Solution Brief

Embedded IoT
Robot Safety Controllers

Intel-Powered, Functional Safety (FuSa)–Capable IPCs Accelerate Robot Deployments

NexCOBOT delivers robot safety controller boards enabled by the Enhanced for IoT Intel Atom® x6427FE processor

"With the SCB 100 and an Enhanced for IoT Intel Atom® processor, we want to provide the building blocks and shorten the overall development life cycle for customers to build a safety-related robot solution."

—Weihan Wang, product manager at NexCOBOT

Industrial robots are becoming a critical asset to the manufacturing sector, with a valuation of USD 21.83 billion as of 2019 that is forecasted to grow to USD 66.48 billion by 2027.[1] Robots perform key roles on the shop floor, including product assembly and verification, defect detection, and moving inventory. However, one of the primary hurdles to adopting automated machines and robots is ensuring worker safety in any shared robot-human environment. Within the field of industrial robot design, safety-related controllers play a pivotal role in connecting manual inputs to the servo drives that control robot joints and motors. Safety-related controllers are dedicated systems or programmable logic controllers (PLCs) that, for example, constantly measure robot movement speed against established parameters. If a robot's speed ever exceeds the parameters, the safety controller relays a signal to stop all movement.

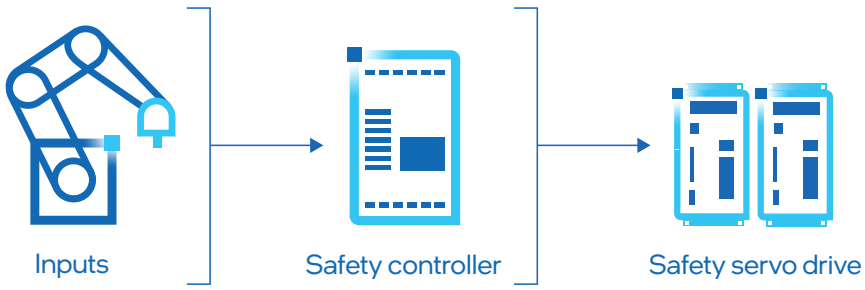


Figure 1. The safety controller measures input from a variety of sources, including the machinery itself. If speed exceeds preestablished thresholds, the safety controller will relay a signal to shut down the machinery.

Challenge: Certification as a barrier to entry

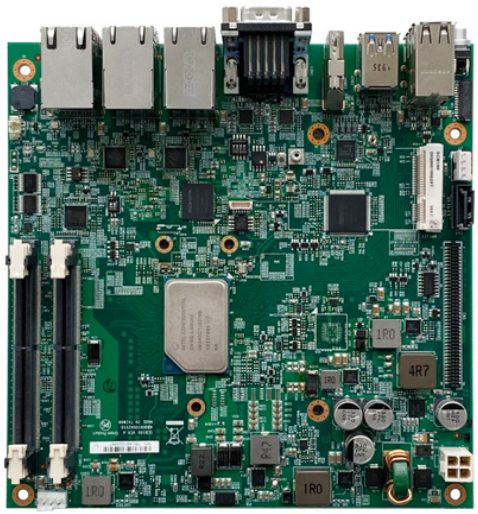
The requirements of a safety-related controller are regulated by international standards. Of particular importance is the Category 3 Performance Level d (Cat3 PLd) requirement under ISO 13849, which has several implications when designing a safety-related system. Manufacturers need to have their robotic systems certified by third parties in order to deploy their systems. As part of the certification process, the manufacturer needs to submit documents and design specifications that prove their robots can meet the Cat3 PLd requirement. Weihan Wang, product manager at NexCOBOT, estimates this certification can take up to 18 months on average and creates a huge barrier to entry for most businesses.

Solution: FuSa-capable control boards

To help accelerate time to deployment, NexCOBOT offers a safety-related control board in the SCB 100 offering. The SCB 100 is an industrial PC (IPC) board enabled with key FuSa features in the Intel Atom® x6427FE processor. With this solution, robot builders and their customers receive the support and documentation to accelerate their system-level certification process for Cat 3 PLd. Robot builders and manufacturers also benefit from the next-generation performance of the Intel® Enhanced for IoT processor, allowing for greater flexibility and modularity in their configurations. Equipping robot builders with the tools to build safer, performant robotic solutions in shorter time frames is a core element to NexCOBOT's mission. Wang states, "With the SCB 100 and an Enhanced for IoT Intel Atom® processor, we want to provide the building blocks and shorten the overall development life cycle for customers to build a safety-related robot solution."

NexCOBOT SCB 100

- FuSa-capable[2] to IEC-61508, SIL2, and ISO 13849, Cat 3 PLd[2]
- Intel Atom® x6427FE processor
- EtherCAT slave support
- 12-channel input/4-channel output safety I/O
- HDMI support
- Supports 2x DDR4 SO-DIMM, up to 32 GB
- Supports 4x Intel® GbE ports, 6x USB 2.0/3.0, 2x COM, 1x mPCIe



Enhanced for IoT Intel Atom® x6000E Series processors

- Up to 1.7x greater single-thread performance vs. previous generation[3]
- Up to 1.5x greater multithread performance vs. previous generation[3]
- Up to 2x greater graphics performance vs. previous generation[2]
- Integrated functional safety and real-time computing[4,5]
- Out-of-band/in-band remote management

Figure 2. The SCB 100 board is highly customizable and modular.

How it works

The SCB 100 board was purposefully designed for robotic applications. The board supports real-time EtherCAT slave communication protocol, a de facto standard for distributed motion control. Real-time systems help ensure that all operations are smooth and continuous, which contributes to greater safety and productivity. The SCB 100 also features extensive modularity, with multiple I/O channels and HDMI support. With the Intel Atom x6427FE processor, this solution also delivers the performance needed to support both computing and safety-related workloads on the same board, which can help reduce hardware components in any given deployment. Wang says, "The SCB 100 provides a very high-performance margin to enable a total solution, so design and functional safety requirements will be easier to meet."

Performance and key FuSa features

Wang states, "For robot builders, being able to prove that a design can pass certification is an essential requirement." In addition to the performance levels of the Intel Atom x6427FE processor, these other key features help meet FuSa requirements:

- **Intel® Safety Island –** During operation, Intel Safety Island checks the processor to help ensure that the architecture is functioning as expected. For example, if a signal failure occurs in the DRAM, Intel Safety Island will collect that information and generate a safety output signal to the rest of the system.
- **In-Band Error Correcting Code (ECC) –** This feature corrects single-bit memory errors in standard, non-ECC memory.
- **Intel® Slim Bootloader with Pre-OS checker –** This lightweight bootloader replaces the UEFI BIOS on the SCB 100 board and supports key features such as verified boot, measured boot, and secured firmware updates. The Pre-OS checker is a SIL2-capable[2] software component that verifies the integrity of the boot process.

See backup for workloads and configurations. Results may vary.

Intel Enhanced for IoT processors

The SCB 100 utilizes Intel Atom® x6000E Series processors enhanced for IoT embedded and industrial applications. In addition to FuSa and real-time computing features,[4,5] this processor series delivers up to 1.7x greater single-thread performance, and up to 1.5x greater multithread performance vs. the previous generation.[3] The lineup also supports visual-intensive implementations such as terminals, kiosks, and digital signage with 2x greater graphics performance vs. the previous generation.[3] Businesses will also benefit from in-band and out-of-band remote manageability, so technicians can update or remediate systems even if the OS is not responsive.

For the SCB 100 board, the Intel Atom x6427FE processor opens up many possibilities. HDMI support with the graphics performance boost means that robots and machinery can potentially be connected to terminals with rich interactive displays. The compute performance headroom also supports greater I/O connectivity and expandability, giving robot builders the flexibility to design more-customized solutions.

Accelerated development with a safety-related stack

With the SCB 100 solution, robot builders benefit from FuSa-capable features on key layers in the safety controller stack, including the CPU, IPC board, and operating system. The SCB 100 uses a FuSa-capable Real Time OS (RTOS), which is built around real-time communication protocols that are important to enabling safe robotic environments. To develop a complete solution, robot builders only need to add their own certified functional safety software. NexCOBOT also provides the FuSa-capable[2] software that's part of the Intel Atom x6427FE processor package. This software stack includes familiar code libraries and APIs that are FuSa capable[2] to jump-start software development. More importantly, the FuSa-capable software stack gives robot builders the ability to relay signals from their software through Intel Safety Island to verify calculations performed in the software layer, set custom parameters, and determine new behaviors that generate stop signals to machinery. Customers also receive the SCB 100 safety user's manual per ISO guidelines.

Safety and scalability lead to greater possibility

As robotics becomes more prevalent across key industries, NexCOBOT is ready to meet the challenge of increased demand. Wang says, "One of our key competitive advantages is that we have an established presence in robotic control applications. We know what's important to robot builders, like EtherCAT protocols and real-time I/O functions." This knowledge helps NexCOBOT refine their offerings to the most-essential and desirable features. The SCB 100 is a reflection of these efforts, striking a balance between simplicity and capability that pairs well with NexCOBOT's global presence and high-quality customer support. Wang adds, "We've provided thousands of units to a single customer. We are also a key provider to the second-largest collaborative robot builder in the world right now." Robot builders will find a solid foundation in the Intel-enabled SCB 100 to drive innovation while benefiting from FuSa-capable features and a shorter development cycle.

See backup for workloads and configurations. Results may vary.

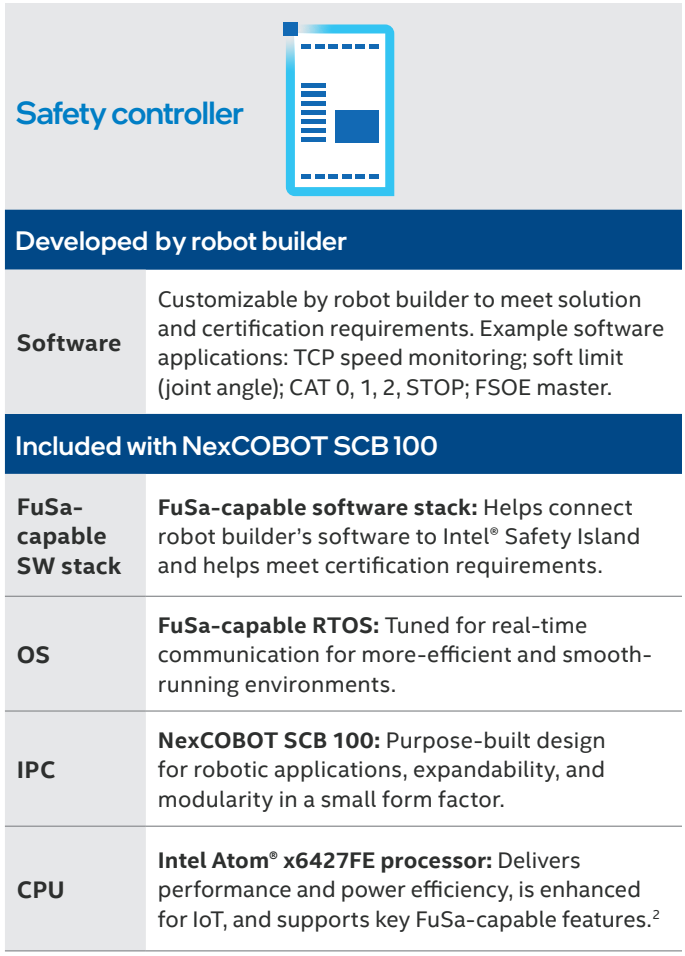


Figure 3. Robot builders need to develop and certify software to complete the safety controller stack.

What is functional safety (FuSa)?

As machinery and robotics become more complex, autonomous, and commonplace in business, industrial, and logistics environments, worker safety is emerging as a key priority. FuSa is a methodology that refers to technology and efforts that help detect and mitigate electronic system malfunctions, help prevent damage and reduce risk, and help increase worker safety. In practical terms, a common example of FuSa is when a system automatically detects a malfunction and sends a stop signal to all moving robotic components. In addition to worker safety, FuSa is important because there are numerous certifications and requirements that are regulated by both global and regional governing bodies, although regulations may differ depending on where a business operates. Select Intel Atom® x6000E Series processors include key FuSa features[4,5] that help system architects meet safety standards and pass these certifications.

Learn more ›

Learn more

NexCOBOT SCB 100

Anchored by the Intel Atom x6427FE processor, this powerful, modular mini ITX board delivers real-time communication capabilities and expandability to support flexible robotic applications.

Learn more ›

Intel® Enhanced for IoT processors

Discover next-generation CPU and graphics performance and support for real-time computing and FuSa in this processor lineup[4,5] for embedded and industrial use-case applications.

Learn more ›

About NexCOBOT

NexCOBOT, a NexCOM company, provides highly modular, intelligent robot control and motion control systems with exceptional levels of customer support globally.

nexcobot.com

1. *Industrial Robots Market Size, Share & Industry Analysis, By Robot Type (Articulated, SCARA, Cylindrical, Cartesian/Linear, Parallel and Others), By Application (Pick and Place, Welding & Soldering, Material Handling, Assembling, Cutting & Processing and Others), By Industry (Automotive, Electrical & Electronics, Healthcare & Pharmaceutical, Food & Beverages, Rubber & Plastic, Metals & Machinery and Others), and Regional Forecast, 2020-2027*, Fortune Business Insights website, June 2020. https://www.fortunebusinessinsights.com/amp/industry-reports/industrial-robots-market-100360
2. Certification in progress.
3. Source: Intel. Claims based on a) SPECCPU2006 metric estimates based on Pre-Si projections and b) 3DMark11 estimates based on Pre-Si projections, using Intel® Pentium® J4205 as prior generation.

   Configurations:
   Performance results are based on projections as of September 1, 2020
   Processor: Intel® Pentium® J6425 PL1=10W TDP, 4C4T Turbo up to 3.0 GHz
   Graphics: Intel® Graphics Gen 11
   Memory: 16 GB LPDDR4-3200
   OS: Windows 10 Pro
   Compiler version: IC18
   Processor: Intel® Pentium® J4205 PL1=10W TDP, 4C4T Turbo up to 2.6 GHz
   Graphics: Intel® Graphics Gen 9
   Memory: 16 GB LPDDR4-2400
   OS: Windows 10 Pro
   Compiler version: IC18

   Performance numbers are Pre-Si projections and are subject to change. Results reported may need to be revised as additional testing is conducted. The results depend on the specific platform configurations and workloads utilized in the testing and may not be applicable to any particular user's components, computer system, or workloads. The results are not necessarily representative of other benchmarks.
4. Not all SKUs include the Intel® Safety Island or support functional safety.
5. Not all SKUs support real-time computing, time-sensitive computing, or time-synchronous networking.

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