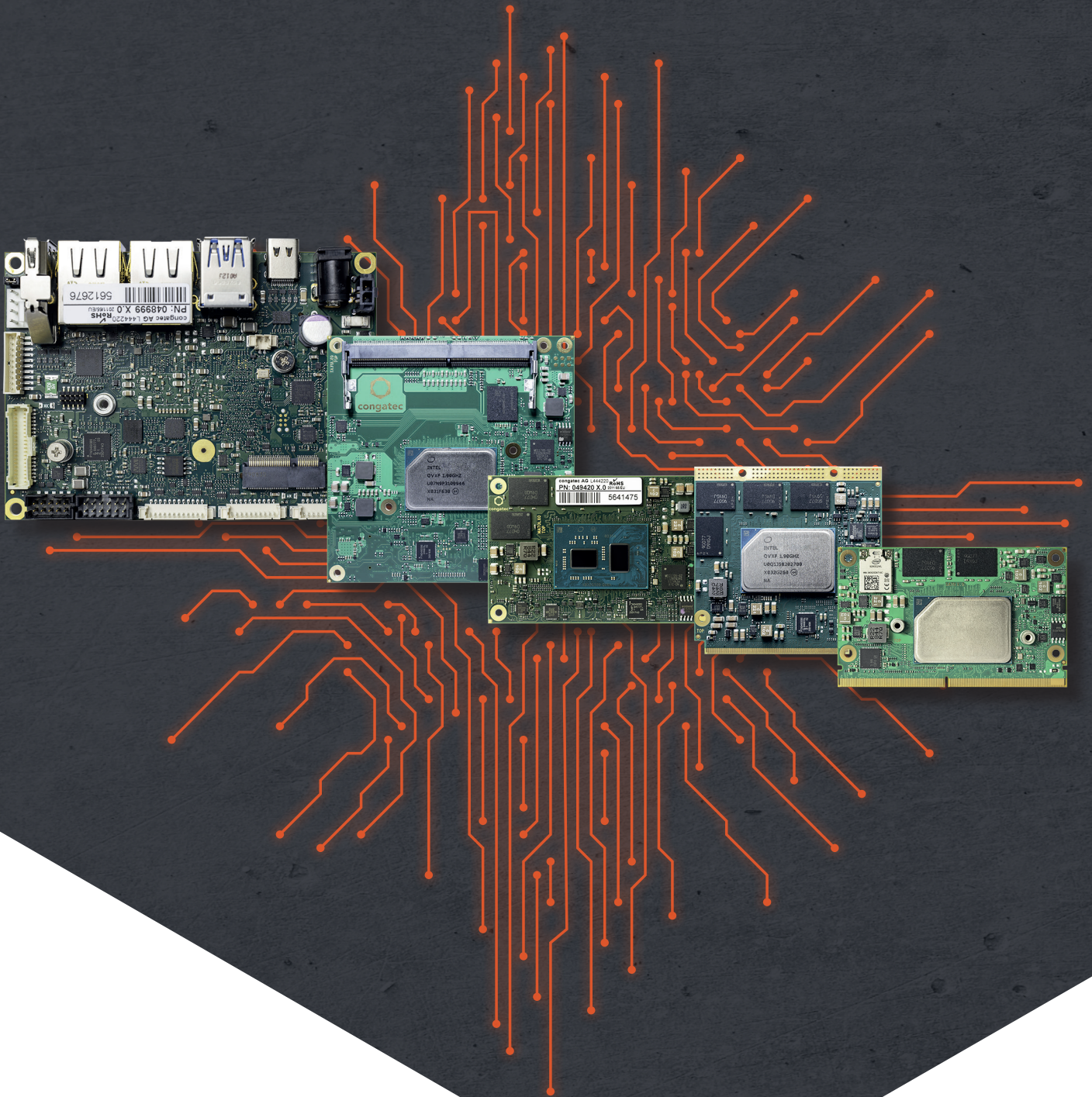




Whitepaper

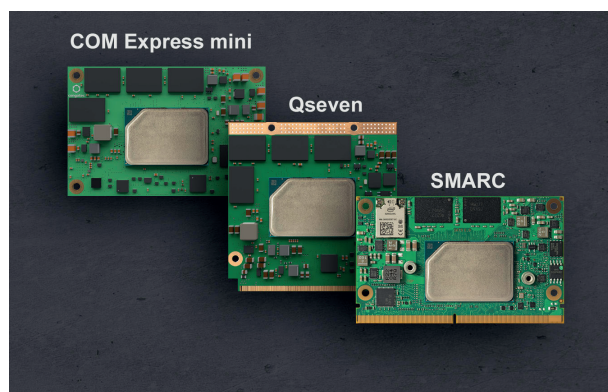
More power for low power

congatec welcomes Intel Atom® x6000E Series processor on embedded computers

More power for low power

congatec has launched the new low-power Intel Atom® x6000 Series, Celeron® and Pentium® processors (code name Elkhart Lake) on five embedded form factors: SMARC, Qseven, COM Express Compact and Mini, and Pico-ITX single board computers (SBCs). What are the benefits of these new low-power x86 platforms?

What industrial IoT applications need today is a combination of high-performance low-power processor technology, robust real-time operation, real-time connectivity, and real-time hypervisor technologies. Featuring the very latest Intel Atom, Celeron, and Pentium processor generation, congatec boards and modules offer more power for low-power applications in every aspect.



Three brothers: SMARC, Qseven, and COM Express Mini Computer-on-Modules are comparable in size; the main difference is simply that over time, OEMs have chosen one or the other form factor.

Target markets include automation and control – from distributed process controls in smart energy networks and the process industry to smart robotics, or even PLC and CNC controls for discrete manufacturing. Other real-time markets are found in test and measurement technology and transportation applications, such as train and track systems or autonomous vehicles, all of which also benefit from the extended temperature options.

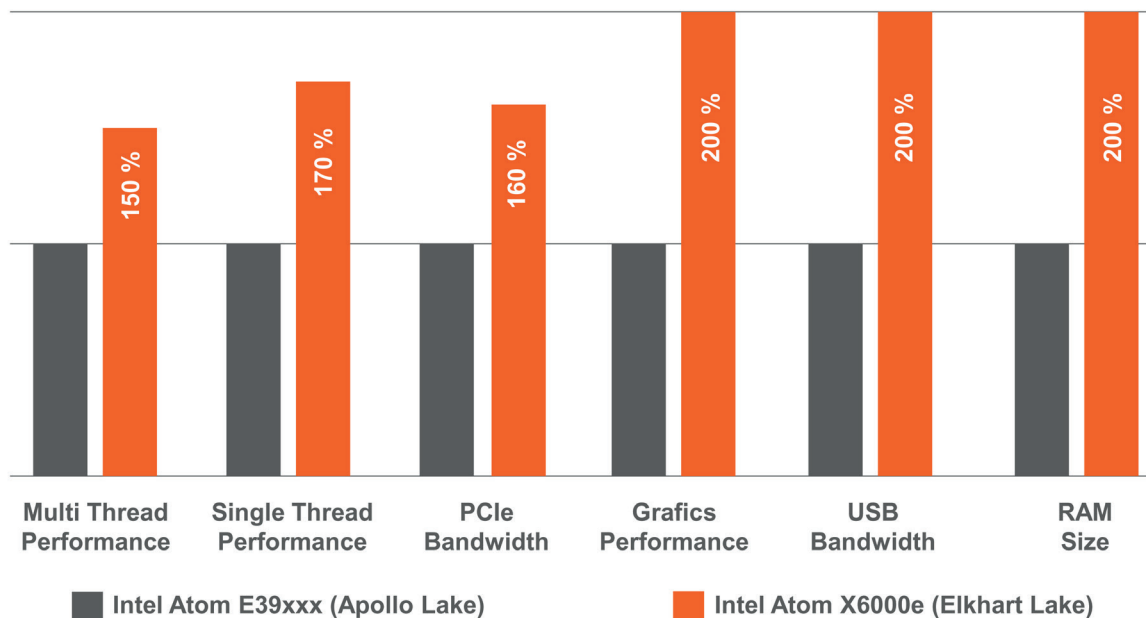
The new low-power processor generation is also a perfect fit for graphics-intensive applications such as edge-connected POS, kiosk and digital signage systems, or distributed gaming and lottery terminals, for which the new congatec boards and modules also offer enhanced remote machine-to-machine communication. The new low-power Intel Atom, Celeron, and Pentium processors (aka Elkhart Lake) will therefore rapidly conquer the embedded and edge computing market and become the new flagship of fanless low-power embedded computing from 4.5 to 12 watts. There are many good reasons for this:

A significant increase in processor performance

The new low-power Intel Atom, Celeron and Pentium processors offer a significant performance boost of up to 50% multi thread and even up to 70 % single thread performance over their predecessors based on the Apollo Lake microarchitecture . For many industrial applications, it is also important that the extended temperature range from -40°C to +85°C is supported. With up to 4 cores and maximum clock rates of up to 3 GHz in boost mode, the new processors bring significant performance improvements to the entire embedded market, including single as well as multi-threaded applications.

However, the fact that Intel Atom processor technology is now available in 10nm is of even greater importance for embedded applications. Embedded users of the previous low-power Intel architectures with the code names Apollo Lake (14nm), Braswell (14nm) or Bay Trail (22nm) who are migrating to the new [Elkhart Lake](#) variants, can therefore benefit from the advantages of Intel's SuperFin technology for the first time. Next to higher packing density, this offers either lower power consumption at the same performance, or higher performance at equal TDP. Both

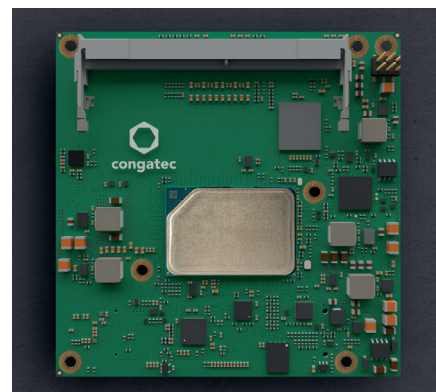
Elkhart Lake vs. Apollo Lake Performance



The congatec boards and modules with Intel Elkhart Lake processors convince across the entire range, offering significant performance improvements over Apollo Lake processors with higher performance per watt.

aspects are key in embedded designs. A comparison of the new designs, which are available in variants from 4.5 to 12 watts, shows that users of each TDP class can benefit from significant performance increases. And since the power-saving modes of the processors are Energy Star 3.0 certified, connected applications consume very little power in standby mode without the need for a special network proxy chip.

The increased data throughput is supported by more RAM, which is expandable up to a maximum of 16 GB LPDDR4 memory with up to 4267 MT/s. Mission-critical real-time applications also benefit from more cost-effective ECC implementations, as Intel Inband Error Correction Code (IBECC) allows the use of more affordable conventional memory instead of dedicated ECC RAM. Customers can configure the ECC and non-ECC mode in the BIOS. The fact that it is possible to apply IBECC only to certain memory areas is a particular advantage as it means that developers don't have to choose between all or nothing. For example, the memory area reserved for a mission-critical virtual machine can be protected from data errors by applying IBECC, while the remaining main memory operates without this feature in favor of higher data rates. But even with activated IBECC, the achievable data rates are often more than twice as high as with DDR3L ECC memory on Intel Atom E3900 processors.



The COM Express Compact board is mainly used for higher performance designs. As a low-end platform for a broadly scalable performance range, it enables particularly inexpensive designs.

	Intel Atom® x6000 Serie		Intel Atom E3900
	LPDDR4/4x 4267 MT/s	DDR4 3200 MT/S	DDR3L ECC 1600 MT/S
100% Read (0% Cache-Miss)	41 GB/s	30 GB/s	14 GB/s
100% Write (0% Cache-Miss)	35 GB/s	26 GB/s	16 GB/s
66/33 Read to Write (0% Cache-Miss)	31 GB/s	23 GB/s	15 GB/s

Twice as fast graphics for immersive experiences

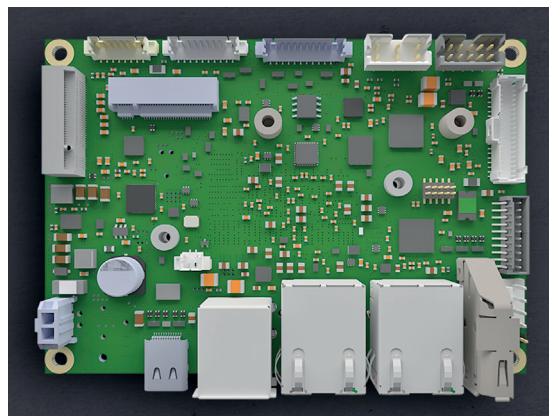
The new congatec boards and modules also offer impressive graphics with twice the speed for up to 3x 4k @ 60fps and 10-bit color depth. This massive increase in graphics performance was made possible by integrating the Intel Gen11 graphics unit, which had already been built into the significantly more powerful Intel Core processors of the 10th generation (Ice Lake). Again, the GPU sits on the CPU die and benefits from the performance and energy optimizations of the 10nm manufacturing technology. But above all, the performance increase stems from the number of integrated Execution Units (EUs), of which there are up to 32. The graphics performance is therefore doubled simply because of the higher efficiency and increased number of EUs, since the low-power Gen9 graphics of Apollo Lake had a maximum of 18 EUs. The Gen11 graphics addresses the resulting higher bandwidth requirements with better compression, larger L3 cache and higher maximum data transfer rates. It also supports all major acceleration APIs such as DirectX 12, OpenGL 4.5, Vulkan 1.1, OpenCL 1.1 and Metal, making it ideal for 3D graphics and a wide range of GPGPU-driven applications. Video-heavy applications, such as digital signage, gaming, streaming clients, and AV head-end systems, benefit from hardware-accelerated encoding and decoding of the latest codecs, such as the ultra data-efficient but also compute intensive HEVC (H.265) and VP9, as well as the widely used predecessors AVC (H.264) and AV1.

Higher data throughput thanks to PCIe Gen3 and USB 3.1 Gen2

For many developers, higher data throughput to peripherals will also be a key benefit of the new Intel Core processors. For the first time, PCIe Gen3 is available in a low-power processors, which means that the data rate has doubled to a maximum of 32 Gigabyte/s (16 Gigabyte per outward and return channel) compared to PCIe Gen2 as supported by Apollo Lake. This is now achieved at 8 GHz instead of 5 GHz clock frequency.

Another new feature for low-power x86 is USB 3.1 Gen2 support, which offers a significant performance increase compared to USB 3.1 Gen1. At up to 10 GBit/s, this enables twice as fast data transfers compared to USB 3.1 Gen1, making it possible to transfer uncompressed UHD video signals – for instance, from a camera to a monitor – via USB for the first time.

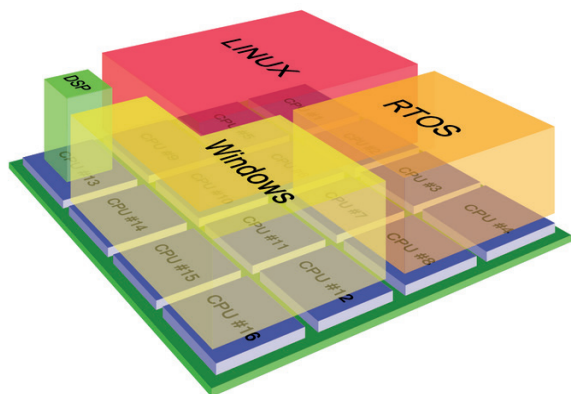
However, increasing the clock rate of peripheral buses can majorly impact system design as this causes new



The Pico-ITX board is ready for immediate application. Extensive accessories and numerous system designs from VARs and partner companies make the Pico-ITX board an attractive choice even for lot size 1. congatec is also happy to advise customers on the selection of the right system partner.

challenges for carrier board developers, especially regarding signal compliance. Higher clock rates make routing significantly more complex and error prone. congatec therefore offers its customers comprehensive carrier board design services and compliance tests. This saves customers from having to rely on external laboratories and, in the event of problems, has the added advantage that they can speak directly to the experts who have already thoroughly tested numerous other COM and carrier combinations, meaning they have exactly the required expertise.

Hard real-time – even via standard Ethernet



Real-Time Hypervisor combining multiple Operating Systems in Perfect Harmony

Functions of the new boards and modules that are particularly appreciated in industrial real-time applications based on VxWorks and real-time Linux are TSN (Time Synchronized Networking), Intel® TCC (Time Coordinated Computing), and RTS (Real-Time Systems) hypervisor support.

TSN enables tactile Internet applications over IP in hard real time. congatec's new Intel Atom processor-based modules and boards offer integrated MACs that support TSN over 1 GbE. Having supported TSN already for a long time, congatec is also providing development platforms that combine TSN networking with real-time control. Customers who want to

integrate TSN into their applications can therefore benefit directly from the application-ready solutions already available.

TCC technology orchestrates real-time Intel IP based communication also towards the I/Os to reduce latency and minimize jitter in synchronous processes. It can be adjusted via the Intel® TCC Software Toolkit. This can be useful for real-time applications in the transportation sector where the processor-integrated CAN bus needs to be integrated.

Comprehensive virtualization support for hardware consolidation

Naturally, hardware virtualization plays an important role in connected real-time systems as real-time multitasking is a key requirement for IoT and edge devices. The Intel Atom processors support virtualization with Intel VT technology, which is an attractive addition to real-time hypervisor technologies such as those offered by congatec with the RTS Hypervisor. Intel VT technology supports single root I/O virtualization (SR-IOV), for example. This allows multiple apps hosted in virtual machines with general purpose operating systems (GPOS) to natively access an I/O interface, e.g. one of the Ethernet interfaces. This is a rather attractive feature, especially because these interfaces are often in short supply.

The RTS Hypervisor from congatec subsidiary Real-Time Systems combines seamlessly with the hardware-integrated virtualization capabilities of [Elkhart Lake](#) processors to run critical real-time applications – in parallel to other multi-purpose operating systems such as Linux and Windows, without causing any additional latency. So, virtualization primarily helps to consolidate numerous tasks on a single system. And the number of tasks is multiplying rapidly in next-generation industrial control systems, which these days, on top of site control, are often also required to interact with each other in real time. In addition, IIoT-based data exchange is needed to monitor distributed machines, optimize asset performance, and introduce new business models with

predictive maintenance and as-a-service offerings. Many applications also require the integration of vision-based artificial intelligence. The RTS Hypervisor is supported by all new congatec boards and modules with the new Intel Atom, Celeron, and Pentium processors. This is a feature that is only available from congatec in this form.

Artificial intelligence and machine vision

Artificial intelligence is widely used for edge analytics today. The new Intel processors support an extensive portfolio of AI products and optimizations for common frameworks. Particularly noteworthy are OpenVino and Microsoft ML support. Microsoft ML is a free machine learning software library for the programming languages C # and F #. It also supports Python models when used in conjunction with NimbusML. The OpenVINO™ toolkit includes the Intel® Deep Learning Deployment Toolkit, optimized OpenCV and media encoding and decoding routines, as well as 20 pre-trained models and code samples. An efficient way to get started with computer vision and OpenVINO is the congatec workload consolidation kit for vision-based situational awareness applications. It is application ready and enables context awareness for robots, autonomous vehicles and video surveillance, passenger and pedestrian counting, or automatic checkout systems in the retail market.

Workload consolidation kit for machine vision

The workload consolidation kit for vision-based situational awareness applications from congatec, which is Intel-qualified as a production-ready Intel® IoT RFP Ready Kit, demonstrates the efficiency benefits of virtualization. It offers three virtual machines (VMs) for workload consolidation of vision applications based on hypervisor technology from Real-Time Systems (RTS). One VM runs a vision-based AI application using Intel® OpenVino™ software for situational awareness. The second VM is real-time capable and operates deterministic control software, while the third VM acts as IIoT/Industry 4.0 gateway. The congatec kit, which was developed in cooperation with Intel and RTS and can also be made available with the new Intel Atom processor generation, targets the next generation of vision-based collaborative robotics, machine controls and autonomous vehicles that need to perform multiple tasks in parallel, including situational awareness based on deep learning based AI algorithms.



Significant security improvements

All IIoT edge devices must integrate security features. OEMs can use virtualization technologies such as the real-time hypervisor from RTS to integrate them. However, ideally, the foundation is already anchored directly in the hardware. The new low-power processor generation has a lot to offer in this respect, too. For example, congatec's new Intel Atom, Celeron and Pentium processor based boards and modules offer innovative options for more comprehensive out-of-band management along with a full range of embedded security features such as verified boot via Intel® Boot Guard 2.1, TPM support including Intel® Platform Trust Technology (Intel® PTT), and Intel® Dynamic Application Loader (Intel® DAL) to enable the development of consistent, truly trusted applications. And when it comes to data encryption and decryption, the new boards and modules also offer more. The Intel® Advanced Encryption Standard New Instructions (AES-NI) and the SHA Extensions for hardware accelerated Secure Hash Algorithms are now even more

powerful. A completely new feature is processor support of SMx ciphers, a set of standard algorithms that are especially used in China. Lastly, HDCP 2.3 copy protection, which is necessary for the playback of the latest HD media, is now available as well.

Continuous 24/7 operation and long-term support

The new Intel Atom, Celeron and Pentium processor-based boards and modules from congatec are designed for high reliability and a long service life. For the processors that are to be used in harsh industrial environments, Intel is offering 10 years of continuous 24/7 operation (100% in sleep state S0), and extended temperature ranges from -40°C to +85°C or maximum TJ of 100°C to 110°C. Intel has plans to offer a guaranteed processor availability of 15 years, which would enable congatec to guarantee the same availability for function-identical products – something that's particularly important for the medical and transportation sector, for example. Currently, the standard availability of congatec boards is 10 years. For OEMs with higher availability requirements, special programs with longer availability can be arranged.

Processor	Cores / Threads	Clock [GHz] (Base/Boost)	CPU L2 Cache (MB)	GFE Execution Units	TDP (W)
Intel Atom® X6425E	4	1.8 / 3.0	1.5	32	12
Intel Atom® X6413E	4	1.5 / 3.0	1.5	16	9
Intel Atom® X6211E	2	1.2 / 3.0	1.5	16	6
Intel Atom® X6425RE	4	1.9 / -	1.5	32	12
Intel Atom® X6414RE	4	1.5 / -	1.5	16	9
Intel Atom® X6212RE	2	1.2 / -	1.5	16	6
Intel® Pentium® J6425	4	1.8 / 3.0	1.5	32	10
Intel® Celeron® J6413	4	1.8 / 3.0	1.5	16	10

Eight new configurations

The new boards and modules are available in Pico-ITX SBC, SMARC, Qseven, COM Express Compact and Mini form factors in the following [processor configurations](#):

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About congatec

congatec is a rapidly growing technology company focusing on embedded computing products. The high-performance computer modules are used in a wide range of applications and devices in industrial automation, medical technology, transportation, telecommunications and many other verticals. Backed by controlling shareholder DBAG Fund VIII, a German midmarket fund focusing on growing industrial businesses, congatec has the financing and M&A experience to take advantage of these expanding market opportunities. congatec is the global market leader in the computer-on-modules segment with an excellent customer base from start-ups to international blue chip companies. Headquartered in Deggendorf, Germany, congatec currently has entities in USA, Taiwan, China, Japan and Australia as well as United Kingdom, France, and the Czech Republic. More information is available on our website at www.congatec.com or via [LinkedIn](#), [Twitter](#) and [YouTube](#).

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