
White Paper

# Intel® Sandy Bridge Brings Many Benefits to the PC/104 Form Factor

## Introduction

ADL Embedded Solutions newly introduced PCIe/104 ADLQM67 platform is the first ever PC/104 form factor board to bring 2nd generation Intel® Core i7 performance to the embedded community. The 2nd generation Core i7 has had great success in the consumer market in everything from high-performance video-gaming and computing desktop machines, to mobile applications such as tablets and netbooks.

The advent of the ADL Embedded Solutions ADLQM67 i7 now brings many of these same benefits that have made Sandy Bridge popular in consumer markets to the embedded space. Intel® has made available a variety of embedded Sandy Bridge CPUs which now benefit from Intel's® long-life support for embedded processors.

## Architectural Improvements

Primary among the architectural improvements included in the 2nd generation Intel® Core i5 and i7 processors are the followings:

- 256 bit wide, Ring-bus Architecture
- Advanced Vector Extensions (AVX)
- Intel® High Definition Graphics 3000
- 16x PCIe lanes at 5GT/s

The new ring-bus architecture makes possible a modular layout approach that allows Intel® to expand and contract the number of CPU cores available on die. The ring-bus is 256 bits wide running at 2.2GHz or 2.5Ghz for the i7 and i5 processors respectively. 256 bits is double the 128 bit width of previous Core i5/i7 processors.

In addition, Intel® has created a new set of single instruction multiple data (SIMD) Advanced Vector Extensions (AVX) which greatly improve the handling of floating point math operations for processing of complex data such as DSP or image processing. These types of general processing tasks have traditionally required external FPGA or graphics cards to implement.

Put together, the 256 bits data bus can now handle up to 8x32bit floating-point operations or 4x64bit double-precision floating-point operations. This enhancement, when combined with the added floating-point computing power of AVX makes for a powerful computing platform. In particular, repetitive data calculations such as are common in DSP or image processing can benefit tremendously from the SIMD AVX set.

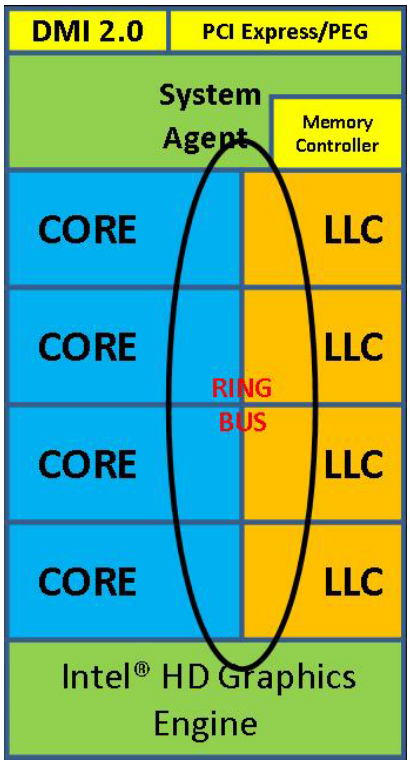


**Figure 1: Sandy Bridge Resource Layout**

Intel® has also integrated a new Intel® HD Graphics 3000 engine into the 2nd generation Core i5/i7 processors. The HD Graphics 3000 core includes 12 execution units (EU) and supports HD video encode/decode, DirectX video acceleration (DXVA), and support for DirectX 10.1 and OpenGL 3.0 in addition to Dynamic Video Memory Technology

(DVMT) 5.0 which offers up to 1720MB dynamic graphics memory. For most applications, the INTEL® HD Graphics 3000 is more than sufficient to handle all video graphics and general purpose processing needs without the need for external hardware.

For situations requiring external graphics processing support or dedicated DSP or FPGA peripherals, the 2nd generation Core i5 and i7 also support the x16 PEG bus which is now configurable as x16, 2x8, or 1x8 with 2x4 lanes. The PCIe lane bandwidth has been increased to 5GT/s from 2.5GT/s thus doubling the available throughput. The PCIe bus allows for interface to dedicated DSP or FPGA computing peripherals should they be necessary.

For PCI/104-Express applications, the Intel® Cantiga GS45 Chipset platform with Penryn CPUs from ADL Embedded Solutions and others has been the computing workhorse over the past 12 to 18 months. Using the SiSoftware Sandra benchmarking utility, the GS45 Core™2 Duo SP9300 processor has been benchmarked at Dhrystones = 18.5 GIPS (Giga Instructions per second) and Whetstones = 15.4 GFLOPS (Giga floating point operations per second). By comparison, the 2nd generation 2655LE Core i7 processor used on the ADLQM67, measures Dhrystones of 32.8 GIPS and Whetstones = 27.8 GFLOPS. This is a remarkable increase of 80% in raw performance.

## Applications

**Command and Control**

When coupled with the I/O capabilities of the Intel® 6 Series QM67 Platform Controller Hub (PCH) chipset, the ADLQM67 becomes a powerful command and control platform. Data of disparate types from different locations can be brought into the ADLQM67, processed, and efficiently outputted to the platform being controlled. The I/O capabilities for the ADLQM67 include two Gigabit Ethernet ports which support boot and jumbo framing, two SATA 3.0 ports operating at up to 6Gb/s, eight USB 2.0 ports, and the PCIe bus which can connect to any number of data and video acquisition peripherals such as Mil-Std-1553 communication cards, and video framegrabbers, etc.

Figure 2: Command and Control Center

**Imaging and Data Signal Processing**

As noted previously, repetitive vector and scalar data calculations such as are those commonly performed on embedded DSP and image data sets, can benefit tremendously from the computing power of the new Core i5/i7 architecture. Using the new AVX set, embedded designers can significantly improve computing performance and in some cases replace external dedicated DSPs or FPGAs to reduce the number of peripherals.

Reducing the number of peripherals and components has the added benefit of reducing the stack size and power requirements of the overall solution. If the platform happens to be an unmanned aerial vehicle (UAV) or other mobile application, the reduction in size, weight and power requirements can translate directly into longer mission range and time, or enhanced capabilities. An example of mobile applications

that can benefit include intelligence, surveillance, and reconnaissance (ISR) which proliferate military land, air, and sea operations.

**Industrial Networking and Control**

In industrial environments, the variety of I/O interface options and abundant processing power of the 2nd generation Core i5 and i7 processors really shine. Industrial control relies on communicating via a variety of communication protocols to interface and control both legacy and future systems. Networking applications typically need two or more Gigabit Ethernet interfaces and the processing power to direct network traffic as necessary. Both of these applications can benefit from the capabilities of the Core i5 and i7 and the variety of communication and networking extensions available via PCIe bus peripherals such as 4-port Gigabit LAN for added Ethernet ports, CAN Bus, Mil-Std 1553, and others.

**Signage and Casino Gaming with Sandy Bridge**

The INTEL® HD Graphics 3000 Engine with dual independent video pipes and a variety of video port options including LVDS, VGA, HDMI, and DisplayPort make it a perfect vehicle for many signage and Casino gaming applications without the need for external graphics cards. For demanding video signage and gaming applications, the Core i5 and i7 provide ample bandwidth for most applications. For fixed graphics applications or low bandwidth video applications, the capabilities of the Sandy Bridge Celeron 827E processor may be more than sufficient to meet customer needs.

**RTOS with Sandy Bridge Celeron**

The Sandy Bridge Celeron 827E is a single core, single-thread processor which features most of the Core i5 and i7 benefits. It does not support AES, AVX, or Intel® Virtualization technology and its Intel® HD graphics engine has a clock rate of 350MHz as compared to the 650MHz clock rate of the INTEL® HD Graphics 3000 engine. However, the Intel® 6 series chipset (QM67 PCH) offered on the ADLQM67 coupled with the single core, single thread architecture of the 827E Celeron makes it an ideal choice for many industrial RTOS applications that do not need all of the computing power of the multi-core i5 and i7. It's relatively low price point with respect to the Core i5 and i7 make it an excellent choice for many cost conscience, RTOS implementations.

## Ruggedization and Integration

For environmentally demanding industrial and military applications, the value of the 2nd generation Core i7 is greatly enhanced by the availability of extended temperature and ruggedization value-added services from ADL Embedded Solutions. Extended temperature options are available in the range of -40°C to +85°C. In addition, conformal coating, bonding, and underfill are also available for the ADLQM67 i7 board to meet rugged environmental requirements.

Lastly, the PCIe/104 ADLQM67 is also supported with the availability of thermal solutions and system enclosures to meet custom requirements related to fit and function, ruggedizing, or extended temperature specifications.

Figure 3: ADLQM67 2655LE Core i7 PCIe/104

## Conclusion

The PC/104 form factor has traditionally had great success in rugged, high performance applications. The introduction of the PCIe/104 ADLQM67 Sandy Bridge continues and enhances this tradition, ensuring that the PC/104 form factor will continue to be a valuable tool for embedded designers for the foreseeable future.

## Contact Information

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