

» Whitepaper «



The 2nd Generation AMD Embedded G-Series SoC
Extended performance for extended temperatures delivering extended benefits

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With the trend towards the IoT, more and more intelligent systems are appearing in our surroundings. They are everywhere - even where roughest environments require extended temperature ranges. But is poor performance due to low power requirements acceptable? No way! So, that's why engineers are searching for the ultimate low power technology that delivers high processing and graphics performance for extended temperatures and harshest environments and thus extends the user experience within their low power IoT applications.

The 2nd generation AMD Embedded G-Series SoC platform is specifically designed to meet these demands. It features a scalable low power processor and adds to this real time capable engine an impressive discrete-class graphics performance on a single die, which is designed to run continuously even within extended temperature ranges from -40° C to 105 °C.

Kontron leveraged this new SoC to design an application-ready building block that is based on the most versatile COM Express® compact form factor standard and that is a perfect fit for a wide range of IoT markets that are sprouting up everywhere. Target applications include outdoor applications such as ticketing and digital signage systems, in-vehicle computers in trains, buses and airplanes, and indoor intelligent devices such as gaming systems or HMIs in industrial, medical or retail.

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The demand for extended graphics

With the IoT trend as well as the increased integration and miniaturization of electronics, intelligent devices are entering all aspects and areas of our daily lives and surrounding us nearly everywhere. And these devices are using more and more graphics-based user interfaces. A well designed graphical user interface thereby has a massive impact on the usability. A study carried out by the University of Utah has verified this. It showed that efficiency gains of up to 50 percent can be achieved simply by either increased screen sizes or dual screen installations. Consequently, there is a growing demand to improve visual experience with fluent, vivid and immersive graphics technologies which ultimately translates into more efficiency, productivity and security in an application.

The demand to support extended temperatures

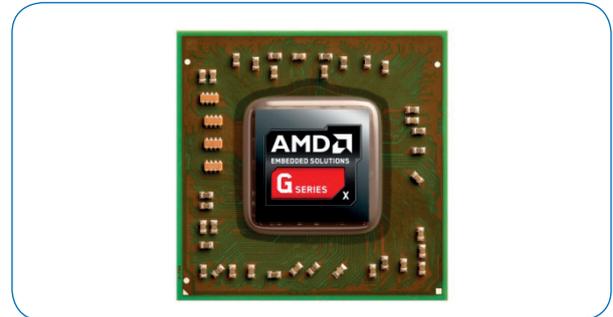
With the IoT and surround computing trend, devices are also being exposed to more and more demanding environments like outdoor and in-vehicle. This is where extreme ambient temperatures are the most critical factors for the devices, as every processor transforms the electrical power into heat; and sunshine can dramatically increase ambient temperatures in any vehicle. The processor technology therefore has to feature both, support for the extended temperature ranges as well as a low TDP to reduce heat dissipation to a minimum. An additional benefit of a low TDP is the fact that fail-safe and maintenance-free fanless cooling is easier to achieve and that heat sinks become smaller, as the processor can work in a larger thermal envelope. Thus, extended temperature support 'by design' also contributes to extended benefits such as reduced design efforts, material and cost. Consequently, target applications for such technologies can not only be found in a broad range of extended temperature markets such as outdoor or in-vehicle but also in standard indoor environments where system costs are critical for the success of a business.

It is superfluous to say that it is not easy to design low power devices for extended performance and extended temperatures. The 2nd generation of the AMD Embedded G-Series SoC platform sets a new milestone and benchmark for long-term available and easy migratable embedded x86 designs. It is thus a perfect fit for many applications such as outdoor ticketing and digital signage systems, in-vehicle computers in trains, buses and airplanes, and indoor intelligent devices such as gaming systems or HMIs in industrial, medical or retail.

The right platform - the 2nd generation AMD G-Series SoC

The AMD Embedded G-Series System-on-Chip is a uniform and freely scalable embedded computing platform that supports industrial temperature ranges and, in several specific variants,

even temperature ranges of up to -40 °C to +105 °C. These new SoCs integrate a dual or quad-core x86 CPU with ECC memory support, a discrete-class GPU and I/O controller on the same die. Thanks to AMD's unique positioning in the embedded segment as a vendor for CPUs and GPUs as well as heterogeneous architectures for most efficient overall processing performance, the new SoCs benefits from AMD's expertise within the entire x86 eco system. With the new G-Series SoC this leads to extremely energy-efficient designs with superior graphics and overall processing capabilities in the low power segment starting at a mere 5 watt TDP.



The new Jaguar architecture

To achieve significant improvements over its predecessor, the new AMD G-Series SoCs are based on AMD's next-generation 'Jaguar' CPU core with 28 nm technology offering a more power-efficient core design. AMD combines two x86 cores to one compute unit. A new feature is the unified 2nd level cache (L2) of up to 2 MB for quad-core configurations and 1 MB in dual-core variants. This unified cache as well as the high-performance core-to-core communication within a compute unit provide significant performance gains compared to the first AMD Embedded G-Series Accelerated Processing Units (APUs): AMD G-Series SoCs deliver a CPU performance improvement of up to 113% compared to AMD G-Series APUs, and a CPU improvement of 125% versus Intel® Atom™ processors when running multiple industry-standard compute-intensive benchmarks.

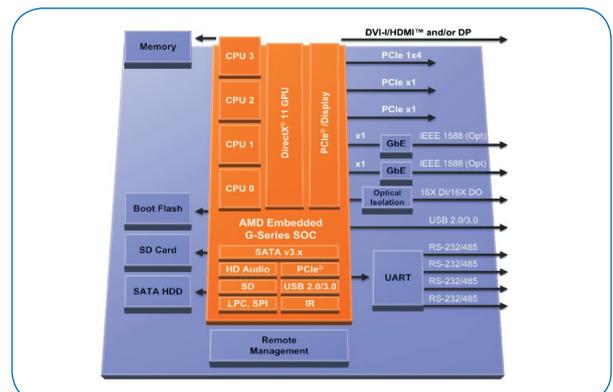


Figure 2: The AMD Embedded G-Series System on Chip integrates a dual- or quad-core x86 CPU with ECC memory support, an integrated discrete-class GPU, and I/O controller on a single die and is capable of executing its tasks even in extended temperature ranges from -40 to +105 °C.

Additionally, the Out-of-Order (OoO) execution is very efficient which contributes to even more processing performance. As with the first Embedded G-Series processors, in the 2nd generation OoO also enables re-arrangement of instruction execution on demand. This enables the processor to first execute instructions where the data is already available, which helps increase the single thread performance per core.

The discrete-class AMD Radeon GPU

The integrated GPU is based on the AMD Radeon 8000 graphics core next (GCN) architecture. It provides discrete-class GPU performance. Designers do not need to integrate a dedicated GPU for superior graphics performance, simplifying the system design dramatically. Compared to the previous AMD Embedded G-Series processors, the graphics core offers frequency increase and instructions per cycle (IPC) improvements. It supports latest 2D and 3D graphics APIs including DirectX® 11.1 and OpenGL 4.2. The graphics core can drive two independent displays with resolutions of up to 4096 x 2160 (4k) via HDMI 1.4a. And this is quite beneficial for dual screen installations as engineers can save one entire system. Further native-supported display interfaces include DisplayPort 1.2, DVI as well as VGA and eDP or 18bpp single channel LVDS. The integrated Universal Video Decode (UVD) hardware acceleration offloads the CPU when playing H.264, VC-1, and MPEG 2 encoded HD videos. Additionally the UVD engine now also includes new video encode capabilities.

Furthermore, the AMD Embedded G-Series allows the graphics performance to be scaled independently of the CPU performance with the support of for AMD Eyefinity technology. By adding an Eyefinity compatible graphics unit, designers can combine the graphics power of both GPUs and design very energy-efficient multi-display solutions supporting up to six independent displays. A broad range of applications for this scenario can be found in indoor as well as outdoor digital signage markets. These are the exact features are exponential price breaking and consequently ice breaking arguments that developers can add to the core benefits when deploying AMD technology.

Utilizing the GPU for computing tasks

The improved GPU performance of the embedded G-Series SoC is not only beneficial in terms of increased resolutions and graphics performance. It can also be leveraged for parallel computational computing. The integrated GPU supports Direct Compute, which is part of DirectX® 11.1, and OpenCL™ 1.2 , enabling high-speed parallel processing and high-performance graphics processing that provides up to 20% improvement over AMD G-Series APUs and 5x improvement versus Intel® Atom . The integration of the Heterogeneous System Architecture (HSA) in the 2nd generation AMD Embedded G-Series SoC enables applications to distribute workloads to run on the best compute element: Scalar workloads can be executed

on the CPU, whereas highly parallel workloads, for instance imaging computations, are automatically handed over to the GPU which is far better suited for vectorized data. Example applications are to be found in power-constrained industrial and medical imaging applications, for example as a handheld, battery-powered ultrasound scanner. With HSA, developers can use one single code basis to be executed independently from the underlying processor architecture. This helps to extend application lifetime, minimize software development costs and maximize ROI. And it is exactly this new approach on how to leverage x86 technologies which makes AMD platforms much more interesting than comparable competitive approaches, as on hardware level they add new features that are more intelligent. And this is quite important for the entire range of low power IoT devices so that the performance per watt can be further improved by leveraging the appropriate technologies.

Advanced power management

Contributing to the excellent performance per watt ratio of the new AMD Embedded G-Series SoC is not only the improved architecture and seconding technologies like HSA, but also the improved power management. In the new SoC platform, power management with enhanced clock gating and C6 'deep power down' capabilities lowers not only overall power consumption. Moreover it is used to freely adjust the available power budget between the dedicated computing cores to increase the performance in single thread applications. This results in a 96 percent increased performance-per-watt efficiency of the platform compared to the previous platform . Another benefit for developers is the configurable TDP. Designers can use this feature to adopt the SoCs' power consumption to the predefined power envelope of the individual application. So one can see that x86 technologies are constantly improving their IoT and surround computing capabilities requiring low power designs.

Comprehensive super-fast I/Os

Another essential part of any System-on-Chip design is, of course, the integrated I/Os. And here the 2nd generation AMD Embedded G-Series SoC platform provides a comprehensive interface collection specifically tailored to the performance and power demands of SFF embedded designs. For connection of high-speed expansions, the new SoC designs offer fast and energy-efficient 4x PCIe Gen 2.0 lanes, for connection of additional discrete GPUs or other high speed peripherals. Four x1 PCIe lanes enable the connection of general purpose I/Os, such as Gbit Ethernet. Storage media such as hard drives, SSDs and Blu-ray players can be connected via two SATA 3.x ports (6 Gb/s). Further generic extensions include two super-fast USB 3.0 and 8x USB 2.0 ports as well as 1x SD card or SDIO controller. 1x SPI connects extensions such as GPS receivers, wireless modems, barcode readers, RFID readers, touch screens and interfaces to Wi-Fi, Bluetooth, Ethernet, and IrDA. For digital signage and other multimedia-oriented

application fields such as POS/POI, the new SoC provides sound via HD Audio. All this is carried out in a BGA-based SoC design that is capable of performing even in harshest environmental conditions, including environments with shock and vibration as well as humidity and even extreme temperatures. So at the end of the day there is not much more required to build an entire system. And this high integration helps engineers to further improve their designs in terms of power efficiency and rich feature set on even smaller footprints.

Security for the Internet of Things

With more and more connected IoT devices, today no processor architecture is complete, if it also doesn't integrate security features for secure software operation and M2M or IoT communication. For this task the AMD Embedded G-Series SoCs integrates a dedicated Platform Security Processor. The PSP is built upon the TrustZone® architecture and designed to protect against malicious access to sensitive data and operations at the hardware level based on open standards and interoperable APIs. It supports the CPU by cryptographic acceleration and also features a software definable Trusted Platform Module (TPM) for all end-to-end and client-to-cloud communication. Furthermore, for remote management of the embedded devices, the Open Source Digital and Mobile Architecture for System Hardware (DASH) technologies can be used. Finally nearly all commercial or freely available Open Source x86 software supports these new processors, which makes it an easy task to find the appropriate setup in terms of security and communication building blocks required for all the different connected IoT connected devices surrounding us.

Kontron's COM Express® compact building blocks

By implementing the 2nd generation AMD Embedded G-Series SoC platform, Kontron is extending its processor range to accommodate rugged, low-power embedded application design for extended graphics capabilities and extended temperature ranges in harsh environments. Customers now have an even broader range of different embedded processor technology at hand from which they can individually pick their perfectly suited platform. And those looking for extended user experience will definitely go for the high performing new AMD G-Series SoCs to which x86 engineers can easily migrate without encountering any major barriers. This is true for both the entire software eco system within the x86 development environments as well as for COM Express® as the leading form factor for highly integrated, low power designs. These designs differ dramatically from one application to the other, thus a building block range with good support offers the best value for embedded engineers. The COM Express® form factor offers such best practice building blocks for low power up to high performance designs and is consequently ideally suited for both the AMD G-Series and AMD R-Series platforms. Kontron has

therefore chosen the COM Express® compact form factor with pin-out type 6 because, here, it offers the best value in terms of scalability within this range. COM Express® compact features a small form factor footprint of only 95 x 95 mm, which enables the design of extremely compact designs. With the pin-out type 6, all the AMD G-Series SoC platform interfaces are executed in parallel including multiple video outputs, PCI Express, USB 3.0, HD Audio making this module a perfect fit for a wide range of IoT appliances that are surrounding us everywhere.



Figure 3: The Kontron COMe-cSE6i is offered in x different SKUs. With its low overall power consumption it enables cost-efficient, fanless system designs with high graphics capabilities in the low power range.

To accelerate application development with the new AMD G-Series SoC, the module supports the unified Kontron Embedded Application Programming Interface (KEAPI) as well as Kontron's reference carrierboard in the Mini-ITX form factor. This board can even be used off-the-shelf paired with the broad ecosystem of Mini-ITX accessories to improve time-to-market and development cost of innovative applications. With SIM card support and Smart Battery Support, OEMs can use the reference carrierboard to simply develop a broad range of IoT connected mobile devices found in industrial automation, medical, and digital signage as well as POS/POI.

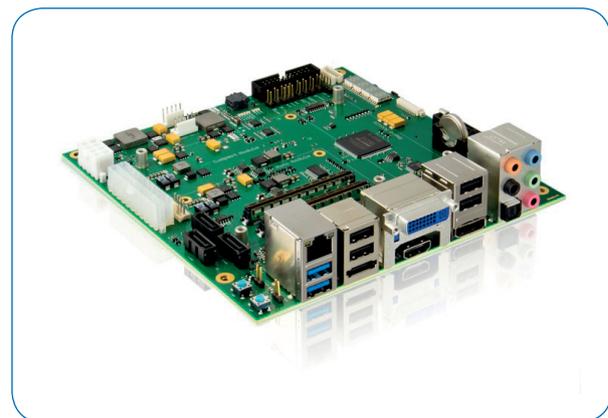


Figure 4: OEMs can leverage the reference carrierboard in the Mini-ITX form factor to accelerate application development or use it off-the-shelf to improve time-to-market and development cost.

Customized designs and IP on demand

On demand, customers can also leverage Kontron's broad offering of integration services for their individual applications. These services include custom-designed hardware as well as hardware-related software services including cellular communication implementations for all the manifold upcoming IoT/M2M appliances. This extends the availability of the new SoC technology towards customized boards and system designs. By using Kontron's extended migration services including validation and verification, customers can also minimize their development efforts and achieve time-to-market much faster. Efforts can even be more minimized when application engineers choose Kontron's original design and manufacturing services

(ODM) to obtain their dedicated system as an application-ready platform. Kontron's ODM services range from the development of embedded computing intelligence, go on to include system assembly and culminate in whole supply chain management – even covering Just in Time (JIT) delivery to the customer's customer and including lifecycle support for each component involved. Customers are thus in a position to fully concentrate on their core competences of application development and improvements with IoT-based services. ODM services release them from the unnecessary ballast of hardware implementations or procurement and logistics management for serial productions of their embedded computing platforms.

¹ www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCMQFjAA&url=http%3A%2F%2Fnews.advanced-inc.com%2Fwp-content%2F1nec_productivity_study_0208.pdf&ei=T4oqVJq7KcfJOZDPgMAI&usg=AFQjCNHzSqUm-S_tPzzU PwYVwHdGfdIs9Q&bvm=bv.76477589,d.ZWU or at: <http://www.pcworld.com/article/143341/article.html>

² AMD GX-415GA scored 209, AMD G-T56N scored 98, and Intel® Atom™ D525 scored 93, based on an average of Sandra Engineering 2011 Dhystone, Sandra Engineering 2011 Whetstone and EEMBC CoreMark Multi-thread benchmark results. AMD G-T56N system configuration used iBase MI958 motherboard with 4GB DDR3 and integrated graphics. AMD GX-415GA system configuration used AMD "Larne" Reference Design Board with 4GB DDR3 and integrated graphics. Intel® Atom™ D525 system configuration used MSI MS-A923 motherboard with platform integrated 1GB DDR3 and integrated graphics. All systems running Windows® 7 Ultimate for Sandra Engineering and Ubuntu version 11.10 for EEMBC CoreMark. EMB-37

³ OpenCL 1.2 currently supported in the following operating systems: Microsoft Windows 7; Microsoft Windows Embedded Standard 7; Microsoft Windows 8; Microsoft Windows Embedded Standard 8; Linux (AMD Catalyst™ drivers). OpenGL 4.2 currently supported in the following operating systems: Microsoft Windows 7; Microsoft Windows Embedded Standard 7; Microsoft Windows 8; Microsoft Windows Embedded Standard 8; Linux (AMD Catalyst drivers). Ongoing support options TBA.

⁴ Based on performance evaluation of AMD G-Series SOC model GX-415GA vs. AMD G-Series APU model G-T56N; and vs. Intel® Atom™ model D525 and D2700 while running Sandra Engineering 2011 Dhystone benchmark. EMB-38

⁵ Overall performance was measured using a suite of industry benchmarks consisting of 3DMark06, 3DMark11, POVRay v3.7, Passmark v7, PCMark8 v2.0, and BasemarkCL 1.0. The GX-412HC's TDP is 7W and GX-210HA's TDP is 9W. The performance delta of 53% was calculated based on GX-412HC's geometric mean of 555.3 and GX-210HA's geometric mean of 363.6. The performance-per-watt delta of 96% was calculated based on GX-412HC's performance-per-watt ratio of 79.3 and GX-210HA's performance-per-watt ratio of 40.4. The AMD Stepe Eagle GX-412HC and G-S SOC GX-210HA used an AMD Larne motherboard with 4GB DDR3-1333 memory and 320GB Toshiba HDD. The system ran Windows® 7 Ultimate. EMB-104

About Kontron

Kontron is a global leader in embedded computing technology. With more than 40% of its employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators.

Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchanges under the symbol "KBC". For more information, please visit: www.kontron.com

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