# EIU

ELECTRONICS INFORMATION UPDATE

A Mouser Magazine

EUROPE | JULY 2023

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# The Age of Automation

## FEATURES



**PLUS**

## REGULARS






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EMPOWERING INNOVATION TOGETHER™

# Matter: Unifying devices under one protocol

**Mouser Electronics® Empowering Innovation Together™ delves into the new wireless protocol Matter. Not only is it for consumers who want smart home systems to work together, but Matter also holds endless possibilities for innovative enterprises that need a robust platform on which to innovate.**

*You can find it all at:*

mouser.com/empowering-innovation/matter-protocol

MOUSER ELECTRONICS

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# In this issue...

Industry has embraced new technologies to be more efficient, save time, and enable scalability. We look at the increasingly intelligent industrial automation solutions available in our July issue with articles themed: Digital IO for next-generation control'; 'Enhancing quality with machine vision'; 'Delivering predictive maintenance';' Adapting Ethernet to Accelerate Industry 4.0'; and 'Applying Matter to the factory floor'.


Adam Taylor & Dr Richard Harriss conclude our Systems Engineering mini-series with a look to the future. In Tech Tips, Neutrik addresses AV & IT Compliance to IEC/UL 62368-1 & 60320-1 Safety Standards. David 'Connector Geek' Pike asks, 'Is there a future for press-fit connectors?' and Stuart Cording discusses monitoring and maintaining industrial systems. Plus the news round-up, Dev Kit Pick and, of course, a review of the most innovative products now in stock at Mouser.

Published by Mouser Electronics.
For Editorial contact Nick Foot at *nick.foot@bwwcomms.com*.

For Advertising, contact
Claudia Bertaccini at
*claudia.bertaccini@mouser.com.*





# EU-US Council enhances cooperation

The European Union and the United States recently held the fourth ministerial meeting of the EU-US Trade and Technology Council (TTC) in Luleå, Sweden. Co-chaired by European Commission Executive Vice-President Margrethe Vestager, European Commission Executive Vice-President Valdis Dombrovskis, United States Secretary of State Antony Blinken, United States Secretary of Commerce Gina Raimondo, and United States Trade Representative Katherine Tai, it was joined by European Commissioner Thierry Breton, and hosted by the Swedish Presidency of the Council of the European Union.

The EU and the US remain key geopolitical and trading partners. The EU-US bilateral trade is at historical highs, with over €1.55 trillion in 2022, including over €100 billion of digital trade. The EU and the US agreed on a list of key outcomes to advance transatlantic cooperation on emerging technologies, sustainable trade, economic security and prosperity, secure connectivity and human rights in the digital environment. In addition, both parties also reaffirmed their unwavering commitment to support Ukraine.

The EU and the US share the common understanding that Artificial Intelligence (AI) technologies hold great opportunities but also present risks, and showcased the first results in the TTC Joint Roadmap for Trustworthy AI as well as risk management through dedicated experts' groups working on the identification of standards and tools for trustworthy AI. Going forward, this work will include a focus on generative AI systems. The EU and the US have advanced work on semiconductor supply chain early warning and subsidies transparency, with a mechanism to prevent subsidy races, and deepened cooperation on their respective Chips Acts and research to replace PFAS in semiconductor supply chains.

The EU and the US also agreed on a common international standard on megawatt charging systems for the recharging of electric heavy-duty vehicles, to facilitate transatlantic trade and investment with recommendations for the government-funded implementation of e-vehicle charging infrastructures. Both parties have accelerated their cooperation towards a common vision and industry roadmap on 6G wireless communication systems and issued a 6G outlook with guiding principles and next steps to develop 6G technology.

In addition, the EU+US meeting produced a list of high-level principles on the protection and empowerment of minors and data access for researchers, which are in line with the EU's Digital Services Act. Both parties are also deeply concerned about Russia's strategic use of disinformation narratives, and foreign information manipulation and interference (FIMI) actions in third countries. A joint statement setting out actions to combat foreign information manipulation and interference in third countries includes a standard for structured threat intelligence and capacity building, particularly in Africa and Latin-America.

The EU and US are working to grow their €1.5 trillion worth of bilateral trade further by making it easier to trade and they have today taken steps to facilitate trade in key sectors, extending mutual recognition for pharmaceutical goods to include veterinary medicines and updated the existing EU-US marine equipment mutual recognition rules.

As part of their commitment to greener and fairer trade, the EU and US have agreed on a work program for the Transatlantic Initiative on Sustainable Trade, which will lead to closer cooperation on jointly advancing the green transition. A newly-launched Clean Energy Incentives Dialog will help ensure that EU and US incentive programs for a clean economy are mutually reinforcing. The EU and US are also aligning their respective regulations related to export restrictions on sensitive items to Russia and Belarus.

TTC Joint Statement: **https://ec.europa.eu/commission/presscorner/detail/en/statement_23_2992**

# MACOM's Euro centre to boost GaN/GaAs MMICs

MACOM Technology Solutions recently completed the acquisition of the key manufacturing facilities, capabilities, and technologies of its OMMIC SAS facility. Located near Paris in Limeil-Brévannes, France, OMMIC SAS will become the foundation for MACOM's recently established European Semiconductor Center, which is intended to increase availability of higher frequency Gallium Arsenide (GaAs) and Gallium Nitride (GaN) monolithic microwave integrated circuits (MMIC).

*"We are excited to open MACOM's European Semiconductor Center," stated Stephen G. Daly, President and Chief Executive Officer, MACOM. "We look forward to building upon the existing team's expertise in material science, semiconductor wafer processing and millimeter-wave MMIC design."*

# Vishay joins sponsors of Women in Electronics

Vishay has become a Gold sponsor of Women in Electronics (WE), a non-profit public charity providing leadership growth and development, mentorship, networking, thought-leadership events, and resources to advance gender parity. "We are proud to support Women in Electronics and their commitment to the professional growth and advancement of women in the electronics industry," said Joel Smejkal, Vishay President and Chief Executive Officer. "Vishay is thrilled to be a part of a community championing women and helping the industry evolve toward a more inclusive future."

"Our team at WE is grateful for the partnership and support from Vishay that will enable us to provide essential development programs and resources, along with events and thought leadership to help make strides toward diversity, equity, and inclusion efforts in the electronics industry and beyond," says Jackie Mattox, WE Founder and CEO. "We look forward to creating a sense of belonging for all talent to thrive."

Women in Electronics (WE) was founded in 2017 by a group of industry professionals to offer a sense of community and unite with colleagues to advance results in gender parity. Current sponsors include Amphenol, Arrow Electronics, Avnet/Newark/Farnell, Kyocera/AVX, Altium/Nexar/Octopart, Cornell Dubilier, Digi-Key, EETech, Flex Electronics, Galco Industrial Electronics, Littelfuse, Master Electronics, Molex, Rochester Electronics, Orbweaver, Plexus, RS, Rutronik, Samtec, Sourceability, Supplyframe, TTI Family of Specialists, Vishay, Waldom, and YAGEO Group.

**www.womeninelectronics.com**

WOMEN in Electronics
THOUGHT LEADERSHIP POWERED BY WOMEN

# EU approves €8B for chip research

Semiconductor manufacturing has emerged as a significant geopolitical talking point as supply-chain issues and other market forces force governments to take a more aggressive stance. Recently, the European Union put forth several semiconductor research projects with €8 billion in public funds, backed by €13.7 billion in private funding, amounting to €22 billion.

There are currently 68 Important Projects of Common European Interest (IPCEI) from 56 companies in 19 countries. The EU investment group includes Intel, Infineon Technologies, STMicroelectronics, GlobalFoundries, and Wolfspeed, with companies like Taiwan Semiconductor considering building production sites in Germany.

**https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en**

# STMicro and Sanan Opto to advance SiC ecosystem

Addressing the increased demand for wide-bandgap semiconductors, STMicroelectronics (ST) and Sanan Optoelectronics are creating a joint venture for high-volume 200mm SiC device manufacturing to support automotive electrification and industrial power and energy applications. Slated to begin construction in Chongqing, China, the SiC fab should start production in Q4 2025. Sanan will also build a separate 200mm SiC substrate manufacturing facility using its own process.

The joint venture will make SiC devices exclusively for ST, using ST proprietary SiC manufacturing process technology. The total inbvestment for the full build-out of the project is expected to be about $3.2 billion, including capital expenditures of about $2.4 billion over the next five years, financed by the two partners, local government support, and loans to the venture.

"China is moving fast towards electrification in automotive and industrial sectors, markets where ST is already well-established with many engaged customer programs. The combination of Sanan Optoelectronics' future 200mm substrate manufacturing facility with the front-end JV and ST's existing back-end facility in Shenzhen, China, will enable ST to offer our Chinese customers a fully vertically integrated SiC value chain," said Jean-Marc Chery, President and CEO of STMicroelectronics.

"The establishment of this JV will be a major driving force for the wide adoption of SiC devices on the Chinese market," said Simon Lin, CEO of Sanan Optoelectronics. "Being an international, well-known, high quality SiC foundry service company, Sanan will also supply its SiC substrate to this new joint venture, by building a dedicated new SiC substrate factory.

This is an important step for Sanan Optoelectronics' ambitions as a SiC foundry.

The completion of the project is subject to regulatory approvals.

**www.st.com**

life.augmented

三安光电 Sanan Optoelectronics


# Keysight leads 6G-SANDBOX ESA project

With the intent of advancing the integration of satellites with terrestrial 5G and 6G networks, the Horizon Europe-funded 6G-SANDBOX project has signed an agreement to establish an Open Innovation Laboratory with the European Space Agency (ESA). The focus of the collaboration, with Keysight Technologies as project leader, is to integrate non-terrestrial network (NTN) capabilities into the 6G-SANDBOX testbed, incorporating satellite connectivity across a range of different orbits, including Geostationary (GEO) and Low Earth Orbit (LEO), with the ESA 5G/6G Hubs.

This will enable the 6G-SANDBOX testbed to validate novel NTN topologies through additional 5G and 6G test capabilities. The effort will also support the goals of Horizon Europe's Smart Networks and Services Joint Undertaking (SNS JU) to further the competitiveness of Europe's communications industry.

6G-SANDBOX was launched in January 2023 by Keysight in collaboration with 16 partners to create a pan-European testbed for 6G experimentation, combining digital and physical nodes to deliver configurable, manageable, and controllable end-to-end networks to validate technologies and other advancements for 6G. In addition, 6G-SANBOX will enable companies in the European Union (EU) to test promising technical 6G enablers, including network automation, cybersecurity, digital twins, and AI. Since 2021, ESA's 5G/6G Hub has showcased terrestrial and non-terrestrial network convergence, enabled by 5G and upcoming 6G over satellite. 6G-SANDBOX has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe research and innovation program under Grant Agreement No 101096328.

**www.keysight.com**

# Next-gen E-Axles for EVx

Nidec and Renesas Electronics will join forces to develop semiconductor solutions for a next-generation E-Axle (X-in-1 system) that integrates an EV drive motor and power electronics for electric vehicles. An E-Axle integrates a motor, inverter, and gearbox to realize high performance and efficiency in a smaller size and lower cost while also integrating power electronics controls in an X-in-1 platform that provides multiple functions. Developing preventive safety technologies such as diagnostic functions and failure prediction is crucial for ensuring safety and security in vehicles.

Addressing this dvelopment need, the two companies will combine Nidec's motor technology and Renesas' semiconductor technology to creat an advanced proof of concept for the X-in-1 system. The companies plan to launch the first product by the end of 2023, which will feature a 6-in-1 system with a DC-DC converter, OBC, and power distribution unit, as well as a motor, inverter, and gearbox. In the second phase, Nidec and Renesas plan to develop a highly integrated X-in-1 PoC that incorporates a battery management system (BMS) along with other components. The first proof of concept will include SiC (silicon carbide) power devices, and the second will integrate GaN (gallium nitride) for excellent performance in high-frequency operation.

**www.nidec.com/en/renesas.com**

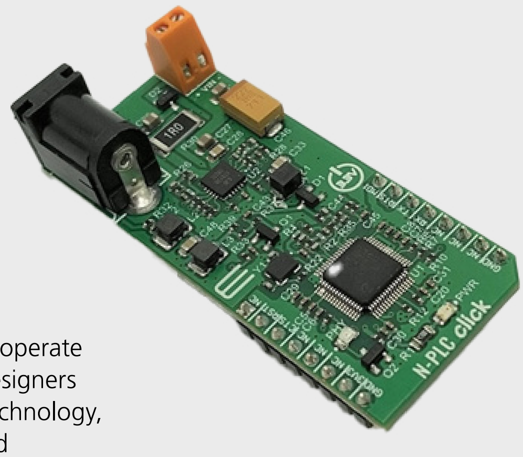
# Vitesco and onsemi sign SiC 10 year deal

Ensuring a supply of advanced wide-bandgap semiconductors is now a critical issue for companies that wish to stay competitive in the power electronics space. Addressing this need, Vitesco Technologies and onsemi have announced a 10-year supply agreement worth $1.9 billion for silicon carbide (SiC) devices to support the former's electrification efforts. Vitesco is also providing $250 million for onsemi equipment for SiC boule growth, wafer production, and epitaxy. Lastly, Vitesco and onsemi will also collaborate on optimized customer solutions, exemplified by onsemi's EliteSiC MOSFETs which are being used by Vitesco for traction inverters and electric vehicle drives.

According to Hassane El-Khoury, President and CEO of onsemi: "This collaboration will enable Vitesco Technologies to address their customers' demand for longer range and higher performance in electric vehicles. onsemi provides superior performance and quality, supply assurance, and manufacturing at scale of SiC technologies based on decades of experience in manufacturing power semiconductor products in high volume automotive applications."

**www.onsemi.com**

# Semitech's PLC tech now available as a Click Board




Addressing rapid prototyping and technology evaluation for Industrial IoT and other applications, Semitech Semiconductor announced that its SM2400 PLC solution is now available as a Click board from MikroElektronika (MIKROE).

Plug-and-play Click boards enable developers to easily evaluate advanced technologies and explore product ideas using modular, tested, and affordable hardware. Semitech's SM2400-based Click board can communicate over DC power lines and in conjunction with a coupler board can also communicate over AC lines. Features include multiple communication modes via firmware downloads, excellent noise resistance, and a PC-based GUI for easy evaluation and demonstration.

The cost-effective system can operate on AC or DC lines, and lets designers easily evaluate a company's technology, experiment with products, and reduce time to market through rapid prototyping.

Making Semitech's PLC technology more accessible via a PLC Click board is a modular solution that eases evaluation, integration, and prototyping fforts.

The Semitech PLC Click board will be bundled with a GUI-based user application to further enable easy evaluation and testing, supporting a number of standard-based and proprietary modes offered on Semitech's SM2400 platform.

Click boards follow a modular prototyping add-on board standard invented by MIKROE, which revolutionizes the way users add new functionalities to development boards.

Click boards enable design engineers to change peripherals easily, enable hundreds of Click boards to be connected to the microcontroller or microprocessor via the mikroBUS socket standard. The common interface allows any Click board to attach to the main board instantly.

**www.semitechsemi.com**

# IEEE defines specs for multi-Gb fibre optic automotive Ethernet

Addressing high-speed connectivity over fibre optics, the IEEE 802.3cz-2023 standard "IEEE Standard for Ethernet Amendment 7: Physical Layer Specifications and Management Parameters for multi-gigabit glass optical fiber automotive Ethernet" is an amendment to IEEE Std 802.3-2022 that adds Physical Layer specifications and management parameters for 2.5 Gb/s, 5 Gb/s, 10 Gb/s, 25 Gb/s, and 50 Gb/s operation on glass optical fibre in an automotive environment.

The 802.3 Task Force includes numerous individuals affiliated with key carmakers, such as PSA, Toyota, BMW, Ford, GM, and Volvo; Tier 1 suppliers; and components suppliers. The IEEE 802.3cz-2023 (nGBASE-AU) standard has been designed from scratch to meet stringent automotive requirements, using glass optical fibre to improve power consumption and reduce aging problems. IEEE 802.3cz provides a solution for 25 Gb/s and 50 Gb/s single lane connections with four inline connectors and a maximum length of 40 meters in the car over OM3 multimode fibre.

The standard specifies speeds of 2.5, 5, 10, 25, and 50 Gb/s per lane while meeting automotive temperatures from -40 °C to +105 °C and OEM reliability requirements with a maximum link length of 40 metres with four inline connectors. The solution is more cost-effective since the higher optical power budget allows lower-tolerance connectors.

The communication channel allows for a simpler physical layer with a lower DSP/equalization complexity and no echo cancellation. This results in lower power consumption, lower latency, and a smaller silicon area.

Fibre is inherently immune to EMI and does not emit interference. Cables can withstand extreme temperature ranges from -40 °C up to +125°C, and operation at the 980 nm wavelength allows VCSEL devices to comply with automotive reliability and lifetimes. Since no shielding is needed, connectors are smaller and mechanically more robust, and the smaller diameter of the OM3 fibre results in cost savings.

The IEEE 802.3cz-2023 Standard is available for download at: **https://standards.ieee.org/ieee/802.3cz/10918/**

# What's the Matter with Smart-Home tech?

With its widespread industry support from leading semiconductor manufacturers, including NXP Semiconductors, Silicon Labs, STMicroelectronics, Schneider Electric, Texas Instruments, Infineon Technologies, Nordic Semiconductor and Microchip Technology Inc., the Matter protocol promises to revolutionize smart home technology. In the latest installment of Mouser's award-winning Empowering Innovation Together (EIT) series, Mouser provides insights and resources to equip engineers and developers with the knowledge needed to design products that harness the power of this new standard.

The EIT Matter series features two new episodes of The Tech Between Us podcast, hosted by Mouser's Director of Technical Content Raymond Yin. In episodes part one and two, Yin is joined by Chris LaPré, Chief Technical Officer at the Connectivity Standards Alliance. The pair cover the market's introduction to Matter and explore the types of smart home devices compatible with the new standard. They also dive into the role the CSA plays with Matter and the future focus areas of interest. A third podcast, In Between the Tech, features an interview with Sujata Neidig, Director of Marketing for Wireless Connectivity at NXP Semiconductors. She'll discuss the types of hardware and software behind the Matter protocol, how it impacts manufacturers when it comes to product design and development, as well as what considerations engineers need to make when designing with Matter.

"Matter provides an exciting and innovative way to connect manufacturers, engineers, and consumers through a unified protocol, " says Raymond Yin, Mouser Electronics' Director of Technical Content and host of The Tech Between Us podcast. "I'm thrilled to see and share how companies and individuals are helping create a world of interconnected devices that bring us together by utilizing the Matter standard." Through educational interviews, infographics, articles, webinars and blogs, this installment explores topics like how to choose a suitable System-on-Module (SoM) for integration, tips for using Matter in product development, tutorials on developing applications based on Matter and more.

Following the Matter standard, the EIT series will further explore digital therapeutics, environmental sensors, Wi-Fi 7, and industrial machine vision. It will uncover the technical developments needed to keep pace with the evolving world, as well as highlight various new products in the marketplace.

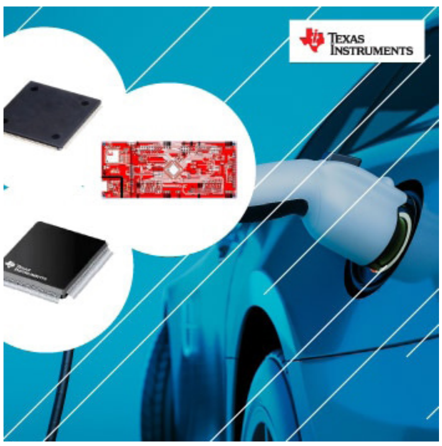
**https://eu.mouser.com/empowering-innovation/matter-protocol/**


# **Webinar:** simplifying EV chargers

As technology for electric vehicles (EVs) develops, there is now a growing demand for EVs to support both onboard charging (OBC) and DC fast charging. These additional requirements make it essential to develop simpler modular charging solutions that are easily scalable. Recently, Mouser teamed up with Texas Instruments to provide the engineering community with a new webinar entitled 'How to Simplify EV Charger Designs using C2000™ Microcontrollers'.

The webinar highlighted the importance of choosing a suitable MCU product family designed for efficiency in EV applications, such as TMS320F2838x/TMS320F2838x-Q1 C2000 32-bit MCUs and TMS320F2837xD Delfino dual-core MCUs, as well as accompanying development kits such as the LAUNCHXL-F280039C LaunchPad™ or the LAUNCHXL-F2800137 LaunchPad™ for initial evaluation and prototyping.

Presented by TI's Navaneeth Kumar who has 21 years of system expertise in products such as industrial and automotive motor control, solar inverter and UPS renewables, grid infrastructure and digital power, the webinar discusses: MCU features for scalable modular charging solutions; the flexibility of key peripherals; reference designs.




**https://emea.info.mouser.com/webinar-ti-evmcu-emea-lp/**

# Win a drone

Test your memory for the chance to win a DJI mini camera drone! Join Mouser Electronics and some of its valued manufacturers for a summer game. Match the logos in 90 seconds for the chance to win!

Easy and intuitive for beginners, DJI Mini 2 SE supports one-tap takeoff and landing with 30 minutes of flight time. Multiple intelligent modes enable users to get impressive 12MP photos and 2.7K HD videos.

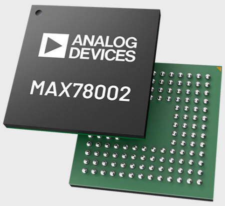
**https://emea.info.mouser.com/summer-memorygame-signup**

# More micros

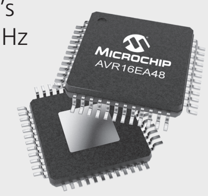
Microcontrollers are the foundational building blocks of any embedded systems design. Specified for a wide range of use cases, from ultra-low power fitness trackers to industrial automation sensor nodes, and automotive motor control to consumer smart home thermostats, the microcontroller is the computational heart of every embedded design. These versatile devices are increasingly highly integrated and optimised to suit specific applications, featuring the memory capacities, peripheral interfaces, and power management capabilities required.

New microcontroller highlights available from Mouser include:


The EZ-PD PMG1-B1 high voltage microcontroller from Infineon Technologies suits a broad range of USB C power delivery developments such as power tools, small consumer appliances, and electric bikes. Capable of accommodating a 4VDC to 24VDC input voltage with a tolerance up to 40VDC, this Arm® Cortex® M0+ 48MHz based microcontroller core features a comprehensive set of peripherals, including 21 GPIOs, 2 x 8-bit ADCs, 8 x 16-bit timer/counter/PWMs, a 12-bit ADC, and a cryptographic true random number generator (TRNG). An integrated buck/boost converter offers a configurable switching frequency from 160 kHz to 600 kHz and delivers an output voltage range from 3.3VDC to 21.5VDC.




Designed for battery-powered, ultra-low-power artificial intelligence at-the-edge applications, the dual-core MAX78002 AI microcontroller from Analog Devices, Inc. features an Arm Cortex-M4 core with a floating-point unit (FPU) capable of operating up to 120MHz and a 60MHz 32-bit RISC-V coprocessor. In addition, the MAX78002 integrates a convolutional neural network (CNN) accelerator that is optimised for use with deep neural network models with input image sizes of 2048 x 2048 pixels and a network depth of up to 128 layers. The accelerator is capable of processing VGA images at 30 fps. Image sensor interfaces include a MIPI CSI-2 camera controller, a 12-bit parallel camera interface, and an I2S controller for digital audio use cases. Example use cases for the MAX7002 include industrial sensors and process control, smart security cameras, and portable medical diagnostic equipment.




The AVR EA family is the latest addition to Microchip Technology's 8-bit AVR microcontroller line-up. Capable of running up to 20MHz and featuring 64 KB flash, 6 KB SRAM, and 512 B EEPROM, the EA family is available in 28-, 32- and 48-pin packages and suits a wide range of industrial, consumer and automotive applications. Data conversion and timer functions include two 16-bit timer/counters, four 16-bit input capture timer/counters, a 12-bit 375 ksps differential input ADC with an integrated programmable gain amplifier and a 10-bit DAC. Serial bus interfaces include three USARTs, an SPI, and an I2C-compatible two-wire interface capable of operating up to 1MHz in fast mode plus. Programmable GPIO pins are package dependent, ranging from 24 to 48 pins. The EA family is also equipped with various clock options, including an internal 20MHz high-precision oscillator and a 32.768 kHz crystal oscillator.

# Amphenol milestone

Mouser was recently honored with the 2022 Milestone Award from its valued partner Amphenol Corporation. The award was presented to the Mouser team, including Adrianne Kincade and Kevin Penner, Supplier Managers, who were recognized for excellence and dedication in the mutual success between Mouser and Amphenol and for reaching a significant POS milestone.

"On behalf of the Mouser team, we are proud to receive this award and thank Amphenol for the tremendous honor," said Jeff Newell, Mouser Electronics' Senior Vice President, Products. "Winning this award highlights the fantastic work delivered by the team and is testament to the strength of the partnership between Mouser and Amphenol."

With almost 600,000 Amphenol parts available to order, Mouser offers an ever-widening selection of the manufacturer's newest products, from electrical, electronic and fibre optic connectors, to interconnect systems, and coaxial and flat-ribbon cable.


**https://eu.mouser.com/manufacturer/amphenol/**

# All about autonomous vehicles

With increasingly complex hardware and systems, autonomous vehicles require reliable, connected solutions to create a seamless user experience. Driver safety, whether on the road or via cybersecurity, requires significant consideration, making it all the more critical for automotive designers to have access to trustworthy resources and made-to-order components. Mouser is helping engineers stay ahead of the latest automotive design trends with an extensive content hub dedicated to resources and developments in autonomous vehicle technology. In the all-inclusive content hub, Mouser provides technical resources for various automotive design aspects, such as LiDAR design and ADAS power. Access to Mouser's articles, videos, and blogs enables designers of all skill levels to find advanced solutions with reputable components.

Mouser’s vast stock of semiconductors and electronic components includes the following solutions for autonomous vehicle applications:

u-blox SAM-M10Q standard precision GNSS antenna module is small and high-performance with a simple interface that enables easy incorporation into user designs. Low power consumption allows for greater power autonomy for battery-operated devices. This device offers excellent out-band jamming immunity, such as caused by mobile phones. The SAM-M10Q also detects jamming and spoofing attempts and reports them to the host, so the system can react to such events.

ams OSRAM SPL SxL90A LiDAR QFN-packaged SMT lasers allow autonomous vehicles to ‘see’ further and more effectively with the infrared LiDAR components. Devices feature low-thermal resistance to withstand temperatures at high currents.

STMicro’s SPC58 N line performance microcontrollers are built to perform at high speeds with three cores that process accurately in real time. Meeting the highest ASIL-D safety levels, these MCUs support high operating temperatures and ensure augmented connectivity through different communication interfaces.

Taoglas Raptor III MA1280 7-in-1 public safety antenna is mounted in a small, robust, IP67-rated enclosure. It features multiband GNSS (GPS/GLONASS/BeiDou/Galileo), two 5G/4G cellular MIMOs, two dual-band Wi-Fi®, active AM/FM, and LMR (700MHz to 900MHz) antennas.


**https://resources.mouser.com/autonomous/**

# European support locations

## Your local contacts

**Germany (Main Branch)**
Elsenheimerstr. 11
80687 Munich
Germany
Tel: +49 (0)89 520 462 110

**Sweden**
Jungmansgatan 12 (floor 9)
211 11 Malmö
Sweden
Tel: +46 8 590 88 715

**United Kingdom**
Suite C, Floor 2
Artisan Building
Hillbottom Road
High Wycombe, Bucks.
HP12 4HJ, United Kingdom
Tel: +44 (0) 1494-427500

**Czech Republic**
AZ Tower
Pražákova 1008/69
639 00 Brno
Czech Republic
Tel: +420 517070880

**France**
Le Voltaire
1, Avenue Leo Lagrange
19100 Brive-La-Gaillarde
France
Tel: +33 5 55 85 79 96

**Israel**
1 Hanofar Street
43662 Raanana, Israel
Tel: +972 9 7783020

**Italy**
Centro Direzionale Milanofiori
Strada 1 Palazzo E1
20090 Assago-MI
Italy
Tel: +39 02 57506571

**Netherlands**
ESP 222, 5633 AC Eindhoven
The Netherlands
Tel: +31 88 1300 700

**Poland**
Pro-Concept Building
ul. Wyscigowa 56e
53-012 Wroclaw
Poland
Tel: +48 71 749 74 00

**Spain**
Parque de Negocios MAS BLAU I
Edificio Muntadas, Esc. B
C/ Berguedà nº 2, Planta 2
Local C1 y C3
08820 El Prat de Llobregat
Barcelona. Spain
Tel: +34 93 6455263

# TDK gold

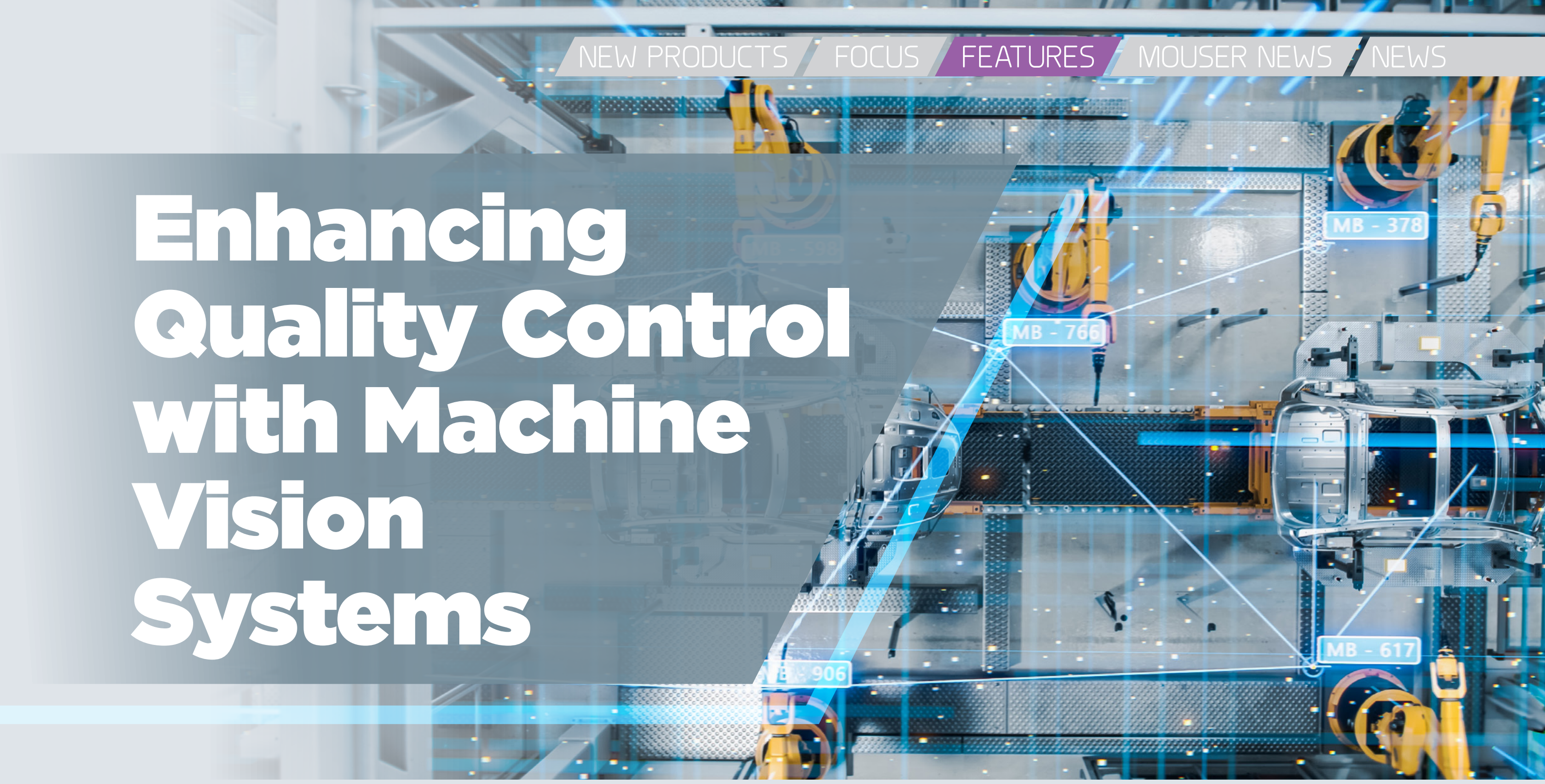
Mouser has won gold in the e-Catalogue Distributor category as part of the TDK European Distribution Award 2023. The award recognises outstanding performance, business development and operational success.

“We are extremely proud to receive this TDK European Distribution Gold Award in the e-Catalogue category, and we thank TDK for our strong business partnership,” said Marie-Pierre Ducharme, Vice President, EMEA Supplier Marketing and Business Development at Mouser Electronics. “Mouser has continued to deliver excellent service and growth, and we are pleased to honour them with this award,” said Dietmar Jaeger, head of TDK’s Global Distributor Division.


The main sales drivers for TDK in the region last year were products for e-mobility and charging infrastructure in the automotive sector, as well as components for regenerative energy production in the industrial electronics sector.

Mouser’s stocked portfolio of TDK parts includes passive components, such as ceramic, aluminum electrolytic and film capacitors, ferrites and inductors, high-frequency products, and piezo and protection components, as well as sensors, sensor systems and power supplies.

**https://eu.mouser.com/manufacturer/tdk/**




# Enhancing Quality Control with Machine Vision Systems

Image credit: Gorodenkoff/Shutterstock.com

By Deval Shah for Mouser

## Introduction

Machine Vision System is a technology that uses cameras and computer algorithms to perform inspections and measurements automatically, typically for quality control and automation in manufacturing environments.

Machine Vision Systems (MVS) have emerged as a benchmark in quality control, transforming production processes across industries. The purpose of these advanced systems is to automate inspection tasks, detect anomalies, and ensure the highest quality standards in manufactured goods. MVS offers improved accuracy, increased speed, and enhanced efficiency.

They eliminate human error, reduce waste, and deliver substantial cost savings, all while ensuring consistency in quality control.

Recent developments in MVS technology reflect a significant increase in deployment in diverse production processes.

This trend can be attributed to the system's ability to adapt, learn, and process complex data quickly.

Whether in the electronics industry for inspecting PCBs, the pharmaceutical industry for pill verification, or the automotive industry for part assembly verification, MVS has become integral to ensuring quality and maintaining competitiveness in today's fast-paced manufacturing landscape.

This article covers MVS capabilities, types, and underlying technology.

It delves into how artificial intelligence, deep learning, image processing algorithms, and neural networks bolster these systems, further enabling them to revolutionize quality control.

As we look toward the future, exploring emerging trends and advancements will underscore the continued potential of MVS in shaping various economic sectors.

## Technology Behind Machine Vision Systems

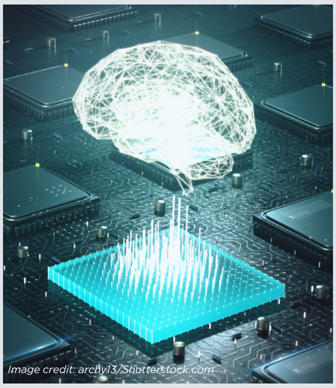
Machine Vision Systems (MVS) harness several advanced technologies to perform effective quality control. The fundamental components include image processing algorithms, artificial intelligence (AI), deep learning, and neural networks. These technologies work together to process and interpret visual data, allowing MVS to inspect, measure, and identify anomalies effectively.

### Image processing algorithms

Image processing algorithms serve as the main component in MVS, converting raw visual data into meaningful insights. These algorithms involve a sequence of computational operations that enhance, analyze, and interpret digital images. Standard procedures such as filtering, segmentation, and feature extraction help improve image quality and isolate the elements of interest, laying the foundation for subsequent analysis.

### Artificial Intelligence, Deep learning, Neural networks

The subsequent stages of interpretation and decision-making are powered by AI and its subsets, deep learning, and neural networks. AI enables MVS to mimic human intelligence, identify patterns, learn from experience, and make predictions.



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Deep learning, a subdomain of AI, goes further by utilizing neural networks - algorithms inspired by the human brain's structure and function - to carry out complex tasks. For example, convolutional neural networks (CNNs), a specific type of neural network, have proven highly effective in analyzing visual data.

CNNs can identify patterns with varying sizes, orientations, and positions in an image, enabling the automated detection of defects in manufactured products.

In essence, the union of these technologies allows MVS to perform at high accuracy. Image processing algorithms provide a solid foundation, while AI, deep learning, and neural networks equip these systems with a dynamic, evolving capability that can adapt and improve over time. Thus, the collaboration of these technologies is propelling MVS to the forefront of quality control solutions and shaping the future of manufacturing and production processes.

## Types of Machine Vision Systems for Quality Control

Machine Vision Systems (MVS) for quality control are generally categorized into three main types: 1D, 2D, and 3D vision systems, each with unique features, benefits, limitations, and applications that cater to different industry needs.

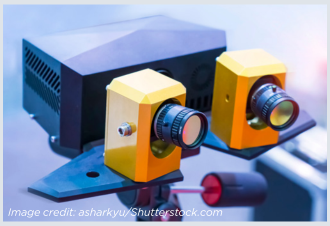


*Image credit: asharkyu/Shutterstock.com*

1D Vision Systems play a vital role in the packaging industry, assisting in barcode and QR code reading for product identification, inventory management, and tracking. For example, in beverage production lines, these systems scan barcodes on moving products, assessing legibility, and thus preventing defective goods from reaching the consumer.

2D Vision Systems are commonly deployed in the automotive manufacturing industry. These systems use high-speed cameras and advanced image processing algorithms to perform critical tasks such as defect detection and part identification. For instance, during the assembly process, a 2D Vision System might inspect and verify whether the correct components have been assembled in the right order and orientation. If a defect or error is detected, the system can signal to halt the production line, thereby preventing faulty units from progressing further in the manufacturing process.

3D Vision Systems capture depth information, enabling accurate measurement of object dimensions and volumetric data. Applications include robotics guidance, surface inspection, and object recognition.

## Advancements and current developments

### Emerging trends

Large Language Models (LLMs) are one of the most significant developments influencing the future of MVS in quality control processes. These models are part of the broader field of Natural Language Processing (NLP) and can understand, generate, and interpret human language.

LLM's potential applications in MVS can be seen in environments where textual or symbolic information needs to be analyzed. For instance, LLMs can be integrated with MVS to analyze the text on product packaging or labels for correctness or adherence to regulations.

They can also facilitate the interpretation of complex patterns or symbols which might be difficult for traditional image processing algorithms to handle.

LLMs, like GPT-3, trained on extensive datasets, can generate human-like text, offering new possibilities for interpreting and responding to complex patterns in image data. This advancement enhances the diagnostic capabilities of MVS, allowing them to provide detailed insights into quality control issues. It moves beyond mere detection, delivering comprehensive reports and facilitating informed decision-making.

## Advancements in sensor technology

High Dynamic Range (HDR) sensors can capture high-quality images under different lighting conditions. Traditional sensors can struggle to capture details in very bright and very dark areas within the same scene due to the limited dynamic range - the span between the lightest and darkest elements an image can capture without losing detail.

HDR sensors address this issue by effectively increasing the dynamic range.

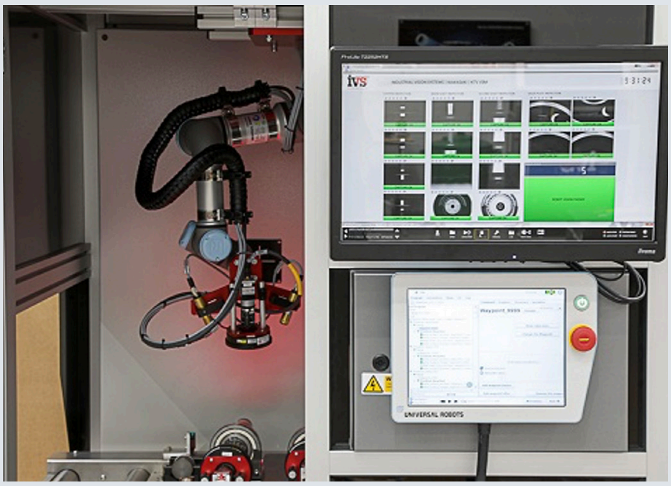
They do so by taking multiple images at different exposure levels (bracketing) and combining them into a single image that preserves details in both highlights and shadows. This process is known as tone mapping.

This adaptability is crucial in manufacturing environments where lighting conditions can vary widely, and unpredictability can lead to inspection inaccuracies.

The introduction of 3D sensors allows MVS to construct three-dimensional representations of objects, enabling detailed inspections and precise defect detection. The accuracy achieved with these developments could replace the need for final human inspection of products, thereby optimizing the quality control process further.

## Integration of machine vision systems with robotics

The integration of MVS with robotics is redefining the parameters of automated quality control. This enables real-time inspections, where robots equipped with MVS can scan products on the production line, identify defects, and even rectify issues without halting the production process.



A cobot equipped with a MVS for quality inspection. Image credit: Kawasaki Precision Machinery and Industrial Vision UK

The collaboration of MVS and robotics is more effective with the introduction of collaborative robots, or 'cobots' A cobot equipped with high-resolution imaging and sophisticated image processing algorithms can accurately identify minute defects that may be overlooked by human inspectors due to fatigue or human error.

Tesla is using MVS to add quality control during the production of their vehicles, reducing time on the line and improving the manufacturing process. Source: Tesla using MVS in assembly line.

Tesla is leveraging the power of MVS and Artificial Intelligence (AI) to accelerate and optimize its production process. Tesla's production facilities have significantly transitioned to automation, implementing advanced MVS for quality control.

These systems use high-resolution cameras and image-processing algorithms to scrutinize vehicles in real time during the assembly.

They inspect body panel alignment, paint quality, and other visual parameters, identifying defects with accuracy beyond human capabilities. Detected irregularities are corrected manually or automated, ensuring each Tesla vehicle adheres to stringent quality standards.

## Conclusion

Machine Vision Systems (MVS) are pivotal in enhancing quality control in manufacturing and production processes. Their ability to process visual data quickly and precisely makes them indispensable in modern industrial settings.

The evolving technology driving these systems, including image processing algorithms and Artificial Intelligence (AI), enhance their functionality and capabilities.

These transformative technologies are evolving rapidly, with advancements such as improved sensor technology and integration with robotics propelling the sector forward. Companies like Tesla are a testament to the large-scale potential of MVS and AI integration, indicating a future where such systems are ubiquitous in manufacturing facilities. As we look towards this future, it's evident that MVS will continue to drive quality improvements and operational efficiency in manufacturing, shaping the industry for years to come.

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# Matter Use Case: Commercial Facilities Automation

**By Tom Klein for Mouser Electronics**

When we discuss the Internet of Things (IoT), we generally consider the consumer side. Applications like smart homes and consumer ecosystems have become the most popular uses for the IoT, but, in reality, the field extends far beyond these examples.

One of the most exciting and important applications for the IoT is in the industrial sector. However, to truly benefit from the potential of the IoT, the industrial sector needs a way to create interoperability between devices that originate from disparate manufacturers. Matter has solved this challenge in the smart home space, and many believe its example can provide a path forward for the industrial sector.

In this blog, we'll discuss the Industrial Internet of Things (IIoT), Matter's impact in the smart home space, and how the industrial sector can apply these concepts to improve the factory floor.

## The Industrial Internet of Things (IIOT)

In general, "IoT" describes an ecosystem of interconnected devices that share data and information, which generally originate from onboard sensors. While the most mainstream application for the IoT is the smart home, the IoT also has huge potential in the industrial sector.

The IIoT refers to the application of the IoT on the factory floor. Here, disparate factory floor devices—such as industrial machinery, control devices, and other general devices such as heating, ventilation, and air-conditioning systems and lighting systems—are all able to communicate with operators and one another in real time.

In the industrial context, the IoT is an important technology because it has the potential to enable devices to share insightful data about factory floor operations with a central hub and with human operators. For example, an IIoT-enabled factory machine could share information about its operation compared to an accepted baseline, helping to indicate when it may need maintenance or service.

Today, most IIoT devices can communicate with their operators, but many still cannot communicate with one another.

This is primarily due to the fact that the IIoT devices on a factory floor often come from different manufacturers, meaning they were not designed explicitly to be interoperable with one another.

To truly unlock the potential of the IIoT, however, these disparate devices need to communicate with each other and make actionable decisions based on those data.

## Setting the Example for the Industrial Sector

While device-to-device interoperability remains a challenge in the industrial sector, the smart home has already found a solution sponsored by the Connectivity Standards Alliance (CSA) and supported by its membership of the leading home automation suppliers and vendors. That solution is Matter.

Matter is a membership-driven standard for home automation that aims to reduce fragmentation between different IoT vendors. Specifically, Matter defines a standard communication protocol that ensures that all Matter-certified devices are capable of interoperability.

The impetus to develop Matter came from the same situation the industrial sector is facing today: The smart home market is too fragmented. A modern smart home consists of devices from a variety of manufacturers, none of which are designed to work together. However, the smart home industry overcame this challenge through the collaborative development of Matter.

Therefore, Matter can be viewed as an example for the industrial sector: Through industry collaboration, device interoperability is indeed possible.

Matter sets the gold standard in terms of security. Uniquely, Matter was designed with device security and privacy in mind, consisting of requirements on the device hardware level all the way up to the system level, where the standard incorporates a number of privacy-preserving measures. Privacy-preserving measures are crucial in industrial applications where communicated data are likely proprietary to a company. Hence, Matter also provides a strong example of creating IIoT device interoperability without compromising security.

## Improving the Factory Floor

With the example set by Matter and the comprehensive technology set forth by the IIoT, some very powerful industrial use cases could be unlocked. Specifically, device-to-device interoperability in the IIoT could enable commercial facilities that are truly automated and scalable.

In an industrial setting, one is likely to find an array of different devices, including circuits for controlling industrial power, lighting systems, factory machinery, and more. When these devices are deployed independently of one another, they each can perform their own task, but the factory as a whole lacks synergy and cohesion.

For example, consider an assembly line where an upstream machine assembles a part and sends it to a downstream machine for further assembly. Now consider that the upstream machine fails and begins producing faulty parts.

Without device-to-device communication, the downstream machine has no way of knowing about these failures and could continue operating on faulty parts, which risks further compounding the errors and potentially leads to machine damage and lost profits.

Instead, with a factory floor full of interoperable machines, each device can know the status of the other devices and can make insightful decisions accordingly. For example, once aware of the upstream device's failure, the downstream device could instead cease operations and notify a human operator to intervene.

In this way, IIoT device interoperability could enable factories with higher autonomy and less need for human intervention, ultimately leading to greater productivity, reliability, and safety.

Device-to-device interoperability in the IIoT also helps factory owners scale and upgrade their equipment with ease. Without a standard like Matter, creating an IIoT ecosystem where devices are interoperable requires employing devices from a single vendor.

This makes replacing or adding equipment to a factory floor difficult because limited options exist for factory owners who want to stay within their ecosystem.

With a Matter-like solution, factory owners instead have the freedom to choose from any number of suppliers when upgrading or adding functionality to their floors without sacrificing their systems' cohesion.

## Conclusion

For the IIoT to achieve its full potential, the industrial sector requires interoperability for disparate IIoT devices. With the example set by Matter, the industrial sector has a clear path forward to creating a factory floor that is safer, more productive, and more profitable than otherwise possible.


# Architecting a High Channel Density Digital IO Module for Next-Generation Industrial Automation Controllers

By Suhel Dhanani, Business Development Director, Analog Devices

There is a lot of ink spilled on Industry 4.0 and the rising ubiquity of intelligent sensors on the factory floor (by me as well as by other authors). While sensor proliferation is something we see in factories, process plants, and even in newer building automation systems, one important change this ubiquity of sensors necessitates is the requirement to process a large number of IOs within typically the same old controller form factor. The IOs can be digital or analog.

This requires architecting a high density IO module with size and heat constraints. I will focus on the digital IOs in this article and take on the analog IOs in a subsequent piece.

Typically, the digital IOs in PLCs were conditioned using discrete components like resistors/capacitors or driven using individual FETs.

The need to minimize the footprint of the controllers along with the real requirement of being able to process 2× to 4× the number of channels are pushing a move away from discrete implementation to an integrated approach.

We could fill an entire article with the disadvantages of a discrete component approach, especially when the number of channels being processed per module is eight or higher, but in summary, high heat/power dissipation, the unwieldy number of discrete parts required (both from a size and a mean time between failure (MTBF) perspective), and the need to have a rugged system specification have almost completely rendered the discrete approach unworkable.

Below shows the technical challenges of architecting a high density digital input (DI) and digital output (DO) modules.

Size and heat are considerations in both DI and DO systems.

### Digital Input

- Size
- Heat
- Support for all input types
  - Type 1, 2, 3, inputs
  - Support for 24V and 48V input
- Robust operating specs
- Wire break detection

### Digital Output

- Support for different types of output driver configuration
- Size
  - Integrated demagnetization of inductive load
- Heat—when driving multiple outputs
- Drive accuracy
- Diagnostics

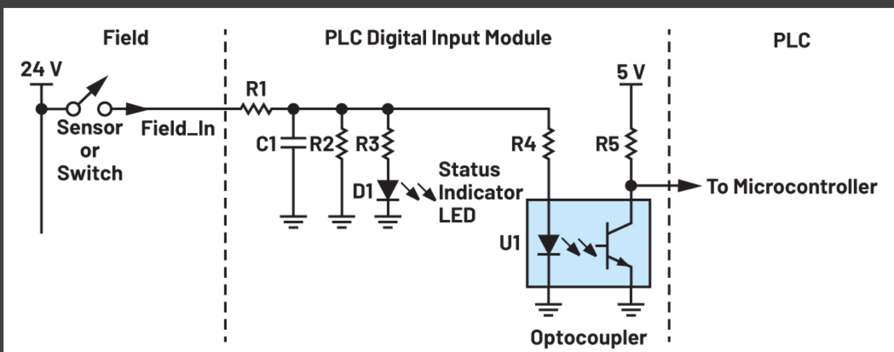



***Figure 1.*** A traditional digital input design using discrete logic.

For digital inputs, it is also important that different types of inputs are supported—both types (types 1, 2, 3) of inputs—and in some cases, 24V and 48V inputs. In all cases, robust operating specifications are very important and sometimes wire break detection is crucial.

For digital outputs, systems use different FET configurations to drive the load. The accuracy of the drive current is generally an important consideration. And in many cases, diagnostics are important.

We will discuss how an integrated solution can help with some of these challenges.

## Designing a High Channel Density Digital Input Module

A traditional discrete design uses a resistor divider network to convert a 24V/48V signal to something a microcontroller can use. There can be a discrete RC filter at the front as well. If isolation is a requirement, an external optocoupler is sometimes used.

Figure 1 illustrates a typical discrete approach to implement a digital input circuit.

This type of design is good for up to a certain number of digital inputs; say 4 to 8 per board. Any number beyond that and it rapidly becomes impractical. The different issues with such a discrete implementation include:

- High power consumption and associated board hot spots
- One optocoupler needed for each individual channel
- Too many components resulting in low FIT rate and even requiring a larger form factor

Most importantly, a discrete design approach means the input current increases linearly with input voltage. Assume a 2.2kΩ input resistor and a 24V VIN. When the input is 1, that is, at 24V, the input current is 11 mA, which equates to power consumption of 264mW. For an 8-channel module, the power consumption is over 2W and for a 32-channel module, the power consumption is over 8W. See Table 1.

| Number of DI Channels | Estimated Power Consumption (W) |
|---|---|
| 8 | 2.1 |
| 16 | 4.2 |
| 32 | 8.4 |
| 64 | 16.9 |

***Table 1.*** Estimated Power Consumption for a Digital Input Module Done Using Discrete Logic

Purely from a heat perspective, this discrete design cannot support multiple channels on a single board.

One of the biggest advantages of an integrated digital input design is significantly lower power consumption and thus heat dissipation. Most integrated digital input devices allow for configurable input-current limiting, dramatically reducing power consumption.

With current limit set to 2.6mA, the power dissipation is reduced significantly to approximately 60mW per channel. An 8-channel digital input module can now be rated at under half a watt as shown in Table 2.

| Number of DI Channels | Estimated Power Consumption (Discrete Approach) (W) | Estimated Power Consumption (Integrated Approach) (W) |
|---|---|---|
| 8 | 2.1 | 0.48 |
| 16 | 4.2 | 0.96 |
| 32 | 8.4 | 1.92 |
| 64 | 16.9 | 3.84 |

***Table 2.*** Estimated Power Savings in Digital Input Modules Using an Integrated DI Chip

Another reason going against a discrete logic implementation is that sometimes DI modules must support different types of inputs.

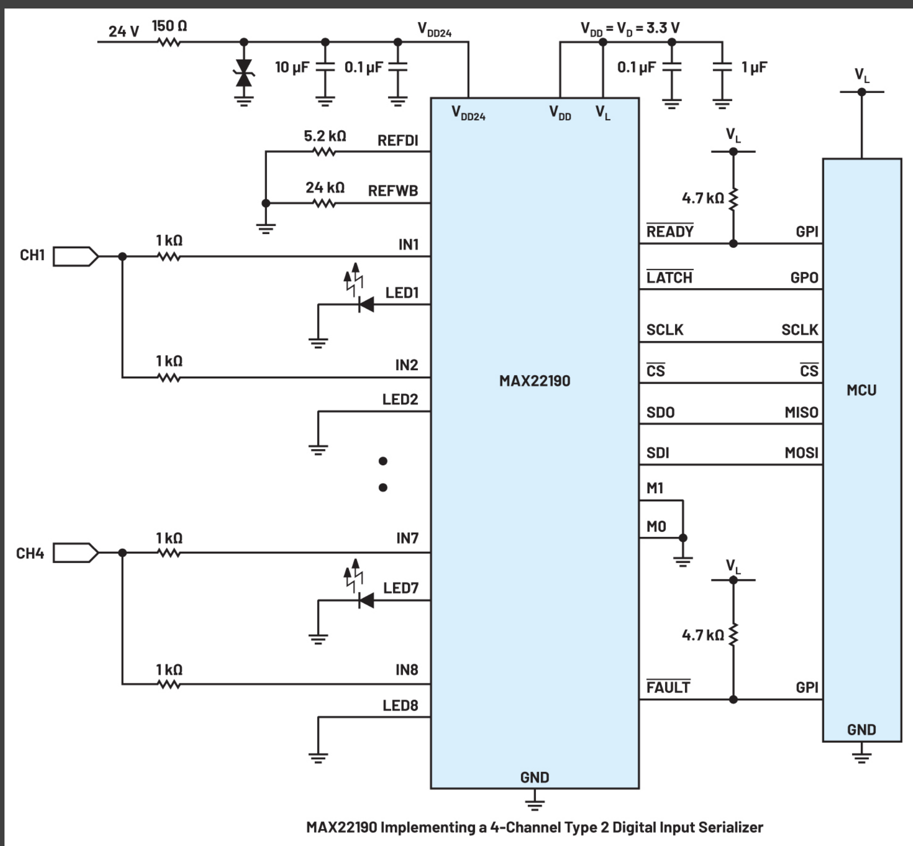



***Figure 2.*** Using two channels in parallel to support a Type 2 digital input.

The standard 24V digital input specification published by the IEC is divided into types 1, 2, and 3. Types 1 and 3 are generally lumped together as the current and the threshold limits are very similar. Type 2 has a 6mA current limit, which is much higher. With a discrete approach, this would require a redesign since most discrete values would need to be updated.

However, integrated digital input products can typically support all these three types. Natively, types 1 and 3 are always supported by integrated digital input devices.


However, to meet the minimum 6mA current requirement for Type 2 inputs, we need to use two channels in parallel for one field input and adjust the current limit resistors. There would be a board change, but it is minimal.

For example, the current Analog Devices DI devices have a current limit of 3.5mA/channel. So, as shown, we would use two channels in parallel and adjust the REFDI resistor and the RIN resistors if the system must interface with Type 2 inputs. For some of the newer devices, we can also select the current value using a pin or through software.

To support a 48V digital input signal (not a very common requirement) would require a similar process where one would have to add an external resistor to adjust the field side voltage threshold. The value of this external resistor is set so that Current limit × R + threshold at pin meets the field side voltage threshold specification (defined in the data sheet of the device).

Finally, since digital input modules are interfacing with sensors, they must be designed to robust operating specifications.

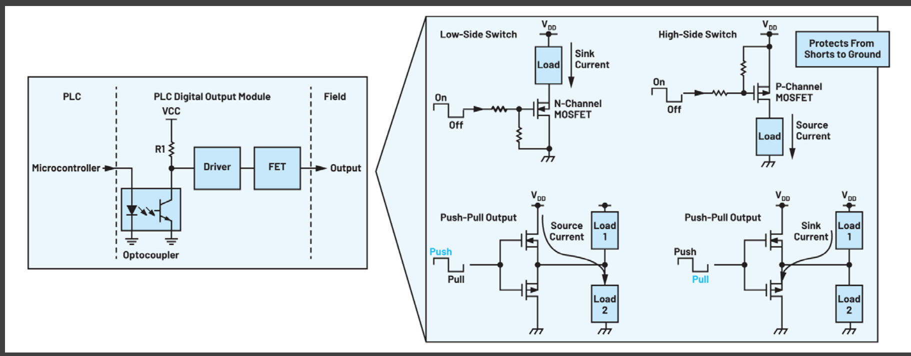



***Figure 3.*** Different configurations used for digital output drivers.

When implemented using discrete components, these protections must be carefully designed.

When choosing integrated digital input devices, ensure these come with these industrial-ready specifications:

- Wide input voltage range (up to 40V for example)
- Ability to operate from field supply (7V to 5V)
- High ESD (±15kV ESD air gap) and surge tolerant (typically 1kV)

It is also very useful to have overvoltage and overtemperature diagnostics so that the MCU can take appropriate action.

## Designing a High Channel Density Digital Output Module

A typical discrete digital output design features a FET with drives circuitry driven by the microcontroller. There are different ways of configuring the FET to drive the microcontroller.

The definition of a high-side load switch is that it is controlled by an external enable signal and connects or disconnects a power source to a given load. Compared to a low-side load switch, a high-side switch sources current to the load, while the low-side type connects or disconnects the load to ground, and therefore sinks current from the load. While they both use a single FET, the problem with the low-side switch is that the load could get shorted to the ground. High-side switches protect the load from shorts to ground.

But the low-side switch implementation is marginally lower cost. Sometimes output drivers are also configured as push-pull that requires two MOSFETs. See Figure 3.

Integrated DO devices can incorporate multiple DO channels in a single device.

Since the FET configuration is different for high-side, low-side, and push-pull, different devices are available to implement each type of an output driver.

## Built-In Demagnetization for Inductive Loads

One of the key advantages of an integrated digital output device is that demagnetization for inductive loads is built-in to these devices.

An inductive load is any device that has coils of wire that, when energized, generally perform some mechanical work; for example, solenoids, motors, and actuators. The magnetic field caused by the current flow can move the switching contacts in a relay or contactor, operate solenoid valves, or rotate a shaft in a motor.

Mostly, engineers use a high-side switch to control the inductive load, and the challenge is how to discharge the energy in the inductor when the switch opens, and the current is no longer sourced to the load. The negative impacts of not discharging this energy correctly include potential arcing of relay contacts, large negative voltage spikes damaging sensitive ICs, and the generation of high frequency noise or EMI that can affect system performance.

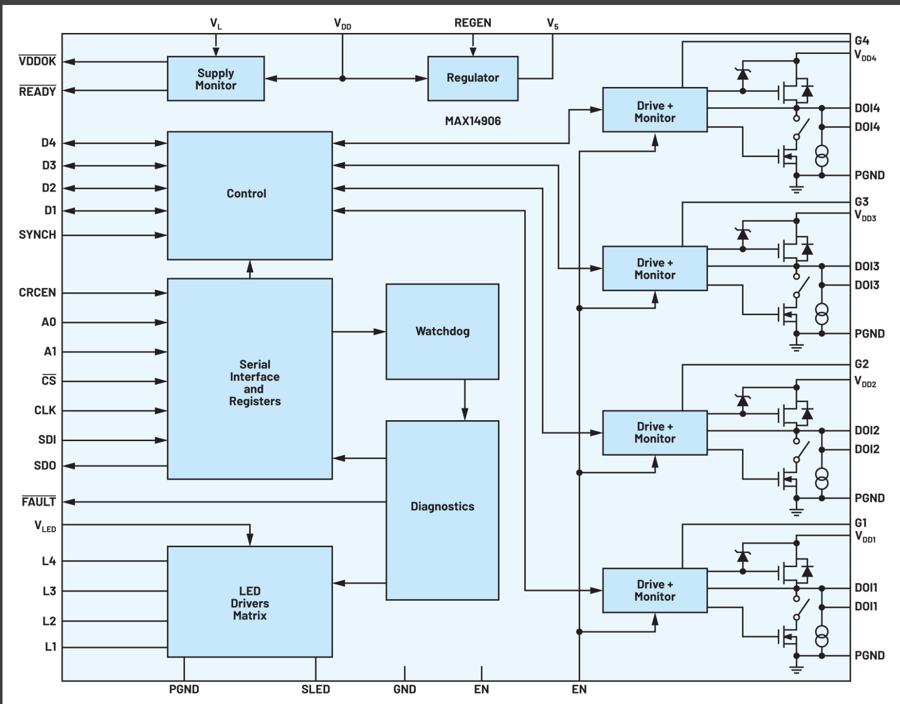



***Figure 4.*** A configurable DI/DO product for a 4-channel implementation.

In a discrete implementation, the most common solution to discharge the inductive load uses a free-wheeling diode. In this circuit, while the switch is closed, the diode is reverse-biased and does not conduct any current.

When the switch opens, the negative voltage across the inductor forward biases the diode, allowing the stored energy to decay by conducting the current through the diode until steady state is reached and the current is zero.

For many applications, especially those found in industrial applications that have many output channels per IO card, this diode is often physically quite large and adds significant extra cost and size to the design.

Modern digital output devices implement this function within the device using a kind of active clamping circuitry. For example, ADI implements a patented safe demagnetization (SafeDemag™) feature that allows our digital-output devices to safely turn off loads with unlimited inductance.

More details are available in the application note "Switching Inductive Loads with Safe Demagnetization."

There are many important factors when selecting a digital output device.

*Image credit: panuwat phimpha/Shutterstock.com*

Some of the following data sheet specifications should be considered carefully:

- Look at the maximum continuous current rating and ensure that if needed, you can parallel multiple outputs to get a higher current drive
- Ensure the output device can drive multiple channels with high currents (over the temperature range). Refer the data sheet specifications to ensure the on-resistance, supply current, and thermal resistance values are as low as possible
- The output current drive accuracy specification is also important

Diagnostic information is also essential to recover from some out-of-range operating conditions.

First, you want diagnostic information reported per output channel. This will be temperature, overcurrent, open, and shorts. On a global (chip) basis, some important diagnostics are thermal shutdown, VDD undervoltage, and SPI diagnostics. Look for some or all of this in the integrated digital output device.

## Programmable Digital Input/Output Device

Once we start integrating DI and DO on an IC, it allows us to build products that are configurable. Figure 4 is an example of a 4-channel product that can be configured as an input or an output.

This has a DIO core, which means a single channel can be configured as a DI (Type 1/3 or Type 2) or a digital output in either a high-side or in a push-pull mode. The current limit on the DO can be set from 130mA to 1.2A. Demagnetization is built-in. To switch between Type 1/3 or Type 2 digital inputs, we only need to set a pin and no external resistors are needed.

These devices are not only very configurable but also ruggedized to work in an industrial setting. This means high ESD, supply voltage protected up to 60V, and line to ground surge protection.

This is an example of something completely different (a configurable DI/DO module) possible with an integrated approach.

## Conclusion

Once you are designing a high density digital input or output module, it becomes clear that beyond a certain channel density, a discrete implementation does not make a lot of sense. From heat, reliability, and size considerations, an integrated device option must be carefully considered. When choosing integrated DI or DO devices, the robust operating specifications, diagnostics, and the support of multiple input-output configurations are some of the important data points to keep in mind.

# Using vibration monitoring, Edge AI and SPE/PoDL for predictive maintenance

Image credit: Phonlamai Photo/Shutterstock.com

**By Thomas Mauer, Texas Instruments**

Factory production lines, manufacturing robots (see Figure 1) and wind turbines can unexpectedly break down due to hardware failures that are very expensive to repair. Some of these failures, such as worn-out gears, motors and mechanical interconnections, may already be visible long before a total breakdown event. Figure 2 illustrates the steps of such degradation over time.

***Figure 1:*** A robotic machinery installation in a factory floor

Predictive maintenance is a proactive approach that can offer significant benefits in factory automation. By using technologies such as vibration sensing and edge artificial intelligence (AI), predictive maintenance can detect potential equipment failures before they occur, allowing maintenance teams to take corrective action before equipment failure occurs and thus reducing the risk of unplanned downtime, increasing equipment lifespans, and improving operational efficiency.

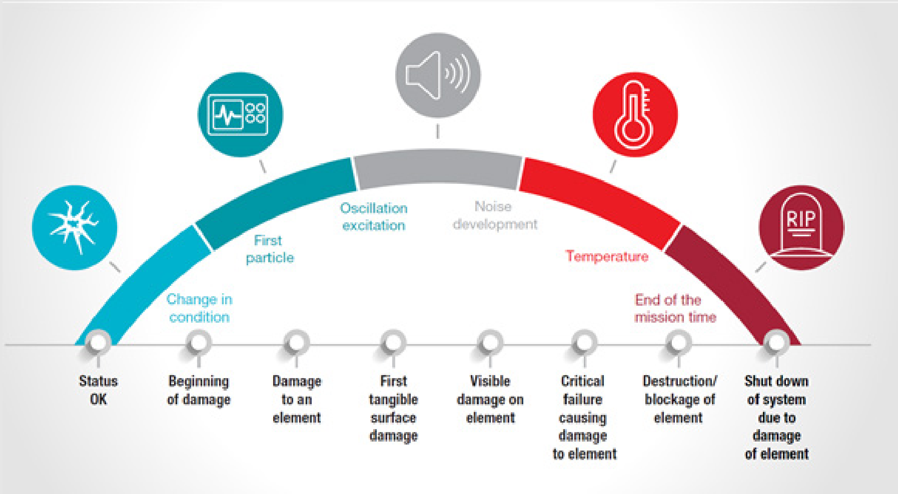



***Figure 2:*** How machinery degrades, from being fully operational to shutting down

Vibration sensing technology plays a critical role in predictive maintenance, allowing the monitoring of equipment for signs of wear and tear or other anomalies, while edge AI enables the monitoring and analysis of equipment in real time.

## Predictive maintenance with vibration sensing and edge AI

A predictive maintenance system with vibration sensing and edge AI contains the components shown in Figure 3.

Attached to the motor or the turbine is an integrated electronics piezoelectric (IEPE) sensor, which measures the vibration in the machinery. The analog IEPE vibration sensor signal requires conditioning, so the data-acquisition block converts the signal from the analog to the digital domain.

Data analysis, typically performed using time- and frequency-domain graphs, is calculated at the sensor board to match the data against the failure models. Fast Fourier transform (FFT) is one method of data analysis.

A degrading motor or turbine will show higher amplitudes, as well as additional spikes in the frequency-domain graph. A data-collecting gateway sends the results of the data analysis to the cloud, where a plant operator uses operative technology to access it.

Figure 4 shows a predictive maintenance system with TI hardware. The IEPE sensor board connects to as many as four IEPE vibration sensors. The IEPE sensor board also performs signal conditioning and data acquisition with the ADS127L11 delta-sigma analog-to-digital converter (ADC).

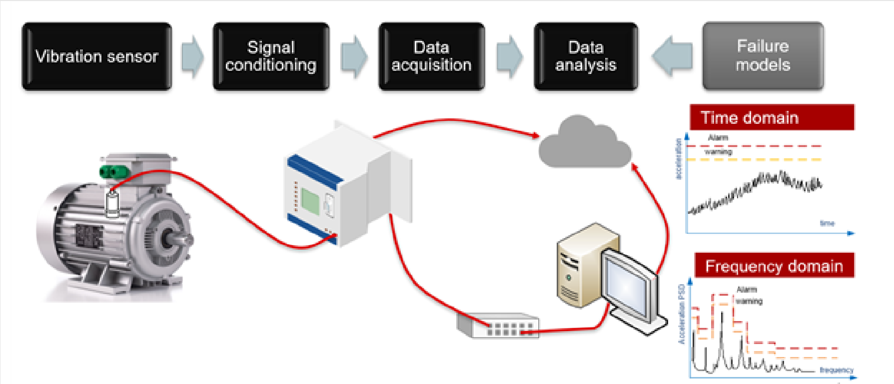



***Figure 3***: A predictive maintenance system with vibration sensing and edge AI

The edge processing board reads the ADC samples using the [AM2434](#) microcontroller (MCU) and performs FFT calculations and additional data analysis. The edge processing board is powered by power over data line (PoDL), which combines data and power using single-pair Ethernet (SPE).

The edge processing board sends data analysis (such as FFT results) over SPE to the gateway carrier board. The gateway carrier board collects data analysis from up to four edge processing boards, which are connected over the four SPE/PoDL ports. In total, this gateway carrier board can collect data analysis for as many as 16 IEPE vibration sensors.

The [Four-Channel Synchronous Vibration Sensor Interface Reference Design](#) (Figure 5) is a synchronous, wideband high-resolution interface. Its main target is vibration sensing applications, but it is also a good fit for any application that requires wideband front-end, such as three-phase voltage and current monitoring in power-factor correction. It contains four signal-chain front-ends and four ADS127L11 ADCs. The parallel interface of the ADC interfaces to the sensor gateway carrier board MCU and enables a high-speed data bus.

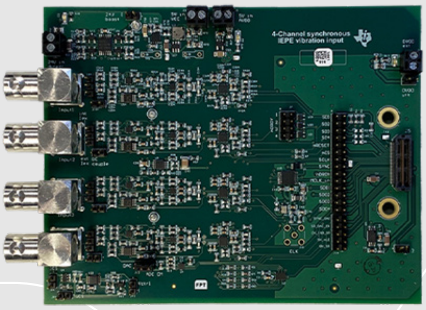


***Figure 5:*** IEPE vibration sensor board

The synchronous four-channel wideband integrated electronic piezoelectric (IEPE) sensor interface connects to four individual IEPE vibration sensors, which are placed directly at a vibration sources such as motor or gear box.

The edge processing board (Figure 6) contains four AM2434 Arm® Cortex®-R5F-based MCUs, programmable real-time cores to interface to the sensor board, and the DP83TD510E SPE physical layer (PHY). The edge processing board receives the ADC samples over the parallel interface from the sensor board. The Cortex-R5F MCU performs data analysis such as FFT and sends that analysis over the 10-Mbps T1L SPE interface to the gateway carrier board.

The edge processing board and IEPE sensor board receive the 24-V power supply over PoDL from the two-wire SPE connection. The edge processing board uses FreeRTOS on the Cortex-R5F MCU and [TQ-Group's TQMa243xL system on module (SOM)](#), which includes the AM2434 MCU, double-data-rate four random access memory, an embedded multimedia card and power-management integrated circuit. The SOM simplifies board layout and time to market when developing the gateway carrier board.

***Figure 6:*** Edge processing board

The gateway carrier board (Figure 7) contains two Arm Cortex-A53 microprocessors and four Arm Cortex-R5F MCUs. The gateway carrier board has four SPE/PoDL power-sourcing equipment ports to provide data and 24 V to as many as four edge processing boards. The cable reach of the SPE interface is up to 2000 meters. The gateway carrier board provides a Gigabit Ethernet uplink port for cloud and operative technology connections. The gateway carrier board's operating system is Linux and uses and [TQ-Group's TQMA64XXL system on module (SOM)](#).

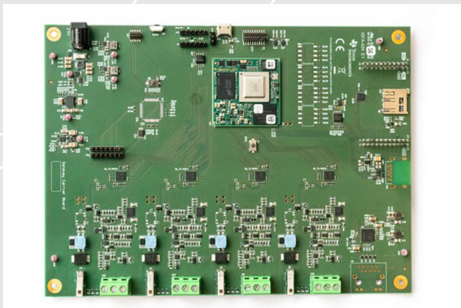


***Figure 7:*** Gateway carrier board

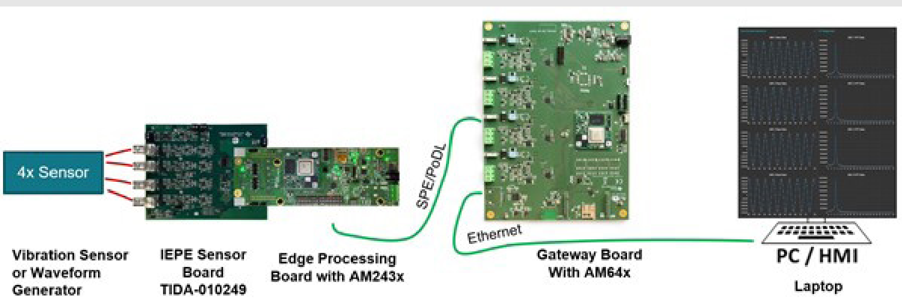



***Figure 4:*** TI evaluation demonstrating a predictive maintenance system

## Conclusion

To reduce downtime, costs and damages, factory plant operators need to invest in automation that supports predictive maintenance with vibration monitoring and edge AI. TI's analog and embedded products enable such predictive maintenance technology.

# Adapting Ethernet to Accelerate Industry 4.0

**By Steven Keeping for Mouser Electronics**

*Image credit: Blue Planet Studio/Shutterstock.com*

Back in the 70s, “Industry 3.0” was the name for the paradigm shift in manufacturing that embraced information technology to boost automation and enhance productivity, precision, and flexibility. As Industry 4.0 matures, the large-scale automation of industry through smart technology, machine-to-machine (M2M) communication, and machine learning (ML) is being realized. The key difference between the two is that while Industry 3.0 provided the information for humans to make better decisions, Industry 4.0 uses digital information to optimize processes largely without our intervention.

More than that, Industry 4.0 can now form a link between the factory design office and its manufacturing floor. By using M2M communications, computer-aided design (CAD) can talk to machine tools and directly program them to make parts. And machine tools can speak to CAD to let it know of challenges in the production process such that items can be modified to make them easier to fabricate.

The Industrial Internet of Things (IIoT) is the platform upon which manufacturers are building their Industry 4.0 solutions. An important role of the network is to form feedback loops whereby sensors monitor processes, and their data is used to control and enhance machine operation.

While implementing the IIoT is far from simple, perhaps the biggest challenge is the cost of investment. While the investment can be justified through cost savings brought by better design and manufacturing, yielding productivity increases and fewer product failures, anything that can reduce capital outflows is likely to accelerate Industry 4.0 adoption. One way to do that is to base a factory’s IIoT network on proven, accessible, and relatively inexpensive Ethernet communication technology.

## Ethernet for Industry

As the most widely used wired networking option across the world, Ethernet brings good vendor support and IP interoperability. Moreover, one set of cabling can be used to carry current as well as data to power connected sensors, actuators, and cameras.

Featuring rugged connectors and cables, “Industrial Ethernet” builds on the consumer version of Ethernet to provide a proven and mature technology for industrial automation. Industrial Ethernet not only allows the transport of vital information, but also enables a remote supervisor to easily access machines, PLCs, and controllers on the shop floor.

However, standard Ethernet protocol is prone to lost packets, which increases its latency. That makes it unsuitable for synchronized and rapidly moving assembly lines. To overcome the standard protocol’s weaknesses, Industrial Ethernet hardware is teamed with deterministic, low-latency industrial protocols, including Ethernet/IP, ModbusTCP, and PROFINET.

Industrial Ethernet deployments use hardened versions of the standard product’s CAT 5e and, for certified Gigabit Ethernet, CAT 6 cable.

CAT 5e cable, for example, comprises eight wires collected into four twisted pairs. The twisting limits signal interference ("cross talk") between each wire pair. A pair offers both sides of a duplex connection. For high-speed systems, such as Gigabit Ethernet, all four pairs are used for carrying data.

Systems with lower throughput requirements (up to 100 megabits per second) can operate using just two twisted pairs, leaving the spares for things like power or conventional phone services.

## Proprietary Solutions Fill the Gap

One drawback of using CAT 5e cable for IIoT deployments is that it is overengineered for many tasks. High-speed Ethernet is all well and good when machine tools are being programmed from CAD, but is hardly required for a sensor reporting the speed of a conveyor belt. And much of an Ethernet-based IIoT is used for gathering modest amounts of sensor information to optimize the manufacturing process.

Image credit: asharkyu/Shutterstock.com

That could mean a lot of capital expense tied up in kilometers of cable with engineering capabilities that are never going to be used.

In the cost-sensitive industrial sector such waste is generally avoided by turning to cheaper alternative. Instead of tying up money in expensive cables, manufacturers have turned to much-less-expensive proprietary fieldbus alternatives to connect sensors and systems that don't need the full capabilities of Ethernet.

These fieldbuses are typically used for applications such as industrial instrumentation and remote I/O and offer cable lengths of up to one kilometer and raw data throughputs of up to ten megabits per second. Many of these proprietary fieldbus options—for example, HART, PROFIBUS PA, and 4-20mA—use relatively inexpensive single twisted pair cable.

Today, factories implementing Industry 4.0 use standard Ethernet for things such as enterprise resource planning (ERP) and CAD, Industrial Ethernet for engineering operations and plant asset management, and proprietary fieldbuses for instrumentation and remote I/O.

This is not ideal because while the first two systems play nicely together, the latter is not interoperable with them.

## Introducing Single Pair Ethernet

IEEE 802.3cg, a recent Ethernet specification amendment, is designed to address industrial applications that are currently serviced by non-Ethernet fieldbuses. The amendment is gaining momentum because it allows all factory Industry 4.0 operations to use the Ethernet platform. Every piece of equipment, from the main factory cloud server, through remote terminals, and down to the lowliest temperature monitor, will be able to talk to each other through a single standards-based protocol.

A key component of the specification amendment is the Single Pair Ethernet (SPE) cable, which, as the name suggests, carries data over just a single twisted pair rather than the multi-pair CAT 5e cable of conventional Industrial Ethernet.

This is a boon to factory owners because it significantly lowers the cost and bulk of much of their building's communication wiring. Better yet, albeit with new Ethernet connectors, legacy proprietary fieldbus single twisted pair wiring can be repurposed for SPE use—there's no need to rip out kilometers of old cable to replace with new ones.

IEEE 802.3cg also introduces two new physical layers (PHYs) to suit industrial applications and keep costs down. The first is for short-reach applications (up to 15 meters), while the second offers up to one kilometer reach and includes an optional amplified transmit level for increased noise tolerance and a low-power idle mode to save energy.

## The Importance of 'Right First Time'

Modern manufacturing demands precision and repeatability. A component or subassembly must be manufactured to tolerances tight enough such that they can be used in any of thousands of examples of an end-product and yet operate perfectly for years. As things get smaller or more complex, the greater the precision required; imagine consistently fabricating a high-end mechanical watch or the latest smartphone.

The IIoT can bring this precision by enabling real-time control and spotting deviations before they get out of hand. Getting products right the first time reduces consumer failures and endless warranty claims. It also saves money, and perhaps more importantly is more sustainable because making things correctly the first time as saves energy, emissions, and precious materials.

## Conclusion

Single Pair Ethernet enables engineers to take advantage of Industrial Ethernet throughout the factory even for operation of the lowliest sensor. That makes it easier gather and analyze the deep data needed to both enhance manufacturing operations and maximize the impact of new technologies such as ML and AI.

# Talking Test

**By Stuart Cording, Consulting Engineer**

Whatever your new normal is – back in the lab, remote or hybrid – you'll need good test resources with the emphasis on accuracy, flexibility, portability and affordability. Electronics engineer and technical writer Stuart Cording, who focuses primarily on the semiconductor and embedded systems sectors, is here to help.

# Monitoring and Maintaining Industrial Systems

Watching how things are manufactured, from our food to vehicles and consumer electronics, is always fascinating. Only through considerable investments in engineering is it possible to streamline processes with automated equipment so that, 24 hours a day, seven days a week, our favorite snacks, cars, and home entertainment can be packaged up and delivered to wherever you prefer to shop.

However, the effort needed to refine operations and install and maintain such equipment is significant. Maintenance, for example, is moving away from fixed schedules toward predictive systems that can recognize different forms of deterioration. This is then noted and shared with the team using Industrial IoT (IIoT) platforms, allowing them time to implement a low-cost, low-effort repair or upgrade rather than suffer an expensive period of downtime and replacement.

Over the years, many businesses have relied on the tenured engineer's soothsaying powers to determine between a good and troubling knocking sound. However, with pressure growing to reduce carbon footprints and increase efficiency, businesses need to turn to test equipment that delivers, as far as possible, quantitative measurements upon which to make decisions.

## Maintaining motors

At the center of many industrial processes are motors attached to conveyor belts, pumps, or air-moving systems for extraction or cooling. Both mechanical and electrical stresses may lead to a breakdown in the winding insulation. This can result in a short to the chassis rendering the motor inoperable. Maintenance teams can schedule regular insulation measurements, but this requires planning downtime for the tests and disconnecting the motor. On top, insulation measurement requires experienced personnel. Without the necessary skill, the results may vary too wildly for trend detection, leading to either missing a pending failure or acting too soon.

Ideally, motor insulation testing would be integrated into a manufacturing facility, and this is just what the K7GE-MG Insulation Resistance Monitor Controller from Omron offers. The approach requires a main unit (K7GE-MGM or ) plus between one and eight probe units (K7HE-MG1), depending on the number of motors you wish to monitor. The main unit delivers its results to a PLC via RS-485 or can be monitored by a dedicated PC using a suitable protocol converter.

It is also available in two models: the K7GE-MGMA for monitoring 100 to 240 VAC, or the K7GE-MGMD for 24 VAC or DC.

***Figure 1:*** Motor insulation remains continually monitored with Omron's K7GE-MG resistance monitor controller.

If the motor is connected directly to its supply, the probe unit is connected between the contactor and the motor. For inverter-driven motors, the connection is established between the inverter and motor. Once configured, the main unit initiates measurements using the Megger method during periods when the motor isn't operating, logs the results, and displays a pass/warning/critical output on the front panel (Figure 2).

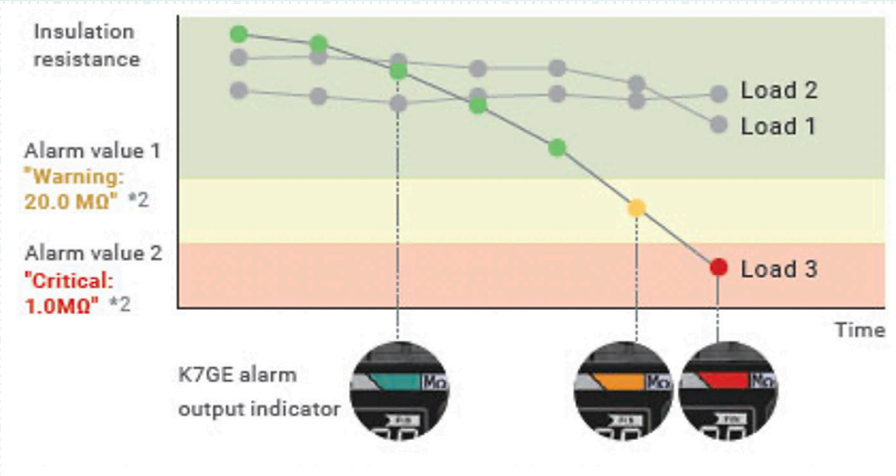



***Figure 2:*** Automated measurement allows the maintenance team to detect pending motor insulation failure that could be related to an electrical or mechanical issue. (Source: OMRON Corporation)

Unlike other megohmmeter equipment that uses 500VDC or more, the main unit uses just 50VDC. Should the motor be started during testing, measurement is interrupted and also logged. If insulation measurement using traditional test equipment is still required, this is easily supported thanks to the probe unit's internal dry contact, isolating it from the target equipment.

## Testing industrial sensor connections

While industrial systems are going digital, many legacy systems still use analog sensor signaling. When troubleshooting, it can be helpful to replicate the signal required rather than try and force the system to generate it. The analog signals used vary, with some sensors generating 4 – 20mA, others ±10V, and many more variations. If this is a challenge you regularly face, then it's worth looking at the DFRobot FIT0778 High Precision Handheld Signal Generator. Fitting easily in your hand or pocket (100 × 60 × 20mm/ 3.94 × 2.36 × 0.79 inches), the unit is powered via USB (5VDC), although a 3.7V, 1000 mAh lithium battery can be optionally fitted. Alternatively, a 15 - 30VDC supply can be attached via the unit's terminal connector (Figure 3).

***Figure 3***: A single rotary-push knob makes for easy configuration of the DFRobot FIT0778 handheld signal generator.

Before generating any signals, the unit can be calibrated to ensure that -10V, 0V, and +10V are correct, and the same applies to the current signal outputs. Operation is implemented with a rotating knob that can also be pressed to confirm inputs and mode selection. The display outputs the setup information, voltage or current selected, or the output setting as a value between 0 and 100%. Even away from industrial automation, this handheld unit could be helpful when testing embedded systems.

## Monitoring processes

While it is nice when everything works, it is even more reassuring when you can see something is working. Then, when it doesn't, you have some initial data to determine why. Process meters turn process signals into a readable format, allowing you to see whether a sensor is outputting data quickly. Helping make the invisible visible is Murata with their DMR30-PM1 DC Process Meters. Measuring 71mm across (fitting into a 50mm hole), this meter provides a bright LED display with five alphanumeric digits in red, green, or blue (Figure 4).

***Figure 4:*** With four capacitive touch inputs, users can configure the DMR30-PM1 process monitor for voltage and current signals.

The unit can measure voltages from 0 to 10V or current loops from 0 to 20mA and operates from a 9 to 32VDC supply. Thanks to its internal microcontroller and four capacitive-touch input buttons, the measurement range, display digits, display brightness, and upper and lower limits can be set.

If needed, the meter can also trigger an alarm at a high or low limit (Figure 5). To improve triggering, a hysteresis value may also be defined. Should the unit be deployed in an electrically noisy environment, slow or fast filtering options can also be used to compensate.

Reaching the low or high limit is displayed on two separate LEDs. Coupled with the alarm is a solid-state relay output that can handle ±250mA at up to ±40VDC. Engagement of the relay is indicated via a separate LED; for testing purposes, the relay may be temporarily engaged using the menu on the control panel.

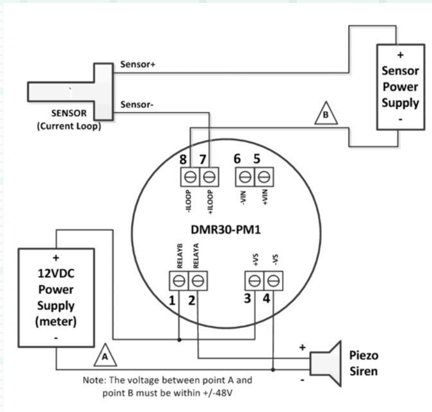



***Figure 5***: If required, the DMR30-PM1 can monitor a process and control an output at a defined upper or lower limit. (Source: Murata Power Solutions, Inc.)

## Finding cables and more

To rework a popular quote, trust is good, but testing is better; an adage to which most can subscribe, especially regarding resolving issues with cabling and electrical panels. And, to support sleuthing technicians on their search for poorly documented switch panels and cable routing is the Extech CLT600 Advanced Cable Locator & Tracer Kit. The kit comes in a carry case with the transmitter, receiver (Figure 6), cables for US power sockets, batteries, and a ground spike. For use in the EU, the optional Euro 2-pin Type C Plug can be ordered separately (CLT-ADP-EU).


***Figure 6:*** Included in the CLT600 kit are a transmitter and receiver, both of which include backlit displays and an in-built torch.

During operation, the transmitter outputs a high-frequency signal that the receiver can detect. Depending on the issue being tackled, this enables the determination of which breaker is responsible for which circuit, helps to find cable breaks (Figure 7) and shorts, and allows tracing of cable paths in walls or underground. For more complex challenges, several transmitters can be used at the same time using one of eight different codes.

When tracing cables and receptacles, the receiver displays the signal strength along with the code. The receiver can also be used for non-contact voltage detection.

The receiver generates an audible tone when a signal is detected. However, if the units are used in an office environment, this may be turned off to minimize disturbance. The displays on both handheld units include backlights that can be turned on and off and a torch light for searching in dark corners and panels. The transmitter can measure voltages between 12 and 450V AC/DC, while the receiver can detect cables buried to a depth of up to 50 cm (19.6 inches).

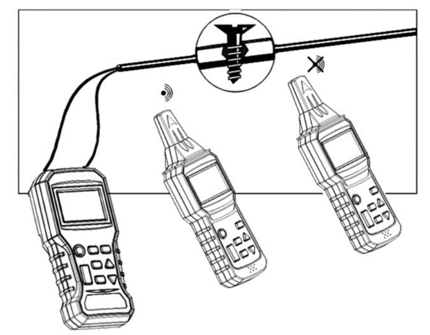


***Figure 7:*** The CLT600 can be used for many cable testing situations, including broken cables. (Source: FLIR Systems, Inc.)

## Keeping manufacturers manufacturing

While legendary engineers kept manufacturing plant up and running in the past, and their exploits are still shared over tea breaks, technology has moved on. Predictive maintenance doesn't need to be all-encompassing or complicated.

The Omron motor insulation resistance monitoring system could easily be deployed on plant that is difficult to reach, thereby saving time and money if the budget isn't there to go full IIoT. Handheld tools are also great for quickly testing sensors and PLC inputs or checking for cabling defects.

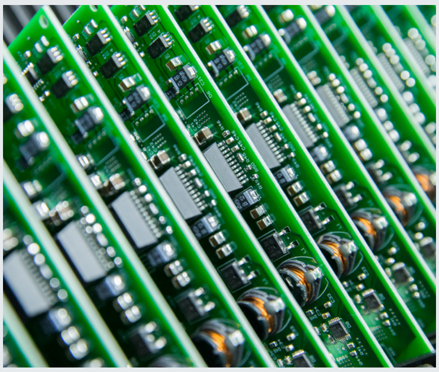
Furthermore, they are easily stored in a cupboard for occasional use. Finally, you can't turn down the offer of a nice panel meter for showing process information, and, with its monitoring capability and alarm output, the unit from Murata makes a great addition to any control panel.

# From the Connector Geek

Don't diss connectors! David Pike is proud to call himself the 'Connector Geek'. He has spent nearly 30 years in the interconnection marketplace, working with manufacturers and distributors, building a reputation throughout the industry for his passion and knowledge. So we gave him his own series...

# IS THERE A FUTURE FOR PRESS-FIT CONNECTORS?

The printed circuit board or PCB has been with us since long before the microprocessor was invented. With the birth of semiconductors and the advent of electronic miniaturization, the established methods of joining circuits, especially using wires and wire wrap connectors, fell out of use and the PCB has come to dominate the electronics market.



The PCB offers several advantages over previous technologies. It is compact, it can be mass-produced in almost any shape to suit the application and, with the development of multi-layer boards, it has become an extremely complex and capable solution for electronic designers.

When the PCB was first introduced, all the components were mounted to the board using through-hole pins.

The terminals or leads were pushed into holes that were drilled into the board and plated to provide continuity. Once placed into the board, the underside was then soldered to ensure a secure physical and electrical contact. While through-hole mounting provides a very stable solution, the disadvantage of this technique is that components can only be mounted to the top surface of the board. The soldering process uses a wave soldering machine that would damage any components that might be mounted underneath.

This limitation has been overcome by the advent of surface-mount technology (SMT). Using SMT, components are fixed to pre-placed solder pads on the surface of the PCB. The components are then secured to the PCB using heat to melt the solder pads and form the connection. As the board does not use a traditional solder bath, components can be mounted to both sides.

## Through-Hole and Surface Mount

SMT boards also allow a far greater density of components to be placed on the board, and SMT has largely replaced through-hole techniques, especially for small designs.

However, components that use through-hole mounting are still highly useful. They provide a reliable way to join the several layers of a PCB, unlike a component that is mounted onto the surface which does not penetrate the board to provide the same connection.

Some components also need to carry a higher energy in the form of greater electrical current. In these circumstances, through-hole components can offer a greater capacity for power. Modern applications in the renewable energy sector are seeing a greater need for power connectors on the PCB in battery management systems. Through-hole components still have a significant future.

Through-hole mounting does not always require soldering, however. Press-fit contacts have been used in the electronics industry since the earliest days of printed circuit board design. Conventional press-fit terminals use solid pins with a square cross-section.

The sharp corners of the pin are designed to deform the plating of the through-holes to form a gas-tight seal, ensuring both a secure mechanical joint and a reliable electrical connection.

The drawback of this technique is that pressing the pin into the hole risks damage to the PCB, and it is rarely repairable.

Despite this, press-fit connectors offer some key advantages for designers and manufacturers. Many designers like the flexibility that press-fit connectors deliver to the production process.

They can be mounted to a PCB after it has undergone the soldering process without the need to reheat the board which reduces the risk of damage caused by thermal stress. As the joint is solder free, it removes the risk of failures due to defects in the soldering process or deterioration over time and, unlike conventional connectors, they can be mounted to the underside of the PCB.

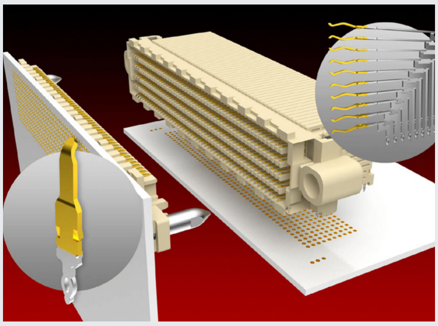
## New Solutions for Press Fit Connectors

Press-fit connectors therefore remain a popular choice for PCB designers, but the conventional fixed square-post shape could be improved upon. The next step in the evolution of press-fit connectors was the compliant pin, resembling the eye of a needle.

The hollow shape allows the pin to deform when it is pressed into the board, reducing the damage caused to the hole plating. The spring shape helps to retain the pin in the hole and allows an element of repairability.

The precise form of these compliant pins varies from one manufacturer to another, but it has become a common sight on even the most up-to-date connector. The hard-metric footprint backplane connectors have become very popular with press-fit contacts as their default termination method.

These are available from many manufacturers including EDAC and TE Connectivity. For more up-to-date high-speed applications, the Samtec SEARAY™ system can support signal speeds of up to 56 Gbps PAM4 using an eye-of-the-needle design for easy fitting.



Samtec SEARAY™ Press Fit Connectors

Connector manufacturer Amphenol Positronic has taken compliant tails one step further. Named Omega after the Greek letter that they resemble, their flexibility ensures the same stable mechanical and electrical joint without the fixed pin that can damage through-hole plating.

The Omega press-fit contact provides an additional advantage for designers who need to protect their printed circuit board. The growing sophistication of miniaturized electronics has allowed PCBs to become more compact and complex.

Their small size means they can be used in devices that are deployed into tough conditions. In the harsh environment of the factory, modern automation systems are tasked with delivering reliable performance. Even PCBs that are sealed inside enclosures must be protected.

One of the common causes of failure in electronic systems is the damage caused by oxidation. Exposed to moisture in the air, the metallic components on the PCB can corrode. With enough time, this corrosion can cause permanent damage and create short or open circuits. The resulting failure can produce results that range from just inconvenient to potentially life-threatening.

To protect the PCB against damage caused by moisture, many manufacturers turn to conformal coatings. A conformal coating is a polymer that is applied to the PCB using a vapor deposition process. The polymer is introduced into a chamber as a cloud vapor that covers the entire PCB with a consistent thickness that is resistant to water and other contaminants.

## Terminating Connectors with Conformal Coatings

The disadvantage of conformal coating is that it must be applied after the soldering of components to the PCB, as the heat of the reflow process would melt the polymer. For most components, this presents no problem. However, the polymer cannot be allowed to cover the contacts of connectors that are installed on the PCB. The polymer functions as an insulator, preventing the connector from working correctly.

The normal method to prevent this happening is to apply a mask over the mating face of the connector before the coating is applied. In this way, the contacts are prevented from being exposed to the polymer. Once the coating has been completed, the mask can be removed, and the PCB used as intended. The process of applying and removing the mask is time-consuming as it needs be conducted by hand, which adds significantly to the overall cost of the PCB.

This is where the new generation of press-fit contact becomes attractive. It offers an alternative to the costly and time-consuming process of masking. The latest designs means that a connector that is fitted with these contacts can be mounted to the PCB after the conformal coating has been applied. The contact simply pierces through the thin conformal layer, and the compliant design ensures a secure, gas-tight joint when fully seated.

## Conclusion


Press-fit termination may not be the newest technology on the market, but it remains a popular solution. With designers looking to protect their devices against long-term damage, press-fit terminals might offer a future of easy assembly with the superior long-term reliability that is afforded by the latest conformal coatings.

# THE SYSTEMS' PERSPECTIVE

By Adam Taylor and Dr Richard Harriss

Adam Taylor and Dr Richard Harriss conclude their deep-dive into systems engineering. Taylor (above left), the Founder and Principal Consultant at Adiuvo Engineering, chartered engineer and fellow of the Institute of Engineering and Technology, and Visiting Professor of embedded systems at the University of Lincoln, believes' Systems engineering encompasses the whole lifecycle...it is the breadth of systems that exist in the world, and also the different ways in which these systems are conceived and used'. Co-author Dr Richard Harriss is an expert in the development of high-integrity electronic systems for both aerospace and space applications. Harriss has a degree in Physics from Oxford University and holds a PhD in optoelectronics. With over a decade of experience working in the electronics industry, Harriss is also a skilled practitioner of model-based engineering (MBE), having significant experience with both Model Based Systems Engineering (MBSE) and Model Based Design (MBD) for FPGA.

## MBSE AND THE FUTURE OF SYSTEMS ENGINEERING



### Introduction

In this final article on our series on systems engineering, we are going to take a look at some of the emerging developments in systems engineering whilst also looking at what the future of systems engineering holds. In particular, we are going to briefly introduce the concept of 'model based systems engineering' (MBSE). MBSE is a fairly new paradigm within systems engineering that is often surrounded by a degree of mystery and confusion. We are going to attempt to briefly describe what MBSE is and how it differs from 'traditional' systems engineering paradigms. We are also going to attempt to put this into the broader context of the challenge facing systems engineering (and engineering more widely) and how this is likely to impact the future of systems engineering.

### The Future Challenge

In 2021 the International Council on Systems Engineering (INCOSE) publish a report called 'Systems Engineering Vision 2035'. This document was made freely available as a resource to the systems engineering community and aims to define the current state systems engineering, the future challenges, and what systems engineering may look like by 2035. This document is well worth a read as it sets out a compelling view of how systems engineering may change in the next decade. Much of this article is based around the content from Vision 2035.

INCOSE's Vision 2035 identifies a number of key challenges facing humanity. These challenges are likely to shape the practice of systems engineering as we try and develop solutions to tackle these, often significant, issues.

The challenges identified by Vision 2035 includes items such as:

- Reducing poverty, inequality, and hunger
- Improving health, wellbeing, and education
- Tackling climate change and improving sustainability
- Ensuring continued economic growth

Combined with the large scale challenges facing humanity Vision 2035 also identifies a number of global megatrends that shape the needs and expectations for systems in the future.

These megatrends are likely to influence the nature of systems and therefore the ways that we develop those systems.

These megatrends include:

- Increasingly interdependent world
- Digital transformation
- Industry 4.0 and Society 5.0 (increasing reliance on cyber-physical systems)
- Proliferation of smart systems
- Increases in system complexity (e.g. inclusion of autonomy and AI)
- Increasing prevalence of trusted systems (safe and secure systems)

Finally Vision 2035 also identifies that there are also likely to be changes to the enterprises that develop systems. These changes are in part a response to the increasingly complex systems that we are developing, but will in themselves impact the way that we engineer and develop the systems of the future.

These changes include:

- Globalization
- Increased focus on sustainability
- Emergence and adoption of new technology (e.g. AI)
- Supply chain integration
- Automation and digital transformation

Overall these challenges are likely to result in a growth in system complexity as we attempt to tackle some of the largest challenges humanity has faced. It is expected that systems engineering will need to adapt to enable us to be better handle this complexity.

## What does the Future of Systems Engineering Look Like?

Over the last 5 articles we have broadly covered what the current state of systems engineering looks like. Hopefully you have gotten a sense that systems engineering is an increasingly valued engineering discipline whose practices and methods are relatively mature. As of the early 2020s many industries and organizations have recognized the benefits of systems engineering and have formally adopted systems engineering either in whole or in part. This is especially true within industries that are routinely required to develop complex systems.

However, the level of maturity of systems engineering practice does vary across different industries with different levels of adoption and also different methods being employed.

When considering the challenges outlined in the previous section systems engineering will likely have to change over the next decade to meet these challenges. In general terms systems engineering will likely need be able to handle increasing system complexity, whilst aligning to global trends across society and industry, all within a context of greater stakeholder expectations. In some industries this may mean that systems thinking and systems engineering practices may become more common place. Whilst in other industries (particularly those already performing systems engineering) the practice of systems engineering may need to evolve.

Systems engineering of the future is likely to see increasing use of model based practices enabled via increasing levels of digitization. We will talk more about model based systems engineering in the next section, however in outline a model based approach is one that relies on modelling, simulation and visualization techniques to specify, design, analyze and verify systems.

This is in contrast to more traditional forms of systems engineering which are often described as being 'document centric'. In a model based approach the technical baseline for the system is moved from documents to integrated (digital) models.

Increasing digitization is likely to enable these models to be become higher fidelity and will ultimately allow significant increases in the ability of systems engineers to analyze and assess different design solutions before building those systems. This will in turn enable better decision making helping to ensure that the solutions that are developed are better able to meet the expectations of the systems' stakeholders.

As well as digitization, AI (artificial intelligence) is likely to impact systems engineering in the same way that it is expected to impact other parts of human society. AI is likely to automate many mundane or routine tasks such as data entry or report generation. The same is likely to happen within systems engineering. However at its core engineering will still likely remain as a human focused activity. This is because engineering generally requires the employment of creativity, leadership, and analytical skills, all of which require human input. This means that engineering will still likely be centered around human engineers, however those engineers will likely employ AI tools that automate much of the routine work that systems engineers currently undertake. This will mean that the role of the systems engineer is likely to become more focused on defining design intent and on making key decisions and less focused on writing reports and collating data.

The systems of the future will be increasingly complex. This is likely to drive systems engineers to have to develop greater cross functional skillsets. This will likely include developing skills in areas such as AI, decision making and data analysis. Data analysis is likely to be a key skillset for systems engineers. As system complexity grows the amount of data that will be required to analyze systems will also grow. This will require systems engineers to become more comfortable working with and analysing large sets of data. The use of data science methods are likely to become more important to the systems engineers of the future. AI is also likely to become a key component of systems of the future. This will mean that systems engineers will need to become more comfortable working with AI enabled systems.

## Model Based Systems Engineering

We have already mentioned that the future of systems engineering is likely to be heavily based around model based systems engineering (MBSE). However, MBSE is a technique that is already in common use in many organizations. MBSE has been used for around a decade now, however it is often seen as a somewhat opaque term and is often surrounded by an air of mystery. INCOSE defines MBSE as follows:

"*MBSE is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases*"

At its core MBSE does not represent a completely new paradigm of systems engineering, but rather is a way of realizing the objectives of a systems engineering lifecycle using models. This is in contrast to traditional systems engineering workflows which are often described as being 'document centric'. A document centric workflow is one where the outputs from the various systems engineering activities are contained in a series of documents (be they textual or other forms of documentation like spreadsheets). The key limitation of this type of approach is that information is contained within a single item (i.e. a document) meaning analyzing such data is often difficult as you are generally reliant on a human to interpret such data. There is also an issue in that information is often duplicated across documents making maintenance of information hard. This duplication of information can also create ambiguity if there is conflicting information in different documents.

By contrast an MBSE based approach aims to move the data that would traditionally be contained in documents into a model of some sort. Often these models are built around some form of database that allows information to be shared and re-used across different aspects of the model.

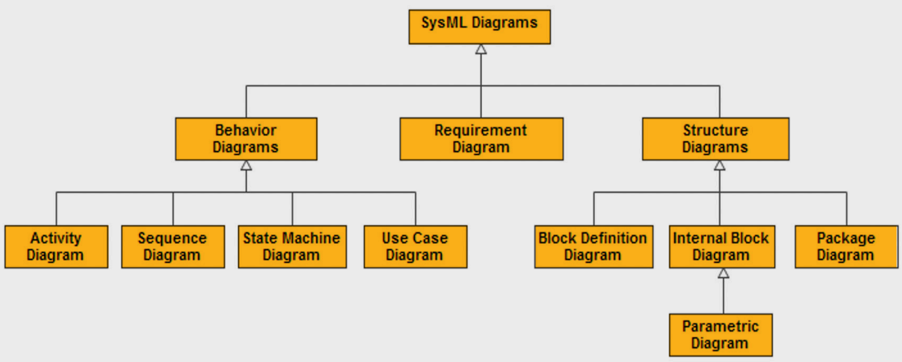
The primary advantage of a model is that it can be analyzed more easily than a set of documents. Duplication of information can also be avoided as a single piece of information can be re-used in multiple places (as opposed to being 'copy pasted' in a document based workflow). This can help to create a single source of truth by ensuring that each piece of information is created only once and then re-used where required. To illustrate why this is useful imagine you are having to make some form of change to your system design. In a document based workflow you might have to go and find all of the documents that are impacted and then manually update all of the relevant documents. In a model based workflow you can more easily link information together making it much easier to find which parts of your system design are impacted by a change. Furthermore if you have created a single source of truth the process of updating your model may also be much quicker as you only have to make a single change to your design that will propagate automatically through the model.

Another key advantage of a model based approach is that it can help to standardize the way that information is presented to a user of the model. Within systems engineering we often draw diagrams or write large bodies of text. Both of these can be ambiguous. Often a model based approach will standardize the way that information is presented (often through the use of a specific diagram notation). Furthermore by standardizing the way that information is stored in a model it is often possible for computer systems to interrogate the model thus enabling automation of key systems engineering tasks.

This can help to drive efficiency and productivity.

Often when we talk about MBSE the subject of SysML comes up. SysML (the system modelling language) is a diagrammatic language that is often used to realize an MBSE based workflow. However it is worth pointing out that the concept of MBSE is larger than SysML. SysML is one (albeit common) way of implementing an MBSE based approach. SysML provides a set of standards for the creation of diagrams that can be used to describe a system as a diagrammatic based model. These diagrams are generally created using a database of objects that are then used to create a set of SysML diagrams. The SysML diagrams are broadly divided into two groups; one group defines the structure of a system whilst the other describes the behavior of a system. Together these diagrams, and the database of objects that underpin them, can be used to describe a system in a way that meets both the general aims of a systems engineering workflow as well as an MBSE based approach. If the reader is interested in finding out more about SysML INCOSE provide a useful introduction here.

It is worth highlighting, however, that there are other equally valid approaches to MBSE that can be implemented.



One limitation of SysML-like approaches is that they define a static view of a system through the creation of a series of diagrams. Another equally valid approach is to describe a system through a series of numerical models that can be executed and simulated. A common way of doing this is using a tool like Simulink from Mathworks. These types of models allow dynamic models of a system to be created which can then be simulated to understand how the system will behave or perform. This type of approach has the advantage of allowing the design space to be explored before the system is built.

This allows the overall behavior and performance of the system to be validated through simulation before committing to a single design. This can help to increase the knowledge of a system before having to commit cost thus making it far more likely that a project will be successful. Often a combination of static modelling (like SysML) combined with some form of numerical modelling (like Simulink) can provide the most powerful approach.

The static modelling provides a way of documenting the design whilst the numerical modelling provides a way of exploring the design space, validating the overall design solutions, and also aiding in better decision making.

Whichever approach is used, the overall aim of an MBSE workflow is often to create a series of model based viewpoints that together describe the nature of the system. A viewpoint is a representation of the data that is contained in the model that provides some specific stakeholder with a set of information that is relevant to them. For example you might have a maintenance viewpoint that describes how a system will be maintained in a way that is relevant to those tasked with considering the logistic support of a system.

The viewpoints that need to be created when creating a system model are defined within an architectural framework. There are many examples of architectural frameworks, for example DODAF - the Department of Defense Architectural Framework.

Each framework defines a set of viewpoints that a model must contain to fully document that system. Often these viewpoints will together satisfy the objectives of the systems engineering lifecycle that is being followed.

## Conclusion

In this article we have provided a brief overview of some of the challenges facing systems engineering going forwards. We have also introduced, at a high-level, the concept of model based systems engineering (MBSE). MBSE is a way of implementing the systems engineering workflow that we have described in the previous articles in this series. MBSE uses models in place of documents to realize the underlying objectives of the systems engineering workflow that is being followed. The future of systems engineering is expected to be model based, supported by increasing digitisation and use of AI, to enable systems engineers to better handle the complexity of the systems we are expected to create in the next decade and beyond.

# The development tools you need

## Top 5 Development Tools

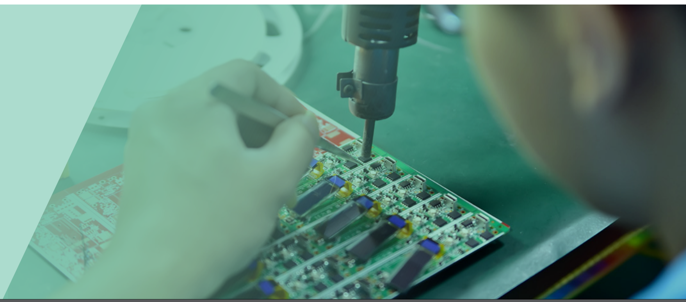


Image credit: Borya Galperin/Shutterstock.com

Mouser offers one of the widest ranges of development kits immediately available off-the-shelf to help designers get started. Here, Mouser's Technical Marketing Manager, EMEA, Mark Patrick, presents his 'Top 5 Pick' of recently-released dev kits.

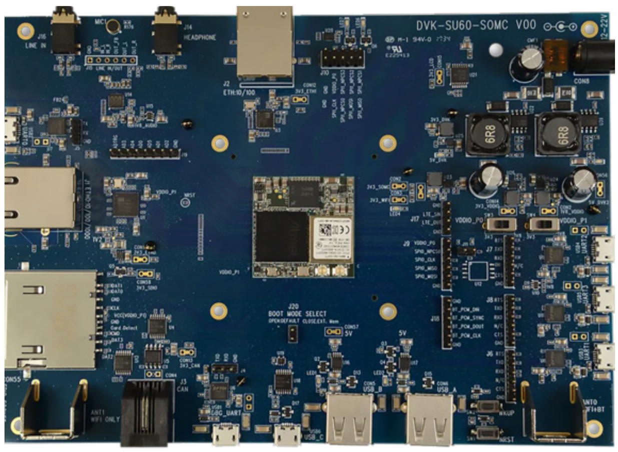
**eu.mouser.com/Development-Tools-Center**

### Enterprise-class Wi-Fi connectivity

### Laird Connectivity 60 Series dev boards

These dev boards are designed to facilitate the evaluation of Laird Connectivity's 60 Series wireless bridge module, a wireless communications sub-system that may be integrated into a variety of host devices via many available electronic and logical interfaces. The SoM provides complete enterprise-class Wi-Fi connectivity with an integrated TCP/IP stack. It also provides full support for 2x2 MIMO 802.11 a/b/g/n/ac WLAN plus Bluetooth 5.1 dual mode dual-mode air standards with a fully integrated security supplicant providing WPA/WPA2/WPA3 authentication, data encryption, and BT protocol stacks.

**FIND OUT MORE >>**





### Frequency-domain analysis

### Digilent Zmod Digitizer 1430-125

Digilent's Zmod Digitizer 1430-125: 2-channel 14-bit module is an SYZYGY™ compatible module containing a dual-channel ADC and the associated front end. A variant of the similar Zmod scope module, the Digitizer 1430-125 is optimized for frequency-domain analysis and RF signal acquisition, and is intended to be used with the SYZYGY™ compatible carrier board with the required capabilities. The 60MHZ anti-aliasing input filter and simple DC-coupled input improve immunity to stray RF radiation, and the very low-jitter-on-board clock generator enables acquisition.

**FIND OUT MORE >>**

## Relative humidity & temp

### Sensirion SEK-SHT40A-AD1B eval kit

This kit is used to evaluate Sensirion's SHT40A relative humidity/temperature sensors. SHT40A sensors are 16-bit, high-accuracy, automotive-grade digital sensors for measuring relative humidity and temperature with different accuracy gradings. The kit includes three SHT40A sensors on an FPCB and a 1m RJ45 adapter cable. SEK-SHT40A-AD1B operates over the -40°C to +125°C temperature range and from 2.3V to 5.5V supply voltage.

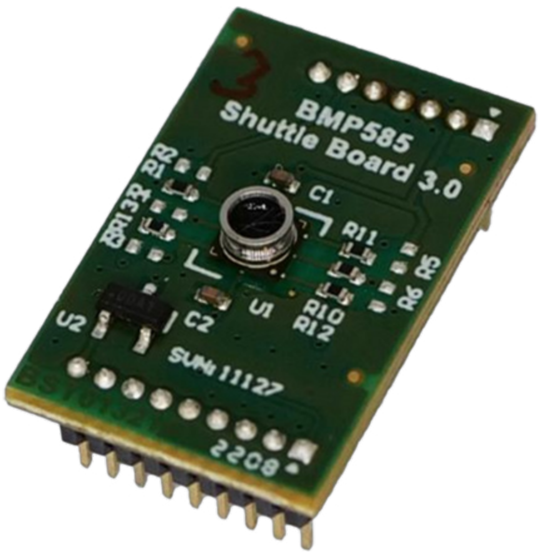
**FIND OUT MORE >>**

## Industrial-grade edge AI

### Seeed Studio NVIDIA Jetson AGX Orin 64GB devkit

This kit features SoC architecture, enabling it to emulate the performance and power of any of the Jetson Orin modules. The kit is configured by default for the Jetson AGX Orin series modules but can be easily re-flashed to emulate Jetson Orin NX or Jetson Orin Nano series modules. A carrier board (included) offers multiple standard hardware interfaces, enabling a highly flexible and extensible platform for rapid prototyping.

**FIND OUT MORE >>**



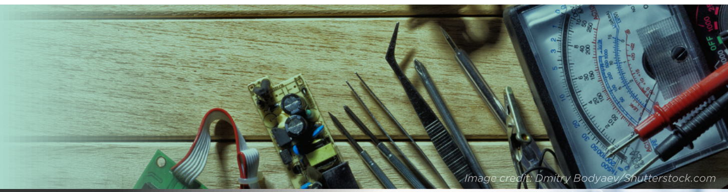

## Pressure sensor

### Bosch BMP585 shuttle board 3.0

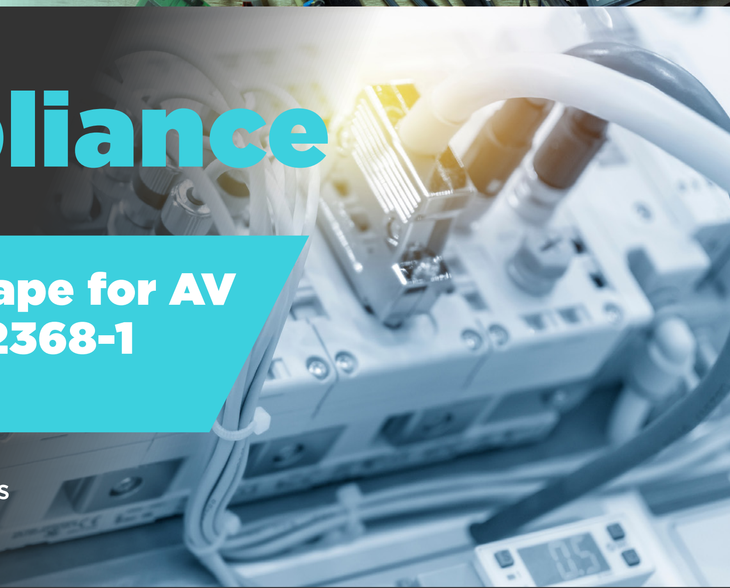
Bosch Sensortec's BMP585 shuttle board 3.0 is used to evaluate various functionalities provided by the BMP585 pressure and temperature sensor. In combination with the application board, the shuttle board – a PCB on which is mounted a BMP585 - allows easy access to the sensor pins via a simple socket, and can be directly plugged into the Bosch Sensortec's application board 3.0.

**FIND OUT MORE >>**

Tech Tips




# AV & IT Compliance



## The Shifting Connector Landscape for AV and IT Compliance to IEC/UL 62368-1 and 60320-1 Safety Standards

**By Fred Morgenstern, VP Technology of Neutrik Americas**

As of this writing (Spring 2023), it has now been a little over two years since IEC 60950-1 and IEC 60065 were obsoleted in favor of IEC/UL 62368-1. Whereas IEC 60950-1 was specific to IT equipment and IEC 60065 was specific to audio video (AV) equipment, IEC/UL 62368-1 brought these categories under one umbrella. The thinking behind merging these categories was: with the increasing technological sophistication of AV equipment—much of which is now at least partially digital and much of which is networked—the lines between AV (Figure 1) and IT had blurred so much that it was sensible to treat them under one standard.

***Figure 1:*** Previously, the IEC 60065 compliance standard was specific to AV equipment. IEC/UL 62368-1 brought AV and IT equipment under one umbrella. (Source: Neutrik)

### The Lighting Exclusion

Interestingly, stage lighting equipment (Figure 2), an essential ingredient of live AV, was excluded from the standard. The industry still waits to see whether theatrical lighting, which is currently certified in the US to UL 1598 and UL 1573, will either be folded into a future revision of 62368-1 or else see its own safety standards largely adopt the principles and specifics of 62368-1.

***Figure 2:*** Stage and theatrical lighting equipment are currently excluded from the IEC/UL 62368-1 standard. (Source: Алексей Синельников - stock.adobe.com)

### Power: UL 1977 and 498; UL and IEC 60320

For decades, the most relevant standards for power connectors in the Audio Visual Lighting (AVL) industry were UL 498—for which components received AXUT2 recognition—and UL 1977—for which components received ECBT2 recognition. Nearly all power connectors used as components within AV equipment for the US market had historically been certified to one or both of these standards.

However, a consensus view held that these standards had become outdated and limited in a number of important ways. The newer IEC and UL 60320 standards—which are similar to each other but have important regional differences such as different amperage ratings for IEC vs. UL—introduced a number of benefits not least of which are global standardization and acceptance.

Will 60320 eventually replace UL 498 and UL 1977 in all audio, video, and lighting applications (and beyond)? There are good arguments in favor of this. Certainly, global acceptance and a reduction in the number of required certifications are enticing to all concerned, be they component manufacturers like Neutrik, finished device manufacturers, or certification agencies.

### Connector Considerations Under IEC/UL 62368-1

Much has been made of the paradigm shift within 62368-1 to a hazards-based device review. Clauses within the standard specifically address electrical hazards such as injury and fire. Generally, 62368-1 tightens (rather than relaxes) the standards in this area.

***Figure 3:*** Neutrik's portfolio features connector series—including XLR, powerCON, powerCON TRUE1 TOP, speakON, and etherCON—which meet all applicable standards to comply with IEC/UL 62368-1. (Source Neutrik)

Required connector creepage and clearance distances, in particular, are carefully defined and may require significant calculations to ensure adherence.

The mechanisms by which enclosures prevent potential ignition from exiting the device in a damaging way have also been overhauled in 62368-1. Depending on the classification of the severity of the potential ignition source, the use of flame-resistant materials rated to V-2 or better may be required. For higher-level potential ignition levels, interior fire enclosures are required.

Changes in the standard relevant to connectors compared to the prior IEC 60065 AV equipment standard are, in some cases, substantial. For example, AV equipment connectors were generally produced using UL 94 HB materials for decades. HB materials had the advantage of being relatively pliable and forgiving—an advantage as the connectors were fastened to the chassis by screws or other hardware. However, their lower flame rating is no longer accepted in certain cases of relatively higher potential ignition levels. For that reason, Neutrik has updated all of its relevant connectors to offer options with V-0 material which exceeds the lower V-2 materials requirement of the specification.

Additional changes were, in some cases, required by the standard to the relatively large openings within some connectors that could allow hazards such as fire to escape. Neutrik's re-engineering also addressed those openings. The result is that Neutrik's connector portfolio fully meets all requirements of IEC/UL 62368-1 (Figure 3).

Examples of popular components that meet all applicable standards in order to comply with IEC/UL 62368-1 are Neutrik's XLR, powerCON® blue/grey, powerCON® TRUE1 TOP, speakON®, and etherCON® chassis connectors. Advantages include improved safety to end users and streamlined certification for device manufacturers.

## Focus on Power Connectors

Neutrik's powerCON TRUE1 TOP line was designed from the ground up for IEC and UL 60320-1 compliance (Figure 4). This line has recently been expanded with large-outlet cable connector options for raw cable like SOOW 12/3 and H07RN-F3G2.5. These new connectors are unique in being certified to IEC EN 60320-1, UL 60320-1, and C22.2 No. 60320-1:19, making them acceptable for cord sets according to IEC 60799 / UL817 and equipment according to IEC 62368-1.

Neutrik's powerCON blue/grey line is the original powerCON. Released in the 1990s, powerCON's twist-lock plus latching feature made it highly desirable in the AVL industry, where it became the standard for moving-head luminaires.

In 2020, Neutrik introduced the new XX-series powerCON blue/grey chassis connectors to ease 62368-1 compliance.

Recently, Neutrik introduced the complementary XX-series cable connectors that provide breakability under load and meet all other requirements of 60320-1 certification (Figure 5). This makes Neutrik the only connector manufacturer to offer both of these Neutrik-original designs—powerCON TRUE1 TOP and powerCON blue-gray—with IEC EN 60320-1, UL 60320-1, and CSA C22.2 No. 60320-1 certifications for safety and ease of implementation.

***Figure 5:*** Neutrik powerCON® XX Connectors are IEC EN 60320-1 and UL 60320-1 certified, making them accepted as a component for cord sets according to IEC 60799 and UL817 and equipment according to IEC 62368-1. (Source Neutrik)

## Generational Change

The paradigm-changing IEC/UL 62368-1 and 60320 standards have generally been considered successful. Neutrik expects the innovations of these standards to be brought forward into other related standards in the future.

***Figure 4:*** Neutrik powerCON TRUE1 TOP Connectors are certified to IEC EN 60320-1, UL 60320-1, and C22.2 No. 60320-1:19, making them acceptable for cord sets according to IEC 60799 / UL817 and equipment according to IEC 62368-1 (Source Neutrik)

# AEC-Q101 rectifiers

**Mouser Electronics, the authorized global distributor with the newest semiconductors and electronic components, is now stocking the AEC-Q101-qualified rectifiers from Vishay Semiconductors.**

These DFN-packaged components provide engineers with an ideal solution for power line polarity and rail-to-rail protection in consumer, industrial, and automotive applications.

The Vishay rectifiers are housed in a low 0.88mm profile DFN3820A package with side-wettable flanks.

These rectifiers cover a 1A to 5A forward current range with 200V, 400V, or 600V repetitive peak reverse voltage options and have a low forward voltage drop. The oxide planar chip technology of the rectifiers facilitates a wide operating temperature range (-55C to +175C).


These rectifiers can be used with AOI systems and meet the stringent standards required for ultra-fast applications includiung ABS braking systems, dual voltage injection drivers, high-frequency inverters and clamping and snubber applications. The AEC-Q101 Qualified DFN-packaged rectifiers are lead-free, halogen-free, and RoHS compliant.

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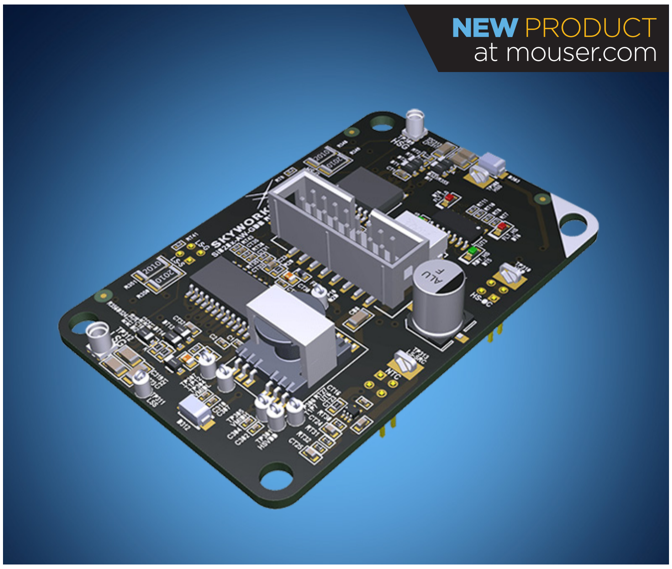
# XM3 gate-driver board targets EV and industrial

**Intended to replace more complex power stage designs with a simpler, cost-effective solution, the Si828x-BAWB-KIT is Skyworks' next generation isolated gate driver board (GDB) reference design optimized for SiC FETs.**

The Si828x-BAWB-KIT boasts an enhanced GDB layout that is perfect for SiC FETs such as the XM3 half-bridge module from Wolfspeed, which works in tandem with the Skyworks' GDB to immensely improve power density and power efficiency for demanding automotive applications such as hybrid electric vehicles, EV drivetrains, and EV fast chargers, as well as industrial motor drives, power supplies, and AC, Brushless and DC motor controls.

The Si828x-BAWB-KIT GDB, available from Mouser, combines the robust Skyworks' GDB short-circuit protection features with the rugged SiC XM3 module to better shield the high voltage/high current XM3 module from overload and circuit damage and effortlessly implement the power switching stage of a system. The Si828x gate driver board was specifically designed to protect the XM3 power module during a short circuit event, detecting any load fault and shutting off the power module in under a microsecond.

The Si828x-BAWB-KIT includes two Skyworks Si828x isolated gate drivers (the Si8284 and Si8285) in a half-bridge configuration. The kit features two isolated power supplies, a peak output current of +20A/-30A and a Common-Mode Transient Immunity (CMTI) of 125kV/µs.




The isolation voltage is 5kV, and the Si828x-BAWB-KIT offers desaturation detection and Miller Clamp protection for the FETs. Status indicator LEDs and test points are provided to ease the evaluation and prototyping process.

The Wolfspeed XM3 half-bridge module offers a high-power density footprint with half the weight and volume of a standard 62mm module, low Inductance (6.5 nH), integrated temperature sensing and a dedicated Drain-Kelvin Pin. The XM3 module implements a conduction-optimized, third-generation MOSFET technology that maximizes the benefits of SiC while minimizing loop inductance and enabling simpler power bussing which keeps the system design robust, simple and cost-effective. Together, the Wolfspeed XM3 module and Skyworks GDB enhance power density over previous modules and discrete approaches to offer a complete, pre-tested and proven solution for the market.

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## Multizone ToF sensor for robotics, AR/VR and IoT


**Mouser Electronics, Inc., the industry's leading New Product Introduction (NPI) distributor with the widest selection of semiconductors and electronic components, is now stocking the VL53L8CX 8x8 multizone Time-of-Flight (ToF) sensor from STMicroelectronics.**

The VL53L8CX 8x8 enhances performance under ambient light with reduced power consumption. The VL53L8CX is based on ST's FlightSense technology and is designed to deliver accurate ranging up to 400cm with a 65° diagonal FoV.

The VL53L8CX measures an absolute distance regardless of the target colour and reflectance. It incorporates a powerful newer generation VCSEL and two advanced meta-surface lenses.

This all-in-one module suits hi-performance applications, such as low-power system activation, gesture recognition, SLAM for robotics, liquid level monitoring, and many more.

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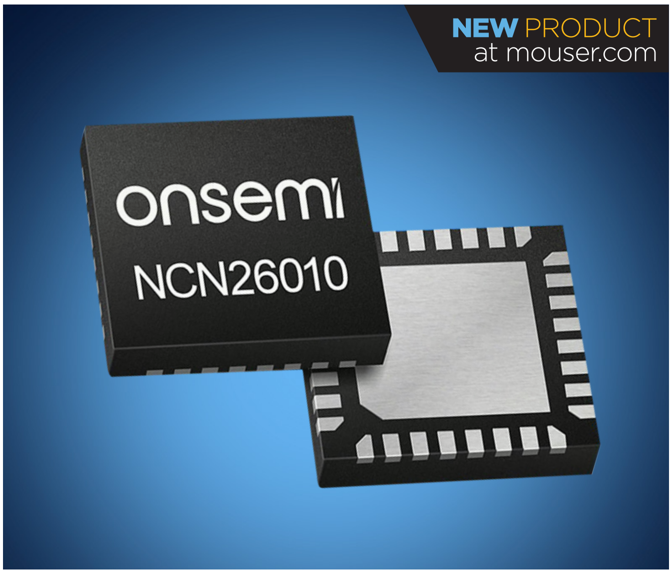
## Ethernet controller reduces wiring




**Mouser is now stocking onsemi's NCN26010 10BASE-T1S industrial Ethernet controller which is designed to provide reliable multi-point communication in industrial settings.**

The NCN26010 is a 10Mb/s, IEEE 802.3cg compliant device including a media access controller (MAC), a PLCA reconciliation sublayer (RS), and a 10BASE-T1S PHY, designed for industrial multi-drop Ethernet networks. It can enable more than 40 nodes on a single twisted pair, exceeding five times the amount of nodes requested by the IEEE 802.3cg standard, reducing installation cost and set-up complexity. This PHY + MAC controller for 10BASE-T1S can connect to controllers, sensors and other devices without the need for an external MAC.

The NCN26010 reduces in-cabinet wiring up to 70% while significantly increasing bandwidth. In backplanes, it simplifies the layout and power distribution without impacting data rates or latencies. Many applications, such as elevators, will be able to increase data throughput over existing wiring with the device and, due to the ability to carry power over data cables, complex sensor networks can be built upon simple and low-cost cable runs.

The NCN26010 makes an ideal replacement for legacy point-to-point and multi-point industrial communication standards. The T1S MAC/PHY device can replace RS-485, CAN, RS-232, HART and others.

As a result, greater data throughput is achieved over existing wiring, eliminating the need to re-pull wires which is often the greatest expense in a networking installation. The NCN26010 also features a proprietary enhanced noise immunity feature which is essential for installations in electrically noisy industrial environments.

The NCN26010 controller is supported by the NCN26010XMNEVB 10BASE-T1S MACPHY evaluation board, the NCN26010BMNEVB Adapter Board, and the NCN26010XMNEVK 10BASE-T1S SPE evaluation kit, all available from Mouser.

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# ADAS deserializers

**The Analog Devices / Maxim Integrated MAX96724/F/R GMSL2/1 to CSI-2 quad-tunneling deserializers convert four GMSL™2/1 inputs to 1, 2, or 4 MIPI D-PHY or C-PHY outputs.**

The MAX96724/F/R enables coexisting transmit bidirectional transmissions over 50Ω coax or 100Ω STP cables that meet the GMSL channel specification. Using industry-standard coax or STP interconnects, up to four remotely located sensors can be supported. Each GMSL2 serial link works at a fixed rate of 3Gbps or 6Gbps in the forward direction and 187.5Mbps in the reverse direction.

In stock at Mouser, the Analog Devices MAX96724/F/R enables aggregation and replicating video data, allowing streams from multiple remotely located sensors to be merged and routed to one or more available CSI-2 outputs. These deserializer devices support high-bandwidth, gigabit multimedia serial links (GMSL-1 or GMSL-2) and offer spread spectrum and full-duplex control channel features.


Applications for the MAX96724/F/R deserializers include Advanced Driver Assistance Systems (ADAS) and other high-resolution camera systems.

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# HP MCU enables RT EtherCAT control

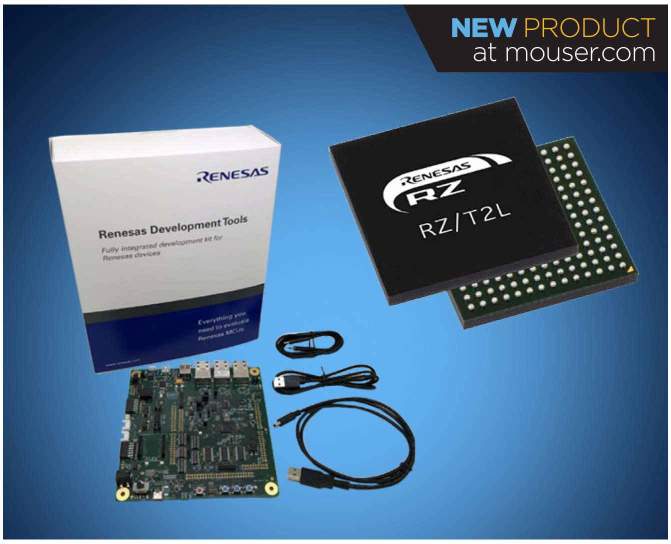
**Optimized for high-speed processing and high-precision real-time control for applications adopting EtherCAT communication protocols, the high-performance microprocessor with EtherCAT from Renesas Electronics is based on the same advanced hardware architecture as Renesas' RZ/T2M MPU.**

Reducing overall footprint by up to 50 percent over the RZ/T2M, the RZ/T2L is the perfect cost-effective and scalable alternative for designers and first-time developers looking to enter the rapidly expanding EtherCAT market with a single-chip motor control solution.

The device is also ideally suited for applications such as AC servos, inverters, industrial robots, medical equipment, wind turbines and elevators.

The RZ/T2L MCU features an Arm® Cortex®-R52 CPU with a maximum operating frequency of 800MHz, an Ethernet MAC and a proven 3-port EtherCAT slave controller designed by Beckhoff Automation for Ethernet communication. The MPU's tightly coupled 576 KB of memory is directly connected to the CPU. This design element reduces execution time unpredictability caused by cache memory, enabling reliable, deterministic processing. All RAM on the MPU is also equipped with an error correction code (ECC) function required for industrial applications.

The robust peripheral capabilities of the RZ/T2L include multi-protocol encoder interfaces for angle sensors, Sigma-delta interfaces, 3-phase PWM and 12-bit ADCs.




These peripherals are arranged on a dedicated low latency peripheral port (LLPP) bus directly connected to the CPU to achieve fast and accurate real-time control functionality. Other notable features of the RZ/T2L include support for various security functions such as secure boot, secure firmware update, JTAG authentication, unique ID and cryptographic accelerator to reduce the risk of data breach and tampering of user programs. The MPU can also be used as a functional safety microprocessor to meet the growing processing requirements for industrial equipment.

To support the development of the RZ/T2L microprocessor, Renesas offers a companion RZ/T2L Starter Kit+, also available through Mouser Electronics.

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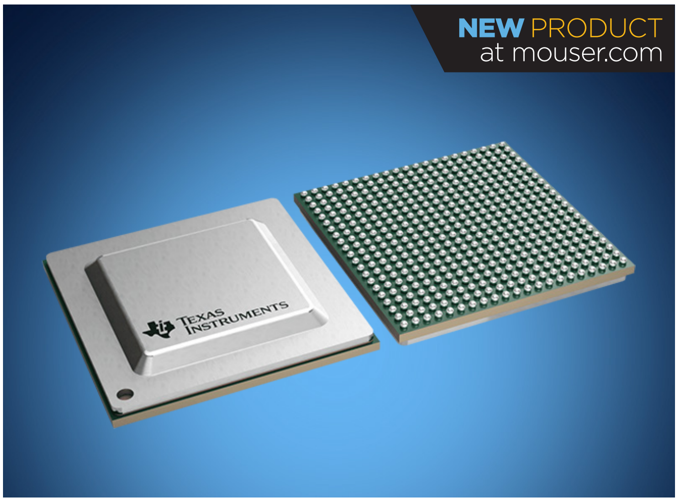
# TI's AM64x Sitara MCUs now shipping




**Mouser is now stocking the AM64x Sitara™ single-core Arm® Cortex®-A53 microcontrollers from Texas Instruments.**

The MCUs are optimized for industrial applications including PLCs and motor drives which require a unique combination of communications and real-time processing with applications processing. The AM64x combines two instances of the Sitara device's gigabit TSN-enabled PRU-ICSSG with up to two Arm Cortex-A53 cores, up to four Cortex-R5F MCUs, and a Cortex-M4F MCU.

The AM64x provides flexible industrial communications capability, including full protocol stacks for EtherCAT SubDevice, EtherNet/IP adapter, PROFINET device, and IO-Link Master. The PRU-ICSSG further provides the ability for gigabit and TSN-based protocols. In addition, the PRU-ICSSG also enables additional interfaces in the SoC, including absolute encoder interfaces and sigma-delta decimation filters.

Functional safety features can be enabled through the integrated Cortex-M4F and dedicated peripherals, which can all be isolated from the rest of the SoC. The AM64x also supports a secure boot.

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# No-ground-plane-required IoT antennas


**5G Phantom no-ground-plane-required antennas from TE Connectivity / Laird provide engineers with a versatile global cellular antenna option for IoT, freight and transportation environments, as well as public safety applications.**

The 5G Phantom antennas cover either the 617MHz to 7125MHz or 698MHz to 7125MHz frequency bands without needing a fixed ground plane, even for regions where lower 600MHz bands are required. These antennas offer global cellular coverage in a tamper-resistant, direct-mount, threaded stud with superior quality and integrated N-female connector, for tamper-resistant installation.

Available from Mouser, 5G Phantom no-ground-plane-required antennas' direct coaxial connection provides consistent performance, even at higher frequencies, avoiding performance losses associated with other mounting methods.

Minimum gain ripple around horizon and uniform azimuth patterns reduces the chance of signal dropouts, while offering consistency and minimal shifting gain.

The 5G Phantom antenna series delivers high levels of efficiency, over 95% up to 4200MHz, and gain up to 8.0-dBi. These rugged antennas also feature a tamper-resistant and highly durable IP67-rated enclosure and UL 94 flammability rating, making them ideal for harsh environments.

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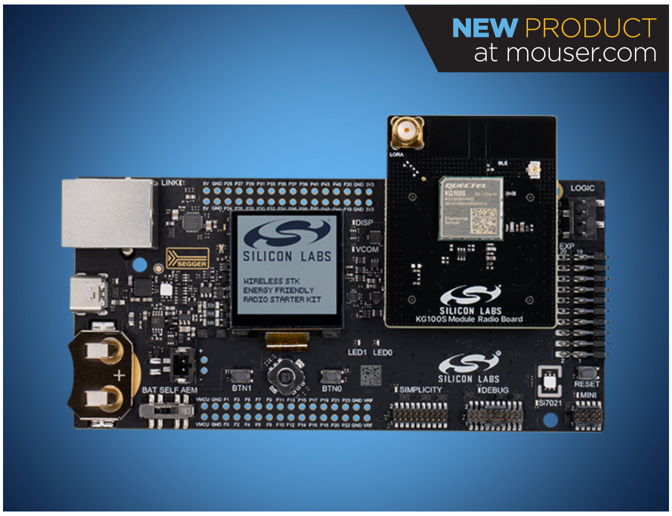
# Pro Kit for Amazon Sidewalk expands IoT Cloud connectivity




**Designed as a complete end-to-end Amazon Sidewalk Development Platform solution, the Silicon Labs' Pro Kit for Amazon Sidewalk provides all the necessary tools and resources for developing high-volume scalable IoT applications using Bluetooth and sub-GHz wireless protocols.**

The Pro Kit simplifies the development process and reduces costs enabling users to focus their resources more on innovation and less on testing and integration as they develop applications for the Amazon Sidewalk network.

The Silicon Labs Pro Kit, available from Mouser Electronics, comes pre-programmed with Amazon Sidewalk firmware and Amazon Web Services (AWS) pre-registration, instantly and securely connecting users in a few minutes. Amazon Sidewalk is a secure, low-bandwidth, long-range wireless network that uses Bluetooth Low Energy (LE) and 900MHz networks to create shared wireless mesh networks that route through the AWS cloud with multiple layers of encryption.

Under Amazon Sidewalk, intelligent devices can constantly stay connected using dedicated bridges or gateways, forming a distributed network that allows devices to connect and send data to any bridge in range instead of being limited to one bridge. These bridges and gateways help the community stay connected beyond the home and 'across the sidewalk' to create more reliable or unobstructed connectivity for richer user experiences across all IoT-enabled devices, including home security systems, utility meters, appliances, consumer devices and more.

Silicon Lab's Pro Kit comes equipped with a KG100S-RB4332A radio board and a 915MHz antenna that provides a complete reference design to support Bluetooth, FSK, and CSS protocols. An xG24-RB4187C radio board and BRD8042A FSK/CSS adapter board are also included for users looking to develop a more discrete design.

The kit's mainboard contains an onboard SEGGER J-Link debugger with a Packet Trace Interface (PTI) and a Virtual COM port, enabling application development and debugging of the attached radio board and external hardware through a 20-pin (2.54mm) expansion header. Other kit features include advanced energy monitoring, a low-power 128x128 pixel Memory TFT LCD, user LEDs/pushbuttons, breakout pads for wireless SoC I/O and support for CR2032 coin cell batteries.

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# Automotive sensor eval kits


**Mouser is now stocking the ASEK-20 sensor evaluation kit from Allegro MicroSystems which is intended as a benchtop engineering tool for evaluating multiple Allegro devices and sensor families by utilizing device-specific daughterboards (available separately), to program and assess individual Allegro sensors, including angle position sensors, switch and latch sensors, linear position sensors, current sensors, and more.**

For versatility, the ASEK-20 sensor evaluation kit can also be used to characterize the performance of various sensor devices, and is ideal for prototyping register value increments, or developing procedures for programming code streams. The kit includes the ASEK-20 chassis with a main motherboard, a protoboard, USB and ribbon communications cables, and a DC power supply with AC adapters.

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