



# Intel<sup>®</sup> 915G/915GV/910GL Express Chipset Graphics and Memory Controller Hub (GMCH)

White Paper

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## Revision History

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Revision Number	Description	Revision Date
-001	Initial Release.	June 2004
-002	Updated to include Intel® 915GV Express chipset	August 2004
-003	Updated to include Intel® 910GL Express chipset	September 2004

# 1 Introduction

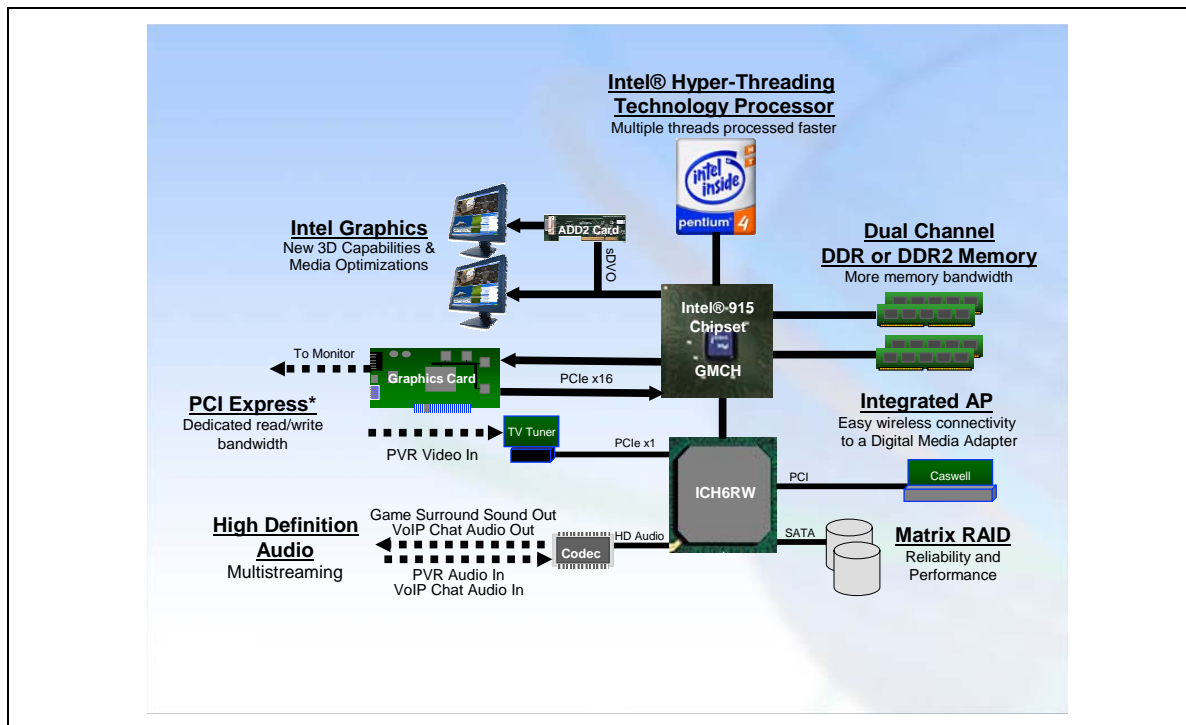
This document details the Intel® 915G/915GV/910GL Express chipset graphics and memory controller hub (GMCH) key benefits and operation. It is intended for a technical audience interested in learning about the 915G/915GV/910GL Express chipset architecture.

Please refer to the *Intel® I/O Controller Hub 6 / 6R / 6W (ICH6) / (ICH6R) / (ICH6W) White Paper* for complete details on the I/O hub controller.

The 915G/915GV/910GL Express chipset is Intel’s first PCI Express\* and DDR2 chipset with integrated Intel® Graphics Media Accelerator 900 for the Intel® Pentium® 4 processor in the LGA775 package. The 915G/915GV/910GL Express chipset GMCH , with its enhanced architecture graphics engine, delivers not only high 2D/3D graphics performance, but also provides an efficient high-bandwidth communication channel connecting the processor, system memory, I/O subsystem, and other components together to deliver a stable mainstream desktop platform solution. The 915G/915GV/910GL Express chipset GMCH also provides a PCI Express Graphics (PEG) Port interface for discrete PEG adapters, or conversion of the digital video output streams from the integrated graphics engine to VGA, NTSC signaling or digital flat panel modes.

Figure 1 illustrates how the 915G/915GV/910GL Express chipset GMCH connects the processor and various components to make up a complete 915G-based desktop platform.

**Figure 1. Intel® 915G/915GV/910GL Express Chipset Block Diagram**





The introduction of the 915G/915GV/910GL Express chipset GMCH brings high performance, flexibility and stability to Pentium 4 processor-based systems. The 915G/915GV/910GL Express chipset GMCH Pentium 4 processors in the LGA775 package provides system cost savings with its new integrated high-performance graphics engine. With the support of 533 MHz and 800 MHz processor system bus, single- or dual-channel DDR333/400 or DDR2 400/533 system memory, integrated graphics core or discrete PEG cards, the 915G/915GV/910GL Express chipset GMCH provides high system flexibility and scalability. In addition, the 915G/915GV/910GL Express chipset-based platforms use a single, innovative Intel® software stack, adding stability to the whole platform.

## 1.1 Processor Interface

The 915G/915GV/910GL Express chipset GMCH supports the host bus frequencies of 533 MHz and 800 MHz. By providing a bandwidth of up to 6.4 GB/s with 800 MHz-enabled processors, the 915G/915GV/910GL Express chipset GMCH delivers higher throughput when accessing memory and I/O devices to improve system performance. The 32-bit host addressing is supported, and up to 4 GB of the processor's memory address space is decoded. The 915G/915GV/910GL Express chipset GMCH implements its own cache line size of 64 bytes to match the cache line size of the processor. This allows an entire 64-byte cache line to be transferred in two bus clocks, enabling faster data transfers for today's demanding applications. It also supports Dynamic Bus Inversion (DBI), which limits the number of data signals that are driven low on the bus on each data phase. This performance significantly decreases the power consumption of the 915G/915GV/910GL Express chipset GMCH. In addition, the 915G/915GV/910GL Express chipset GMCH host bus implements AGTL+ on die termination to help reduce the system BOM cost.

## 1.2 System Memory Interface

The 915G/915GV/910GL Express chipset GMCH memory interface is designed to be flexible and can be configured through a set of registers to support either single- or dual-channels of DDR (Double Data Rate) or DDR2 memory (333 MHz or 400 MHz DDR, 400 MHz or 533 MHz DDR2) SDRAM memory. This allows up to 8.5 MB/s of memory bandwidth available, providing a balanced platform. DDR memory capability supports two data operations being completed within one clock cycle, resulting in faster data transfer and higher memory bandwidth. This translates into twice the throughput of regular SDRAM. The 915G/915GV/910GL Express chipset GMCH memory interface can support up to four double-sided DIMMS for a maximum of 4 GB of system memory. The memory technologies supported are 256-Mb, 512-Mb, and 1-Gb SDRAM technologies.

The 915G/915GV/910GL Express chipset GMCH is equipped with many advanced system memory interface features to create a balanced performance environment for the platform. Twelve pairs of DDR/DDR2 system memory clocks are integrated into the GMCH. This eliminates the need for external memory clocks to the DIMMs, and allows better control of system timings for higher system robustness. The memory controller supports the memory thermal management capability that increases the system reliability by decreasing thermal stress on the system memory and the 915G/915GV/910GL Express chipset GMCH. Suspend-to-RAM support allows for environmentally friendly and energy efficient systems by enabling lower power states when the system is idle.

With two 64-bit wide data channels, the memory controller supports up to 64 simultaneously open pages (four ranks of eight bank devices \* 2 channels) in dual-channel mode and up to 32 open pages in single-channel mode, reducing the access time to system memory. The GMCH also supports Data Masking by providing eight additional data masking signals from the GMCH to memory. Byte writes of less than a Qword are allowed to increase memory bandwidth.

New to the 915G/915GV/910GL Express chipset GMCH is support of interleaved mode. This mode provides maximum performance on real applications. Addresses are ping-ponged between the channels, and the switch happens after each cache line (64-byte boundary). If two consecutive cache lines are requested, both may be retrieved simultaneously, since they are guaranteed to be on opposite channels. To achieve interleaved mode, both channels of memory must be populated with equal memory capacity, but the technology and device width may vary from one channel to the other.

## 1.3 Direct Media Interface

The 915G/915GV/910GL Express chipset GMCH utilizes the Direct Media Interface (DMI) as the chip-to-chip connection between the GMCH and the I/O controller hub 6 (Intel® ICH6). This high-speed interface integrates advanced priority-based servicing allowing for concurrent traffic and true isochronous transfer capabilities. Base functionality is completely software transparent permitting current and legacy software to operate normally.

## 1.4 Intel® Graphics Media Accelerator 900 Architecture

Intel® Graphics Media Accelerator (GMA) 900 graphics delivers new levels of performance to end-users who demand more realistic digital experience in today's complex graphics environment.

Graphics require dedicated memory and processing, and applications have divergent memory needs. Some applications, such as e-mail and Internet browsing, require very little graphics memory. Others, such as games, require more. Intel GMA 900 graphics supports both of these demand levels through a unique intelligent memory manager called Dynamic Video Memory Technology (DVMT). DVMT handles these diverse applications by providing the maximum availability of system memory for general computer usage, while supplying additional graphics memory when a 3D-intensive application requests it. The Intel GMA 900 graphics architecture also takes advantage of the high-performance Intel processor installed in your system. Many compute-intensive graphics operations can be handled by the system processor, providing an optimal blend of performance and cost.

The Intel Graphics Media Accelerator 900 core supports the latest 2D and 3D APIs, delivering real-life environment and character effects. A 256-bit internal path enables up to four textures per pixel on a single pass for super light maps, atmospheric effects, and more realistic surface details. Intel Graphics Media Accelerator 900 provides hardware acceleration for Microsoft DirectX® 9 features such as Pixel Shader 2.0, Volumetric Textures, Shadow Maps, Two-Sided Stencil, and Slope Scale Depth Bias to deliver intense, realistic 3D graphics with sharp images, fast rendering, smooth motion, and incredible detail.

Intel Graphics Media Accelerator 900 also features support for the latest LCD and wide-screen displays to enhance the personal computing experience, offering significant benefits for applications requiring 32 bpp and higher display resolution. Intel GMA 900 graphics is Intel's

first Desktop platform to support Dual Independent Display technology. This capability allows two separate displays to be connected to the system at the same time. One way to use this capability is to create a larger desktop work surface spanning multiple displays. Applications can be moved from one monitor to another, or can be displayed on more than one monitor simultaneously. In addition to supporting CRTs via a VGA connector with a maximum pixel clock of 400 MHz (up to 2048x1536 resolution @ 85Hz refresh rate) and easy graphics upgradeability via a PCI Express x16 Graphics (PEG) connector, the 915G/915GV/910GL Express chipset GMCH also allows for an easy upgrade to digital displays and TVs with Advanced Digital Display 2 (ADD2) cards. The ADD2 cards utilize the Intel GMA 900 architecture to enable the support for TVs, LVDS and TMDS displays (Flat Panels, Digital CRTs, etc.).

## 1.5 PCI Express\* x16 Graphics Interface

The 915G/915GV/910GL Express chipset GMCH PCI Express x16 Graphics (PEG) interface is designed to provide flexibility as well as performance. For users that demand the latest graphics cards, upgrade through the PEG interface is simple. The GMCH contains one 16-lane (x16) PEG port intended for an external PEG card. The PEG port is fully compliant to the *PCI Express Base Specification* revision 1.0a, operates at a frequency of 2.5 Gb/s on each lane while employing 8b/10b encoding, and supports a maximum theoretical bandwidth of 40 Gb/s each direction. This allows the 915G/915GV/910GL Express chipset GMCH to be paired with today's highest performance standalone graphics solutions.

The interface also provides flexibility when using the Intel Graphics Media Accelerator 900 architecture. The PEG interface can be run in Intel® SDVO mode, an innovative solution where the 915G can be paired with Advanced Digital Display 2 (ADD2) cards providing a variety of solutions.

### 1.5.1 Advanced Digital Display 2 (ADD2) Cards

The 915G/915GV/910GL Express chipset GMCH is the first chipset to support ADD2 cards. ADD2 cards are designed to plug into a PCI Express x16 Graphics (PEG) connector but will be utilized by the 915G/915GV/910GL Express chipset GMCH as a digital display upgrade. The cards make use of the multiplexed SDVO ports from the Intel Graphics Media Accelerator 900 architecture to provide an easy upgrade path for display.

Through the use of ADD2 cards, 915G chipset systems can offer an easy and low-cost solution when Time Multiplexed Differential Signaling (TMDS), Low Voltage Differential Signaling (LVDS), or TV-Out displays are desired. The extra functionality associated with ADD2 cards requires no additional circuitry or design constraints on the motherboard. By using ADD2 cards, the 915G chipset offers system designers the following flexibility:

- No burden to the motherboard with additional circuitry or costs to support a variety of display options
- Does not require feature set tradeoffs on the motherboard or back panel in order to support a variety of display options
- Can utilize a single motherboard design to support a variety of display options. For example, by using ADD2 cards, a single motherboard can support: CRT only, DVI flat panel, CRT and Flat panel simultaneous, S-Video TV Out, etc.

For a listing of ADD2 Card vendors, please contact your local Intel representative. §



## 2 Summary

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The 915G chipset enables ultimate flexibility with different system bus speeds, memory configurations, and graphics solutions. The 915G chipset supports 800 MHz and 533 MHz system bus for LGA775 processors, either 333MHz/400MHz DDR memory or 400MHz/533MHz DDR2 memory in single- or dual-channel mode, Intel Graphics Media Accelerator 900 graphics or discrete PCI Express x16 Graphics cards. Intel 915G chipset-based platforms also offer integrated Hi-Speed USB 2.0, High Definition Audio for improved sound quality and new audio usage models and enhanced RAID support. The 915G chipset ensures that tomorrow's applications will run best on Pentium 4 processor platforms.

The 915G chipset enables lower system price points with graphics and hi-speed USB 2.0 integration. The 915G chipset delivers a complete range of support for the Pentium 4 processor with integration of the enhanced Intel Graphics Media Accelerator 900 core. This chipset is a great choice for users who want superb graphics quality for the latest digital entertainment without the complexity and cost of an add-in graphics card. It is also an ideal solution for business users who demand highly stable drivers and value the Intel® Stable Image Technology quality.