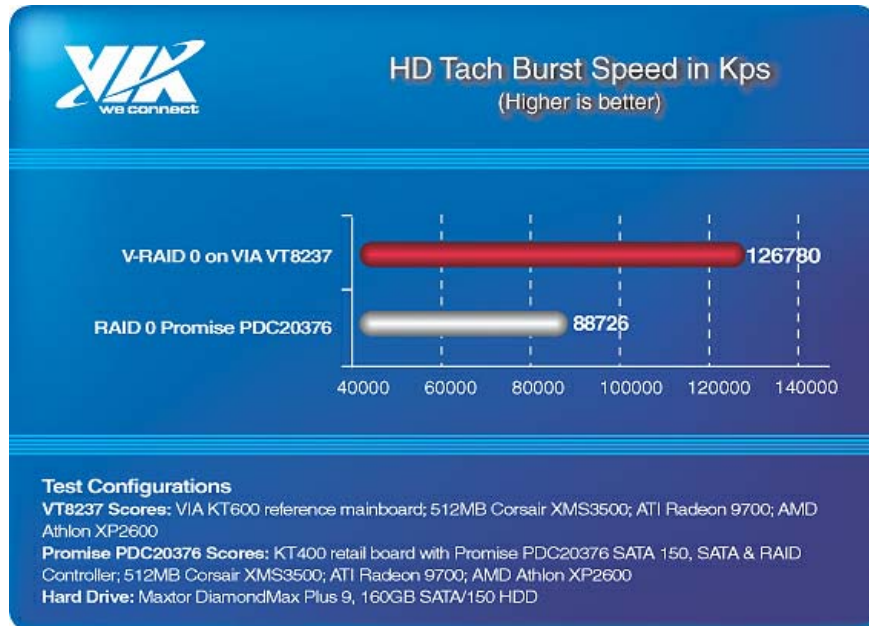
The performance benefits of V-RAID are further illustrated in Figure 6, which compares the performance of V-RAID with that of the discrete Promise PDC20376 RAID controller using SATA and PATA configurations across a complete range of standard hard disk performance benchmarks.

Figure 6: V-RAID Performance Comparison: Parallel ATA and Promise RAID
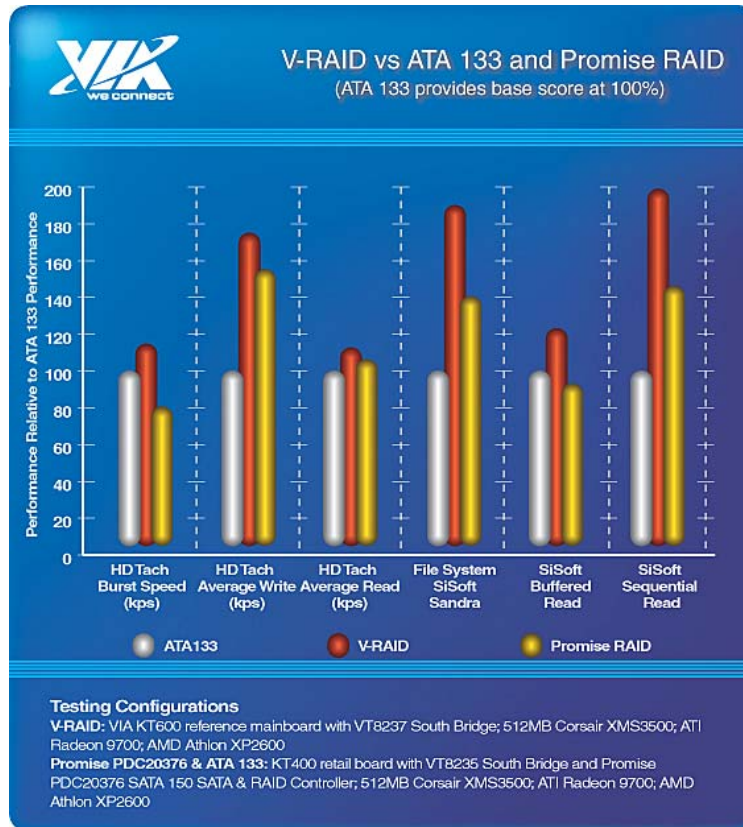
V-RAID Software Interface

With its unique user-friendly software interface, V-RAID makes it easier and faster than ever before to install and manage RAID configurations. Users who are not confident in using the RAID BIOS to configure RAID arrays can do so from within their Microsoft® Windows® or Linux operating system in a few easy steps, VIA's DriveThru technology also enables users to easily migrate from a standard Parallel ATA or Serial ATA drive configuration to a higher performance RAID configuration 'on-the-fly' – without having to endure lengthy installation procedures involving complicated BIOS set-ups and operating system re-installations. Figure 7 shows screenshots during the V-RAID set up.

Figure 7: Screenshots Using the V-RAID Software Interface
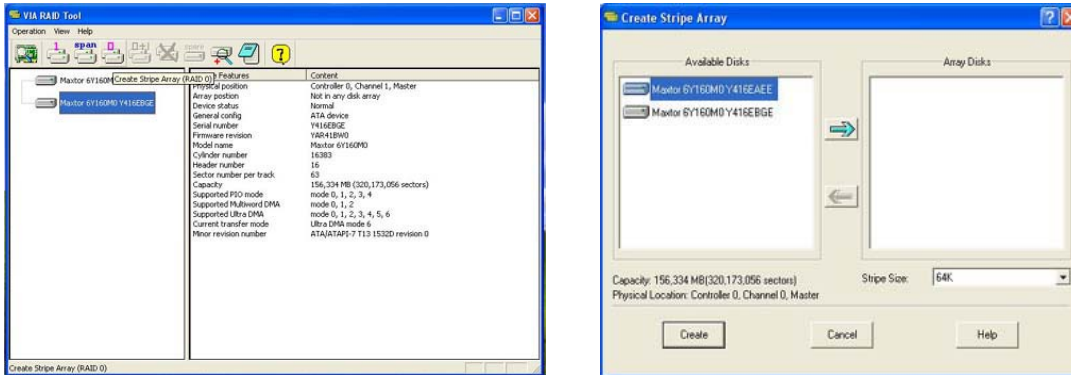
The leading-edge feature set offered by the V-RAID software interface is listed in Table 3 and compared with the limited feature set of the Promise utility.

Table 3: V-RAID vs Promise RAID Feature Comparison

Utility	V-RAID	Promise RAID
Availability	Packaged with driver	Download from the website
Create arrays	Yes	No
Delete arrays	Yes	No
Delete/Create spare HDD	Yes	No
Select boot array	Yes	No
Report RAID configuration status	Yes	Yes
Warning when HDD is broken	Pop-up dialog box and manual rebuild control	PC noise and auto rebuild

Section Notes

[1]*RAID Level 0+1 requires four Serial ATA drives; support for the two additional drives can only be implemented with two external Serial ATA ports enabled through a SATALite PHY. See Figure 4.*

VIA Advanced Connectivity Suite

The VIA Advanced Connectivity Suite in the VIA VT8237 offers a host of high-bandwidth network and peripheral connectivity options, including support for up to eight high-speed USB 2.0 ports and high-throughput 10/100Mb/s Fast Ethernet.

USB 2.0

The VT8237 enhances connectivity options with its support for eight high-speed USB2.0 ports, delivering forty times the bandwidth of USB 1.1. The VT8237 includes eight function ports featuring integrated physical layer transceivers. All eight ports support a full range of USB 2.0 and USB1.1 devices, and achieve data transfer rates of up to 480Mb/s. USB enables plug'n'play, and supports isochronous data transfers. Peripherals can be inserted into the system with driver support for many user classes such as external storage. The controller also implements legacy keyboard and mouse support so that legacy software can run transparently in a non-USB-aware OS environment.

Network Controller

The VT8237 features commercial strength networking capabilities courtesy of an integrated VIA IEEE 802.3 compliant 10/100Mb/s 32-bit PCI bus master Ethernet MAC with standard MII (Media Independent Interface) interface to an external PHYceiver. With driver support built into most operating systems, including Windows and Linux, ensuring instant connectivity, the reliable Fast Ethernet controller is ideal for both enterprise class and home networking applications.

PCI Interface & LPC Bus

Featuring a PCI 2.2 compliant PCI controller, the VT8237 offers support for up to six PCI masters. It also has built-in controllers a keyboard and PS2 mouse, and supports a full range of legacy devices through the LPC bus, including Super I/O, boot Rom and embedded microcontrollers.

VIA Vinyl™ Multichannel Audio Suite

The VT8237 South Bridge provides OEMs and motherboard makers with an unrivaled choice of market leading integrated and onboard audio performance options, delivering rich, warm surround sound at resolutions as high as 24/96 through up to six- or eight-channel outputs. VIA Vinyl Audio and VIA Vinyl Gold Audio enable users to enjoy music, watch the latest DVD movies, play games, record and create content, and connect to the latest devices with crisp, clear performance, representing the highest levels of audio quality in a mainstream integrated or onboard solution.

VIA Vinyl Audio

The VT8237 South Bridge integrates the high-performance VIA Vinyl AC'97 controller to enable six-channel audio support and the transfer of the highest resolution audio possible over the AC'97 standard.

For the best audio performance, the VT8237 should be combined with VIA Six-TRAC (VT1616) codec to enable premium quality AC'97 surround sound. Supporting six-channel outputs with 20-bit resolutions, the VIA Six-TRAC delivers full 5.1 surround sound to enable theatre-quality home audio and realistic 3D gaming sound effects on mainstream PC systems.

Figure 8: VIA Vinyl Audio Six-Channel Configuration
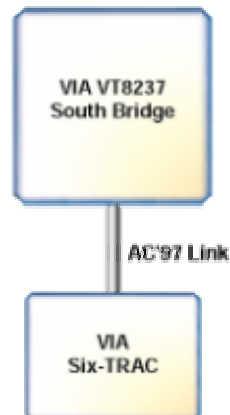
The VIA Six-TRAC also features mixer circuitry that integrates stereo enhancement to provide a pleasing 3D surround sound effect for stereo content. Further provisions in the hardware include the DualMAX™ feature that allows for downmixing of six-channel inputs such as DVDs into four-channel, or even two-channel outputs. The Six-TRAC also integrates a unique CoolAMP™ architectural design that allows motherboard makers to choose the best possible amplifier to maximize audio quality and gain control, maintaining optimal performance of the Six-TRAC even in extreme conditions.

The VIA Vinyl Six-TRAC is further enhanced through the Stylus Audio driver that integrates the latest Sensaura technology for premium gaming support enabling total audio immersion.

VIA Vinyl Gold Audio

To meet the growing demand for the highest fidelity multi-channel surround sound, the VT8237 South Bridge can also be coupled with the PCI-based VIA Envy24PT onboard audio controller.

Enabling 24-bit resolution and 96KHz sampling rates for digital connections, the VIA Envy24PT is the only PC audio solution that supports up to eight-channel outputs for improved flyover effects with the latest Dolby® Digital EX and DTS ES DVD-Video soundtracks.

To connect with other devices, the VIA Envy24PT comes equipped with an integrated S/PDIF transmitter and IEC958 line driver that allows the easy and accurate transfer of PCM, DTS, and AC3 audio data in pure digital formats to items like stereos and portable audio devices.

For high-resolution eight-channel surround sound, the VIA Envy24PT can be paired with the VIA Six-TRAC codec plus an additional DAC though an I^{2}S-link. Further provisions will enable the VIA Envy24PT to be connected to the forthcoming VIA Vinyl VT1617 codec for even higher levels of audio fidelity.

Figure 9: VIA Vinyl Gold Audio 8-Channel Configuration

VIA V-MAP Architecture

As an integral component of VIA's unique V-MAP (VIA Modular Architecture Platform) architecture, the VT8237 can be paired with a complete range of current and future VIA North Bridge designs across all the major Intel Pentium 4, AMD Athlon XP, AMD Opteron, and VIA C3/Eden ESP processors; Figure 10 gives illustrates the Intel Pentium 4 processor platform compatibility.

Figure 10: VIA VT8237 Supports Current and Future VIA North Bridges on the Intel Pentium 4 Processor Platform

Through this approach, OEMs and motherboard vendors can minimize development costs and speed up time to market by consolidating their product lines on a standard but scalable platform that enables them to meet the diverse needs of multiple market segments through the rapid integration of different feature sets. As an added benefit, V-MAP also allows a common VIA Hyperion driver base that optimizes system performance while maintaining full stability and compatibility and facilitates technical support.

Ultra V-Link Interconnect

The VT8237 features the new Ultra V-Link that delivers data throughput speeds of up to 1066MB/s from the South Bridge to the new generation of high performance VIA North Bridge solutions, such as the PT880. The Ultra V-Link bus delivers the necessary bandwidth and low latency required by today's increasingly demanding multimedia applications, and also provides headroom for I/O traffic generated from ever increasing CPU and memory bus speeds. Not only does Ultra V-Link speed up data transfer rates, it also addresses potential bottlenecks on the South Bridge that may be created by the growing use of high-speed USB2.0 and 1394 peripherals.

8X V-Link Interconnect

Through its support for the 8X V-Link interface, delivering data throughput speeds of up to 533MB/s, the VT8237 is also fully compatible with existing VIA North Bridge solutions such as the KT600, giving OEMs and motherboard manufacturers additional flexibility in integrating new levels of advanced I/O functionality into their current platform designs.

VIA Hyperion 4in1 Unified Driver Set

A pioneering unified driver set, the VIA Hyperion 4in1 drivers optimize system stability and performance for all systems running Microsoft Windows operating systems.

Appendix: VIA VT8237 Block Diagram