Axiomtek Haswell/ Haswell Refresh Products

White Paper

4th Generation Intel® Core™ processors for high performance embedded systems

Haswell – The 4th Generation Intel® Core™ Processor Platform

Haswell is the codename for the processor microarchitecture which has replaced both the Sandy Bridge and Ivy Bridge microarchitectures. The Intel® Haswell family features a new CPU core, new graphics and substantial changes to the platform in terms of memory, power delivery and power management. The Haswell microarchitecture also provides improved performance and power consumption, taking advantage of Intel's 22nm process technology, while simultaneously introducing new integrated graphics named Iris. The improvements in Haswell are concentrated in the out-of-order scheduling, execution units and especially the memory hierarchy. 4th Generation Intel® Core ^{TM} processor family based on Haswell microarchitecture will bring faster, thinner, lighter, cooler, and more secure systems with built-in graphics into the mainstream.

Benefits

I.   Power Efficiency

Haswell processors are much less power hungry than the Ivy Bridge processors. The Haswell-based processors can switch power modes 25 percent faster than the Ivy Bridge. With Haswell, Intel® has dropped the energy usage of the chip to 10 watts, down from 17 watts used by Ivy Bridge. With lower energy consumption, Haswell can provide systems with the benefit of a longer battery life. Reports say that Haswell-powered devices can carry less obtrusive fans along with the thinner form factors compared to current computers. The chart below shows that the power consumption of Haswell is more efficient than Ivy Bridge as well as previous generations.

Power Consumption
CPU+GPU Load = Civ V Unit Bench
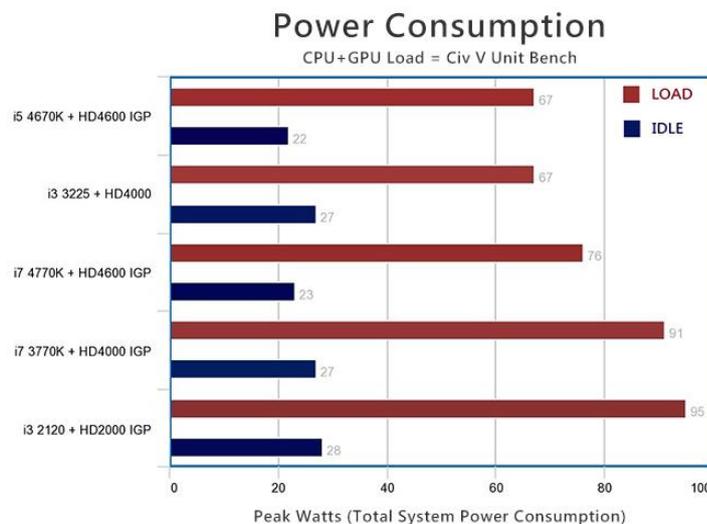
II. Integrated Graphics

The top two levels of integrated graphics in Intel's Haswell microarchitecture are codenamed Iris. Iris Graphics are able to provide up to 2 or 3 times the performance of the Intel® HD Graphics 4K that comes with current Ivy Bridge processors.

This is one of the most impressive performance improvements in the Haswell architecture. Iris Graphics will be used only on the top two highest levels of graphics in the upcoming 4th generation Intel® Core^{TM} processors. Iris will exist alongside the Intel® HD Graphics name and will correspond only to some of the GT3 implementations of Haswell.

Graphics Level	PC Clients	Server / Workstation
GT3e*	Intel® Iris™ Pro graphics 5200	--
GT3* (28W)	Intel® Iris™ graphics 5100	--
GT3e* (15W)	Intel® HD graphics 5000	--
GT2*	Intel® HD graphics 4600/4400/4200	Intel® HD graphics 5200 P4700 /P4600
GT1*	Intel® HD graphics	--

The 15 watt variant of Haswell with the GT3 architecture will be called Intel® HD Graphics 5000 while the 4600 /4400 / 4200 will remain as the names for various GT2 implementations.
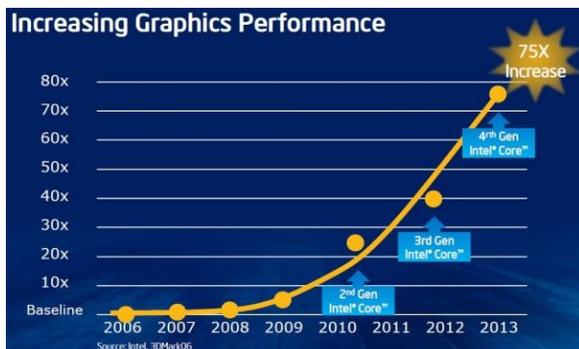
According to the left chart, the graphics capability of Haswell will be as much as 75x better than the chipset-based graphics from 2006. The real question is what variants of Haswell will have that performance level.

III. Haswell Memory Hierarchy

The memory hierarchy for Haswell is the biggest departure from the previous generation. The cache bandwidth doubled in tandem with an increase in FLOP/s from the new FMA units. Moreover, the whole memory system has been enhanced to support gather instructions and transactional memory. Memory accesses start by allocating entries in the load and store buffers, which can track more than 100 uops, statically split between two threads.

The chart below captures the cache bandwidth gap between Ivy Bridge and Haswell. If you compare across all three generations, you'll see that Sandy Bridge's internal bandwidth was also higher than the 1st Generation Core™ i7's in a number of places. Haswell builds on Sandy Bridge and also adds bandwidth in more areas. L2 cache bandwidth (shown above) also doubles, up to 64 bytes per cycle, from 32.

Metric	Nehalem	Sandy Bridge	Haswell
L1 Instruction cache	32K, 4-way	32K, 8-way	32K, 8-way
L2 Data Cache	32K, 8-way	32K, 8-way	32K, 8-way
Fastest Load-to –use	4 cycles	4 cycles	4 cycles
Load bandwidth	16 Bytes/cycle	32 Bytes/cycle (banked)	64 Bytes/cycle
Store bandwidth	16 Bytes/cycle	16 Bytes/cycle	32 Bytes/cycle
L2 Unified Cache	256K, 8-way	256K, 8-way	256K, 8-way
Fastest load-to-use	10 cycles	11 cycles	11 cycles
Bandwidth to L1	32 Bytes/cycle	32 Bytes/cycle	64 Bytes/cycle
L1 Instruction TLB	4K:128, 4-way 2M/4M: 7/thread	4K:128, 4-way 2M/4M: 8/thread	4K:128, 4-way 2M/4M: 8/thread
L1 Data TLB	4K:64, 4-way 2M/4M:32, 4-way 1G:fractured	4K:128, 4-way 2M/4M:32, 4-way 1G:4, 4-way	4K:128, 4-way 2M/4M:32, 4-way 1G:4, 4-way
L2 Unified TLB	4K:512, 4-way	4K:512, 4-way	4K+2M shared: 1024, 8-way

Core Cache Size/ Latency/ Bandwidth

Haswell, Intel's 4th Generation core microprocessor family, offers lower power consumption and much better graphical performance. More significantly, the cache hierarchy can sustain twice the bandwidth, and it has fewer utilization bottlenecks.

4th Generation Intel® Core™ Desktop Solutions

IMB210

The IMB210 is an ATX industrial motherboard based on the Intel® Xeon® E3-v3, Core™ i7/i5/i3, Pentium® and Celeron® series in a LGA1150 socket with the Intel® C226 chipset. The optimized IMB210 is specially designed for workstations through better computing and visual performance and can be used in every major industry for tasks ranging from financial modeling to designing complex buildings and vehicles.

With its built-in Intel® HD Integrated Graphics P4600, supporting triple-display capability and DX11, this industrial-grade motherboard delivers great 3D visual performance through DisplayPort, HDMI and DVI-I ports demanded by professional-grade CAD and media/entertainment fields. Additionally, the IMB210 supports Intel® Turbo Boost 2.0 technology, Intel® Hyper-Threading technology, Intel® HD Integrated Graphics with DX11 support, up to 32 GB ECC DDR3 1333/1600 memory, and one PCI Express 3.0 x16 slot. It also features Intel® Active Management Technology 9.0 (iAMT 9.0), Infineon Trusted Platform Module 1.2 (TPM), SATA RAID 0/1/5/10, as well as PCIe x4 expansion, making it ideal for applications with added security features.

Other I/O features include: 10 USB ports (four USB 3.0 and six USB 2.0), six COM ports (five RS-232 and one RS-232/422/485), dual Gigabit LANs ports, DisplayPort, HDMI, DVI-I, HD audio, eight channels Digital I/O (4-IN and 4-OUT), and PS/2 keyboard and mouse ports. With all these features, the standard ATX form factor motherboard offers faster time to market, exceptional flexibility and an affordable total cost-of-ownership. The IMB210 also provides reliable operation and non-stop capability with watchdog timer and SMBus, as well as SMART FAN function controlling the fan speed to keep temperature within a specified range.

IMB211

The IMB211 is an industrial-grade ATX motherboard with a full-range of integrated peripherals for general industrial and embedded applications. The IMB211 is based on the 4th Generation Intel® Core™ i7/i5/i3, Pentium® and Celeron® processors in an LGA1150 socket with the Intel® Q87 Express chipset. Four 204-pin DDR3-1333/1600 slots provide a maximum memory capacity of up to 32 GB for increased storage. This industrial-grade high performance motherboard also supports Intel® AMT 9.0, SATA RAID, and triple-display capability through DisplayPort, HDMI and DVI-I ports. The board helps users to deploy more responsive, high-performance systems for advanced communication, gaming, industrial and automation applications.

To meet a wide range of industrial and embedded application needs, the IMB211 supports five SATA-600 3.0 ports with transfer rate up to 6Gb/s and RAID 0/1/10/5 to ensure reliable data storage and protection. Additionally, the motherboard offers one PCIe x16 slot, one PCIe x4 slot, one PCIe x1 slot, four PCI slots and one mSATA connector, typically required in applications such as digital video recording, industrial automation, intelligent transit system where a large number of peripheral cards are installed. Moreover, it supports six COM ports (four RS-232 ports and two RS-232/422/485 ports), two PS/2 ports, ten USB 2.0 ports, four USB 3.0 ports, dual Gigabit Ethernet and 8 channels Digital I/O (4-IN and 4-OUT). All of these features are packed into an ATX motherboard form factor, giving the IMB211 exceptional flexibility and an affordable total cost-of-ownership. The platform also provides reliable operation and non-stop capability with watchdog timer which monitors the system for you.

MANO881

The MANO881 is a new Mini ITX motherboard with Intel® H81 Express chipset. The product supports the LGA1150 4th generation Intel® Core™ i7/i5/i3, Pentium® and Celeron® (Haswell/Haswell Refresh) processors. This feature-rich board has two sockets for DDR3 system memory of up to 16 GB. The high-performance Mini ITX motherboard MANO881 supports one PCIe x16 slot and integrated with Intel® HD 5000 graphics for powerful graphic processing and dual-display capability through HDMI, VGA and LVDS ports. The outstanding embedded board also includes rich I/O expansions which can help system integrators to develop solutions quickly at a more competitive price. The MANO881 is excellent for in-vehicle PCs, medical imaging, gaming devices, in-flight entertainment systems, industrial automation systems, and other portable devices.

Axiomtek's MANO881 comes with advanced connectivity including three RS-232-232/422/485 ports, three RS-232 ports, two USB 3.0 ports, eight USB 2.0 ports, two SATA-600, two SATA-300, two Gigabit LANs, HDMI, LVDS, VGA, digital I/O (8 channel programmable), and HD audio. Expansion capabilities include one PCIe x16 slot and mSATA socket. The motherboard supports watchdog timer and SMART FAN. The MANO881 also meets all requirements for the Windows® 7 and 8 OS.

MANO882

The MANO882 is a new powerful Mini ITX motherboard that supports the Intel® Xeon E3-v3, 4th generation Intel® Core™ i7/i5/i3 processors, Pentium® and Celeron® processors with the Intel® C226 chipset. Two SO-DIMM sockets onboard support up to 16 GB of DDR3-1333/1600 system memory. The outstanding motherboard offers HDMI, DisplayPort, VGA and LVDS with triple-display capability, making this board an ideal solution for digital signage, optical inspection for machinery, industrial automation, and control fields. The MANO882 supports Intel® AMT 9.0 security technology to provide complete protection against viruses and attacks. Additionally, the MANO882 is equipped with an Infineon TPM 1.2 security chipset to enhance user data protection.

The industrial-grade MANO882 provides rich I/O connections including six COM ports (two RS-232/422/485 and four RS-232), four SATA-600 with RAID 0/1/5/10 function, dual Gigabit LAN ports, six USB 2.0 ports, four USB 3.0 ports, and eight channels digital I/O (4-IN and 4-OUT). Additionally, the MANO882 supports hardware monitoring and watchdog timer. It also offers long term support and reliable quality.

About Axiomtek Co., Ltd.

Axiomtek Co. Ltd. is one of the world's leading designers/manufacturers of PC-based industrial computer products. From our roots as a turnkey systems integrator specializing in data acquisition and control systems, Axiomtek has mirrored the PC evolution in various industries by shifting our focus toward the design and manufacture of PC-based industrial automation solutions.

Axiomtek Co., Ltd. established in 1990, has more than 60 distributor partners globally. Axiomtek offers Industrial PCs (IPC), Single Board Computers and System on Modules (slot CPU card, small form factor embedded boards and SoM), Fanless and Rugged Embedded System (eBOX, tBOX and rBOX), Industrial Firewall Platform, Industrial Gateway Solution, Touch Panel Computers (TPC), Medical PCs (MPC), Human Machine Interface (HMI), Digital Signage and Players (DS), Industrial Network and Network Appliances (NA).

As an associate member of the Intel® Internet of Things Solutions Alliance, Axiomtek continuously develops and delivers cutting edge solutions based on the latest Intel® platforms.