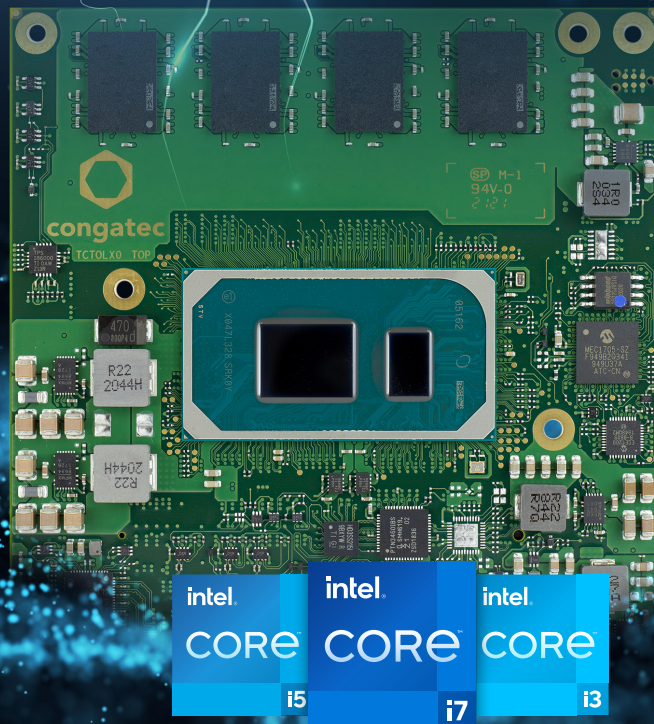




congatec



Whitepaper

How rugged is rugged?

Rugged Computer-on-Modules

How rugged is rugged?

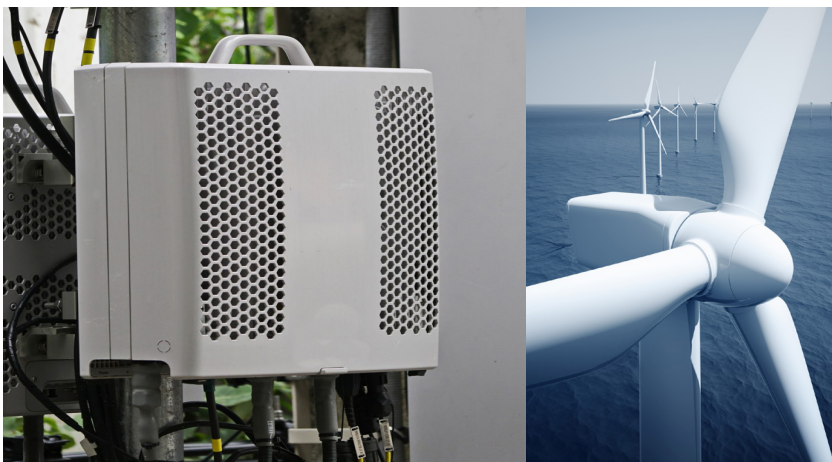
Most standard Computer-on-Modules use SO-DIMM connectors to integrate the main memory. Since the main memory is often customized for the specific application, this modular approach works well for module manufacturers and their OEM customers. However, the resistance of such connectors to shock and vibration is limited. Although lever arm and mass are not so large, even comparatively small vibrations can impair the functional reliability of the RAM when standard memory modules are used. Applications exposed to high shock and vibrations therefore require more robust designs.



Trains, commercial vehicles, construction and agricultural machinery need rugged designs

In the rail cargo sector, for example, vibrations of around $0.002 \text{ g}^2/\text{Hz}$ at frequencies from 0 to 350 Hz are common. Vibration levels experienced in jet aircraft are significantly higher at $0.01 \text{ g}^2/\text{Hz}$ with frequencies up to 2000 Hz. For systems deployed in trucks, levels even reach up to $0.02 \text{ g}^2/\text{Hz}$. And turbine engines, such as those used in wind turbines, pose higher demands still, stressing components with up to $0.03 \text{ g}^2/\text{Hz}$.

Developers of such and many other mobile and stationary systems exposed to shock and vibration – from 5G base stations to trains and drones – are therefore looking for better solutions to



5G base stations as well as wind turbines must withstand wind and weather

connect the main memory. This has led to some adventurous inventions in the past, involving the use of glue, tape or straps to provide additional retention so that the SO-DIMM connector remains functionally secure and, in the extreme case, will not slip out of its socket. However, neither of these solutions deals with issues that affect the socket itself, as the embedded community has noted. The concern here is that movement of the memory module within the socket – typically one of

the comparatively inexpensive, off-the-shelf sockets used in laptops – can cause intermittent pin connection, which in turn can cause a system to crash.

Improvisation is a bad advisor

There are mechanical solutions to secure memory modules in sockets. For instance, memory manufacturers have added screw holes at the far end of their SO-DIMMs to attach the RAM modules securely so that shock and vibration are no longer a problem. And such constructions are indeed quite robust, as the manufacturers of these SO-DIMMs have shown in tests: Mounted on a vibration plate, such constructions survive 30 minutes of exposure to random vibrations of 50 Hz to 5000 Hz and 6 grms increasing in 2 grms increments to 20 grms without any sign of problem. The same applies to shocks of 20 grms – 20 times the gravitational force of Earth – over 1 ms along each of the three axes in addition to vibrations of 0.04 grms/Hz between 20 Hz and 2000 Hz. This proves that such solutions can meet very rugged requirements; and that's a good thing, because otherwise there could be doubt that the Computer-on-Modules themselves survive such tests. So, it is important to have the right fixtures.

Are standards a solution?

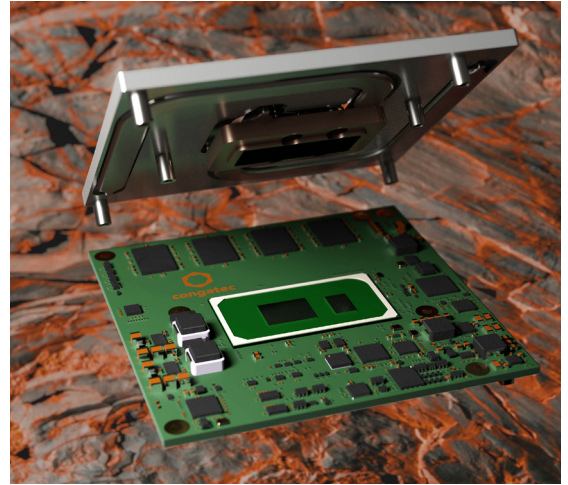
This is all well and good, and since 2010 there has even been a mezzanine memory card standard – RS-DIMM – that meets all the ruggedness requirements of the ANSI/VITA 47 specifications. But as great as the ideas are: Such technology does not have many takers, which is why you hardly ever see mezzanine modules being used. Neither are rugged SO-DIMMs with mounting holes mass-produced, which makes them more expensive than standard ones. In addition, they are also more complex mechanically and hence more expensive to assemble since the screws must usually be attached by hand. Lastly, they also require additional mounting holes on the boards, which further increases production costs. The best solution therefore is to avoid all these add-ons and simply solder the memory directly onto the module. This reduces the bill of materials for components, makes production more cost-effective and, most importantly, ensures ruggedness. Shock and vibration testing of the main memory for system qualification also becomes unnecessary. And there is yet another distinct advantage of soldered memory: Cooling is easier than with conventional memory connectors. First, because the PCB on which it is soldered has better heat dissipation, and second, because the heat sinks of rugged Computer-on-Modules are specially designed for the respective ruggedness requirements and can be equipped with a heat-conducting connection for cooling hot spots such as the main memory.

Soldered is simply better!

The technology behind these solutions is not exactly earth-shattering. After all, you can solder everything onto a circuit board. However, things get more exciting when you look at the entire OEM effort to create a truly rugged solution. Here, it is particularly important to have a modular concept for individual series even when the quantities are not sky-high. Computer-on-Modules, where the processor and memory match perfectly and which are available in various performance classes, are the ideal solution in such cases. They come as application-ready components with specially adapted cooling solutions and everything else custom system designers need. Moreover, they are available in the same configuration for many years, which makes lifecycle management easier for OEMs.

Rugged COM Express Type 6 Computer-on-Modules

congatec recently introduced new Computer-on-Module solutions based on the very latest 11th generation Intel Core processors. These COM Express Type 6 Computer-on-Modules comply with the ETSI EN 300 019-1-7 and IEC 60721-3-7 specifications for portable and non-stationary telecom equipment and have been tested for commercial 7K3, 7M2 and industrial 7K4, 7M2 environments. This class also applies to non-weather protected locations in moderate outdoor climates and transfers between these conditions. For example, where equipment may be exposed to direct sunlight, radiant heat, ambient air movement, condensation, precipitation, and water from sources other than rain and ice, or where equipment is prone to attacks from mold or animals other than termites. Use is also possible in urban areas with common pollutant levels and with industrial activities scattered throughout the area and/or with heavy traffic. Use is further permitted near sand or dust sources.



congatec COM Express modules with 11th generation Intel Core processors are predestined for harsh environmental conditions



Planes and drones are among the most demanding in terms of shock and vibration

Meets all relevant standards

In terms of shock and vibration, these modules are suitable for use in demanding transport and mobility applications up to off-road and rail vehicles. In addition they can withstand continuous operation in extreme temperatures (-40°C to +85°C), high humidity and heavy mechanical stress due to shocks and vibrations and meet all requirements for fire protection. For more price sensitive applications, congatec also offers a lower-cost version with Intel Celeron processor that is designed for the extended temperature range from 0°C to 60°C. Typical customers for the new range of Computer-on-Modules based on the Tiger Lake microarchitecture are OEMs of trains, commercial vehicles, construction equipment, agricultural vehicles, self-driving robots and many other mobile applications in demanding outdoor and off-road environments. Shock and vibration resistant stationary devices are another important application area as digitization

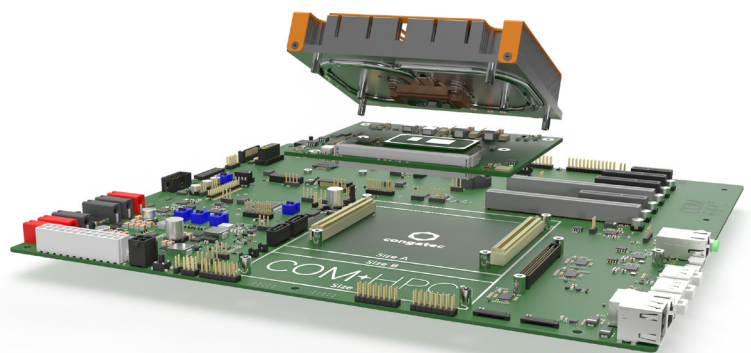
requires critical infrastructure protection (CIP) against earthquakes and other mission-critical events. All these applications can now benefit from super-fast LPDDR4X RAM with up to 4266 MT/s, which congatec offers in graded versions with 32, 16, 8 and 4 GB as standard variants. Depending on the requirements, the highest-performance modules can also be equipped with smaller memory or lower-performance variants based on the Intel Core i3-1115G4E with more than 8 GB RAM. From batches of 100, variants with lower-cost RAM modules and somewhat slower transfer rates can also be made available. In-band error correction code (IBECC) for single failure tolerance and high data transmission quality in EMI-critical environments corroborate the ruggedness of the modules.

Comprehensive development support for ultra-rugged systems

The value package also includes rugged mounting options for the COM and carrier bundle, active and passive cooling options, optional conformal coating for protection against corrosion from moisture or condensation as well as sulfur protection, a list of recommended carrier board layouts and – for maximum reliability – shock and vibration resistant components for the extended temperature range. This impressive technical feature set is complemented by a comprehensive service offering that includes shock and vibration testing for custom system designs, temperature screening and high-speed signal compliance testing, as well as design-in services and all necessary training to simplify the use of congatec's embedded computer technologies.

The advantages in detail

Based on the new low-power, high-density 11th generation Intel Core SoCs, the new modules offer significantly higher CPU performance, nearly 3x higher GPU performance and state-of-the-art PCIe Gen4 support compared to previous models. The most demanding graphics and data processing workloads benefit from up to 4 cores, 8 threads and up to 96 graphics execution units for massively parallel processing throughput in ultra-rugged designs. The integrated graphics not only supports 8k displays or 4x 4k; it can also be used as a parallel processing unit for Convolutional Neural Networks (CNN) or as an AI and deep learning accelerator. The Intel AVX-512 instruction unit, which is integrated into the CPU and supports Vector Neural Network Instructions (VNNI), is another functional element of the platforms to accelerate AI applications. The Intel OpenVINO software toolkit, which includes optimized calls to OpenCV, OpenCL kernel and other industry tools and libraries, enables workload expansion across CPU, GPU and FPGA compute units to accelerate AI workloads – including computer vision, audio and speech recognition systems.



11th generation Intel Core processors deliver a new performance benchmark for systems in harsh environments

The TDP is scalable from 12 to 28 watt and allows the design of completely closed systems with purely passive cooling. The impressive performance of the ultra-rugged [conga-TC570r](#) COM Express Type 6 module is available in a real-time capable design and supports Time Sensitive Networking (TSN), Time Coordinated Computing (TCC) and the RTS hypervisor from Real-Time Systems for virtual machine deployment and workload consolidation in edge computing scenarios.

The ultra-rugged COM Express Compact Type 6 modules with 11th generation Intel Core processors (code name Tiger Lake) with soldered LPDDR4X 4266MT/s dual channel SDRAM are available in the following standard configurations. Customizations are available on request.

Processor	Cores/ Threads	Frequency at 28/15/12W TDP, (Max Turbo) [GHz]	Cache [MB]	Graphic [Execution Units]
Intel Core i7-1185GRE	4/8	2,8/1,8/1,2 (4,4)	12	96 EU
Intel Core i5-1145GRE	4/8	2,6/1,5/1,1 (4,1)	8	80 EU
Intel Core i3-1115GRE	2/4	3,0/2,2/1,7 (3,9)	6	48 EU
Intel Celeron 6305E	2/2	1,8	4	48 EU

Further information on the new conga-TC570r COM Express Compact Module can be found at:

<https://www.congatec.com/en/products/com-express-type-6/conga-tc570r/>.

Information on other Intel Tiger Lake solutions from congatec can be found at:

<https://www.congatec.com/en/technologies/intel-tiger-lake-modules/>.

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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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