March 2024

CAN Newsletter

Hardware + Software + Tools + Engineering

The long journey to standardized body application units on commercial vehicles

Cover story

More than 20 years ago, the standardization story of truck-mounted equipment started with refuse collecting vehicles. One key unit of standardized body applications is the gateway to the in-vehicle networks, which has been standardized in DIN 4630:2023.

USB Interfaces for CAN & CAN FD

PEAK-System provides versatile USB interfaces designed for service technicians, developers, and test engineers seeking access to CAN and CAN FD buses. These solutions simplify tasks such as CAN bus analysis, developing products with CAN connectivity, and flashing ECUs.

- USB interfaces for CAN and CAN FD
- Available with up to 6 High-speed CAN channels (ISO 11898-2)
- Nominal CAN bit rates up to 1 Mbit/s
- CAN FD bit rates for the data field up to 12 Mbit/s
- Optional with galvanic isolation on the CAN connection
- CAN termination can be activated, separately for each channel
- Extended operating temperature range from -40 to +85 °C
- Time stamp resolution down to 1 µs
- No influence on the CAN bus with switchable listen-only mode
- Measurement of bus load including error frames and overload frames on the physical bus
- Induced error generation for incoming and outgoing CAN messages
- Compatible with the standards CANopen®, J1939, NMEA 2000®, and DeviceNet

Every interface from PEAK-System is delivered with a wide range of drivers, software, and programming interfaces.

- CAN device drivers for Windows® 11 (x64/ARM64), Windows® 10 (x64), and Linux
- PCAN-View: Monitoring software for CAN and CAN FD buses
- PCAN-Basic API for developing applications with CAN and CAN FD connection for Windows and Linux
- Programming interfaces for standardized protocols from the automotive sector:
  - PCAN-CCP API for the communication with ECUs according to the CAN Calibration Protocol
  - PCAN-XCP API for communication with ECUs according to the Universal Measurement and Calibration Protocol
  - PCAN-PassThru for using applications that are based on Pass-Thru (SAE J2534) with interfaces from PEAK-System
  - PCAN-RP1210 API for communication according to TMC's Recommended Practice 1210-C with support for CAN, J1939, and ISO-TP
  - PCAN-ISO-TP API for the transfer of data packages according to ISO-TP (ISO 15765-2:2016)
  - PCAN-UDS API for the communication with ECUs according to UDS (ISO 14229-1)
  - PCAN-OBD-2 API for vehicle diagnostics according to OBD-2 (ISO 15765-4)
  - **Upcoming in 2024**: **PCAN-OBDonUDS** for vehicle diagnostics according to OBDonUDS (SAE J1979-2)

embeddedworld
Exhibition&Conference

Meet us in hall **1**, booth **304**

PEAK-System Technik GmbH

Otto-Röhm-Str. 69, 64293 Darmstadt, Germany
Phone: +49 6151 8173-20, Fax: +49 6151 8173-29
E-mail: info@peak-system.com

www.peak-system.com

Imprint

Publishing house
CAN in Automation GmbH
Kontumazgarten 3
DE-90429 Nuremberg
marketing@can-cia.org
www.can-cia.org
Tel.: +49-911-928819-0
Fax: +49-911-928819-79

Reiner Zitzmann (CEO)
VAT-ID: DE812852184
HRB: AG Nürnberg 24338

Publisher
CAN in Automation e. V.
Kontumazgarten 3
DE-90429 Nuremberg
VAT-ID: DE169332292
VR: AG Nürnberg 200497

Editors
Olga Fischer (of)
Holger Zeltwanger (hz)
(responsible according to the press law)
pr@can-cia.org

Layout
Nickel Plankermann

Media consultants
Julia Dallhammer
Tobias Kammerer
Birgit Ruedel (responsible according to the press law)
marketing@can-cia.org

CAN Newsletter Online re-integrated into the CAN Newsletter magazine

The CAN Newsletter Online outsourced in 2013 has been re-integrated into the quarterly published CAN Newsletter magazine. This publication established in June 1992 was originally only available as hardcopy. In the early years of this century, it was printed and downloadable in PDF format. Nowadays, it is hosted on the CiA website. Sometimes hardcopies are ditributed on tradeshows and other events. The re-integration of the CAN Newsletter Online means that the CAN Newsletter magazine contains in the future also overview articles on CAN-related product trends.
Articles on CAN-related product trends provide an overview on recently released products enriched with background information. There will be also previews to upcoming tradeshows as well as reports about fairs and conferences related to CAN technology. The main part continues to provide technical in-depth articles on CAN technology as well as CAN-related application stories. The editorial part also features company portraits and interviews with CAN experts. Brief news about standards and specifications complete the editorial content.

The CAN Newsletter magazine and its valuable legacy issues are available on the CiA website, where you can download them free of charge. Downloading single articles is possible, too. The CAN Newsletter Online is frozen (meaning no new articles will be posted), but it is still online.

Holger Zeltwanger

CES 2024: Only a few new CAN-related products

The CES tradeshow in Las Vegas is an important technology trend fair for the automotive industry. CAN-based embedded and deeply embedded networks were often hidden and not shown openly.

Figure 1: More than 130000 visitors attended the CES 2024 tradeshow, a record with plus 40 percent (Source: CTA)

The tradeshow took place from January 9 to 12, 2024. "No other event in the world connects the full ecosystem of the tech industry like CES," said Gary Shapiro, president and CEO, Consumer Technology Association (CTA). "This year at CES, we are excited to spotlight the critical role that technology is playing to improve every aspect of the human experience." One of the major topics on many of the more than 4300 booths was AI (artificial intelligence). It was front and center with applications that can improve health care, sustainability, productivity, accessibility, mobility, and more.

Qualcomm and Robert Bosch introduced a central vehicle computer capable of running infotainment and advanced driver assistance system (ADAS) functionalities on one single system-on-chip (SoC). Bosch unveiled this central vehicle computer, known as its cockpit & ADAS integration platform, that is based on the Snapdragon Ride Flex SoC.

Qualcomm's Flex SoC is designed to support mixed-criticality workloads, allowing for digital cockpit, ADAS and automated driving (AD) capabilities to be co-implemented on a single SoC. This capability enables automakers to realize a unified central software-defined vehicle (SDV) architecture that scales from entry to premium tiers. Leveraging the Flex SoC, Bosch's vehicle computer can implement ADAS applications such as object/traffic and light/lane detection, automated parking, smart and personalized navigation, voice assistance, control for multiple displays as well as processing for camera, radar, and ultrasonic data.

"We are pleased to work with Bosch to have our Snapdragon Ride Flex SoC enable their new central vehicle computer, further underscoring our shared commitment to technological innovation within automotive," said Nakul Duggal from Qualcomm. "The fusion of infotainment and ADAS functionalities on a single SoC is a milestone for the industry, offering a high performance, scalable solution for automakers to realize next-generation software-defined vehicles."

"With the cockpit and ADAS integration platform, we can once again demonstrate our outstanding cross-domain expertise and experience. We are proud to be ▷

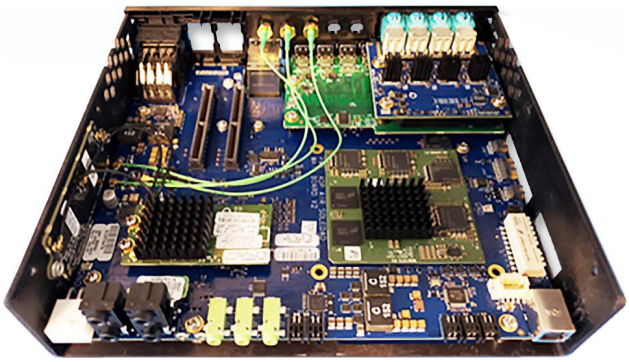


Figure 2: Automotive development platform with four CAN FD and two LIN interfaces (Source: Lantronix)

the world's first Tier-1 supplier to demonstrate the interaction of system functions from previously separated domains in a single central computer in collaboration with Qualcomm Technologies," said Christoph Hartung, president of the Cross-Domain Computing Solutions division at Bosch. "With this cost-effective solution we are paving the way for bringing even more ADAS functions into vehicles, including in the entry-level and mid-range segment."

Lantronix offers automotive development platforms featuring the Snapdragon SoC. The SA8295P board is based on Qualcomm's QAM8295P chipset. It has been developed as an SEooC (safety element out of context) targeting assumed ASIL B classified functional safety use cases. The key components of the QAM8295P module include the SA8295P SoC, four instances of the PMM8295AU power management IC, one third party power management IC, and two 556-ball LPDDR4X SDRAMs. The development platform provides infotainment interfaces such as one Ethernet 1000-Base-T1 and two Ethernet 100-Base-T1 as well as Wi-Fi and Bluetooth. Additionally, four CAN FD and two LIN interfaces are on board.

Awarded at CES

Ambarella partnering with Continental, another German Tier-1 automotive supplier, has been awarded at the CES trade-show for its CVS3-AD685 AI domain controller chip. It targets L2+ to L4-classified autonomous vehicles. Its next-generation CVflow AI engine includes neural network processing that is 20-times faster than the previous generation of CV2 SoCs. The SoC also integrates advanced image processing, a dense stereo and optical flow engine, Arm Cortex A78AE and R52 CPUs, an automotive GPU for visualizations, and a hardware security module (HSM). Of course, the SoC features CAN FD connectivity. Via this interface, the AI software can be fed with information originated in the in-vehicle networks.

"Following the recent endorsements from major Tier-1 suppliers, our CV3-AD domain controller family is transforming the automotive AD and ADAS market, through its unique combination of highly efficient AI processing, advanced image processing and ultra-low power consumption," said Fermi Wang, CEO of Ambarella. "The CV3-AD685 ▷

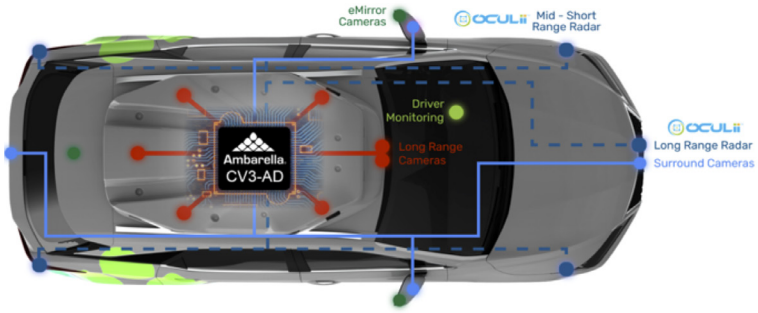


Figure 3: The CV3-AD system-on-chip family designed for use in autonomous driving vehicles and for future advanced driver-assistance systems comes with CAN FD modules on chip (Source: Ambarella)

delivers new mass-production price and performance options for our customers. It extends our lead in AI performance-per-watt and introduces new radar processing capabilities that uniquely enable the single-chip centralized processing of raw video and 4D imaging radar data."

The CVflow's general vector processor (GVP) provides traditional computer vision processing while including specific optimization enhancements for HD radar. Twelve Arm Cortex A78AE CPUs and three dual-core, lockstep pairs of Cortex-R52 CPUs are included. The SoC is targeting ASIL-B on the chip level, with an ASIL-D safety island. The hardware security module (HSM) provides isolation of different domains and secure software provisioning, as well as a suite of advanced cybersecurity features, such as asymmetric/symmetric crypto acceleration, secure storage and key provisioning, encrypted CVflow tasks, true random number generator (TRNG), one-time programmable (OTP) memory, DRAM scrambling, and DRAM virtualization. The SoC is fabricated in Samsung's 5-nm automotive process technology.

Ambarella announced in Las Vegas also the CV3-AD635 and CV3-AD655 SoCs, both providing CAN FD connectivity. The CV3-AD635 supports a sensing suite that includes multiple cameras and radars to enable mainstream L2+ feature sets, such as highway autopilot and automated parking. This SoC meets the GSR2 and the NCAP standards. Additionally, it enables advanced L2+ (also called L2++) with urban autopilot, as well as support for additional cameras, radars, and other sensors. With the previously announced flagship CV3-AD685 SoC, which targets L3/L4 systems – along with the China-focused CV72AQ SoC – the CV3-AD family now covers the full range of AD (automated driving) and ADAS solutions.

"The CV3-AD635 and CV3-AD655 enable proven CV3-AD powerful performance in mass market L2+ and L2++ systems, while helping OEMs to reduce complexity and save costs on thermal management solutions and electric vehicle batteries," explained Fermi Wang. "The strategic partnership between Continental and Ambarella is bringing full-stack vehicle system solutions to the road – beginning with 2027 SOPs – that combine maximum performance and industry-leading energy efficiency," said Ismail Dagli, Head of the Autonomous Mobility Business Area at Continental. "Based on Ambarella's CV3-AD family, our joint solutions enable safer mobility thanks to holistic environmental perception; making them particularly well suited for the growing amount of sensor data in software-defined vehicles. Together, we are shaping the path toward Vision Zero and autonomous mobility."

Figure 4: Vector presented in Las Vegas its solutions for software-defined vehicles (SDV), CAN was not in the focus (Source: Vector)

Intrepid and Vector at CES

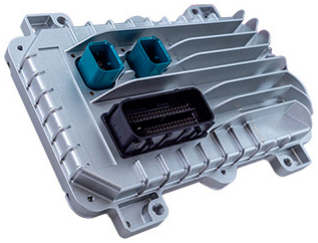


Figure 5: The neoIV Connect data logger is equipped with eight CAN FD ports (Source: Intrepid)

At the CES 2024 tradeshow, about 250 exhibitors presented solutions for self-driving and electric vehicles as well as personal mobility. The CiA members Intrepid and Vector showed in Las Vegas their tools and services for network developments dedicated for the automotive industry.

Intrepid launched a ruggedized IP67-rate data logger, ECU simulator, and gateway solution in a production-ready form factor. This neoVI Connect data logger comes with eight CAN FD channels, two LIN ports, and one Ethernet (100/1000-Base-T) interface. Additionally, it provides Wi-Fi connectivity, an internal cell module, and GPS/GNSS functionality as well as nine IMUs (inertial measurement units). The IMU comprises an accelerometer, a gyroscope, and a magnetometer.

"The neoVI Connect platform was created through engagement with a customer, one of the world's largest vehicle OEMs, who was using our existing neoVI Cloud wireless data logger for fleet management on a low volume vehicle and found it was exactly what they needed for series production with low-to-no development costs," said Dave Robins, CEO of Intrepid Control Systems. "From that, we developed the expanded neoVI Connect to deliver a significant cost savings platform for the entire auto industry, as Intrepid's development costs are shared with its customers, which consist of all electric vehicle OEMs in the US and most of the world's ICE OEMs." ◀

hz

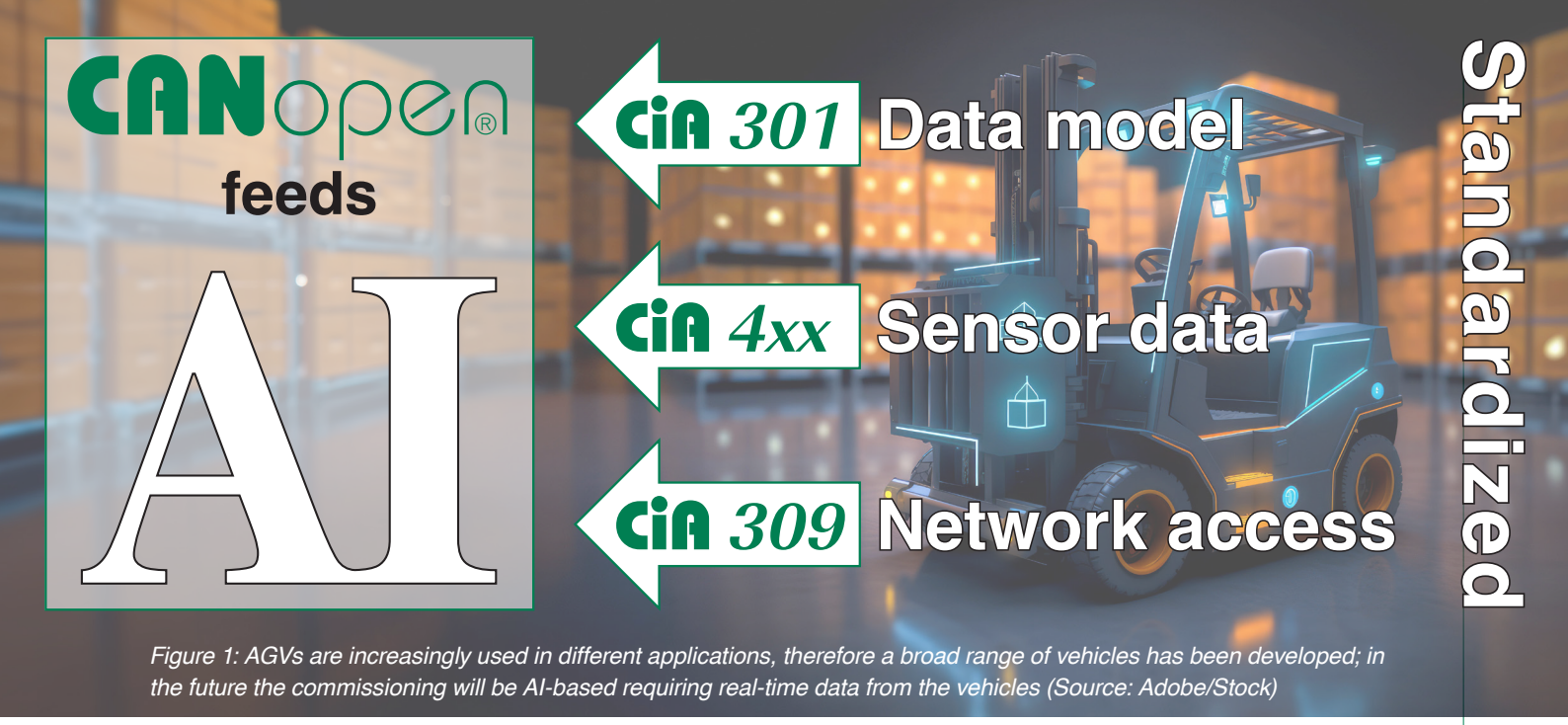


Figure 1: AGVs are increasingly used in different applications, therefore a broad range of vehicles has been developed; in the future the commissioning will be AI-based requiring real-time data from the vehicles (Source: Adobe/Stock)

Last year's CiA motto at the SPS fair in Nuremberg was: CANopen feeds AI (artificial intelligence). CANopen-connected sensors provide information preprocessed in controllers or directly via gateways to high-performance AI-software-running computers. One of the application fields is an optimized commissioning of AGV (automated guided vehicle) and AMR (autonomous mobile robot) fleets.

For 30 years, CiA exhibits at the SPS (Smart Production Solutions) tradeshow: first in Sindelfingen and now in Nuremberg; both locations are in Germany. The SPS exhibition has daughter events in Parma, Italy (May 28 to 30, 2024), Guangzhou, China (March 4 to 6, 2024), and Atlanta, U.S.A. (beginning of 2025). In November 2023, more than 1200 companies presented their automation products to about 50000 visitors in Nuremberg. Many exhibitors showed CANopen devices, especially drive and motion control suppliers, which have implemented the CiA 402 profile.

The benefit of a standardized data model such as specified in the CiA 301 application layer and communication profile is obvious: Application data objects are specified by means of standardized attributes and can be processed by any CANopen host controller. The access to these data objects is standardized by means of a 24-bit address (16-bit index plus 8-bit sub-index). These application data objects and the CANopen communication data objects are part of the CANopen object dictionary.

Figure 2: AMRs equipped with CANopen drives are also used increasingly in the agriculture industry (Source: Dunkermotoren)

The broad range of standardized CiA profiles (CiA 4XX series) enables interoperability of CANopen devices. Furthermore, standardized remote access functions specified in the CiA 309 series allow to collect sensor fusion data and forward them to AI controllers. A typical future AI application on the factory floor and in logistic centers is the management and commissioning of AGV and AMR fleets. The AI application can optimize, for example, the AGV/AMR resources by means of minimizing the trips. This means, the AGV/AMR receive their targets respectively tasks from the AI software via gateways to the in-vehicle respectively in-robot CANopen networks, which provide links to drives and motion controllers as well as other actuators.

The gateways provide the link to the CANopen networks embedded in AGVs/AMRs. On the other side they communicate wirelessly with AI host controller. Such gateways are often embedded in the AGV/AMR host controllers. Stand-alone gateways connecting CANopen networks with wireless links (i.e. WLAN) are also available. ESD Electronics offers even a wireless CAN bridge between two CAN networks.

There are several AGV types on the market. This starts with very small and simple AGVs. The navigation systems of these automatic guided carts range from simple magnetic tape to complex sensor-based solutions that use AI to guide the vehicles. They are not only used ▷

in industrial applications: They also operate in hospitals to distribute meals and empty food trays, clean of soiled linens, biohazard waste, or sterile supplies.

Another type is a forklift AGV. They are applied often in logistic centers transporting pallets. There are also so-called towing AGVs or tugger automated guided vehicles pulling non-powered load carry vehicles. The variety of AGVs is high and new types as well as subtypes appear frequently. But navigation and moving is nearly the same in many applications.

Single- or multi-drive control units

The embedded AGV/AMR CANopen host controller can control all connected drives and motion controllers individually. But it is also possible to control up to eight CiA 402 logical devices by one CANopen interface. In this case, the AGV/AMR designer can unburden the AGV/AMR controller from some control tasks such as synchronizing and coordinating individual drives and motion controllers. By the way, this CANopen feature is available since its introduction in 1994, but has not been implemented in many CANopen devices.

On the SPS tradeshow, several companies presented special drive and motion controllers dedicated for AGV/AMR applications. The Franz Morat Group uses CiA 402 compliant drives from Dunkermotoren for its RNA250 and RNA500 wheel hub drives. These modular products comprise the wheel, the gear, the brake, the motor, and the CANopen interface compliant with the CiA 402. Typical applications include intralogistics, hospital logistics, and autonomous cleaning machines. A new application field are wheel hub drives for outdoor use in agriculture. The CANopen drive systems for AGVs by Dunkermotoren are based on the BG 95 dPro DC servo controllers with an integrated encoder. They are combined with KG 120 or KG 150 bevel gears.

Wittenstein is another supplier of servo controllers for AGVs. The cyber iTAS system 2 is a servo drive system for AGV/AMR products with masses between 1 t and 3 t. It features optionally a CANopen interface compliant with CiA 402. The company states on its website: “The integrated safety architecture of the cyber iTAS sys-tem 2 requires fewer cables and connectors, fewer interfaces, components, and modules.” This reduces the risk of errors as well as the effort for assembly and documentation.

There are also other providers of dedicated motion control products for AGVs and AMRs. Kofon offers differential speed 2-wheels sub-systems with an optional CANopen interface. Metronix has developed in co-operation with DPM and Fritz Antriebstechnik an AGV using the BL4840-M servo controller. This forklift AGV is used in the production line at Porsche. The MW500 wheel drive system by Maxon is suitable for loads up to 500 kg. It features a CANopen interface and provides an integrated encoder based on a Hall sensor. Heidrive’s CANopen motion controllers are used in the Wheelmax series of wheel drive systems offered by the Allied Motion, the parent company. The Heimotion HMP and HMD motors can be combined with cycloidal, in-wheel, and reinforced planetary gearboxes. The drive controllers come with an optional CANopen interface. Variants with the STO (safe torque off) function are available.

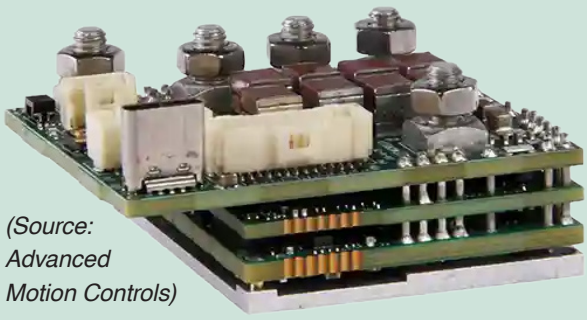
STXi exhibited at the SPS 2023 its AGV/AMR wheel drive system comprising a wheel, a planetary gearbox, a brushless servo motor with integrated brake and encoder, and a CANopen-compatible servo drive. It can be connected to a CANopen host controller, e. g. a programmable logic controller (PLC). The wheel drive system features an STO function, which turns off the torque and stops the AGV or AMR safely. This feature eliminates the need for external parts such as safety relays. Other manufacturers of wheel drive systems offer an STO function, too. For example, the MobiMS wheel drive system by STXi, which is used in AGVs by Safelog.

Nanotec, a CiA member for 20 years, presented in Nuremberg its CANopen-connectable wheel drive systems designed for AGV/AMR applications. They are suitable for loads up to 400 kg. The company produces two types of wheel drives: Modular wheel drives that combine wheel, gearbox, and bearing in a space-saving unit as well as compact integrated wheel drives that consist of wheel, gearbox, brushless DC motor, and encoder, thus reducing the number of moving parts and connections.

Advanced Motion Controls (AMC) manufactures CANopen servo drives for AGVs and warehouse automation systems. The company has supplied its CANopen product to an automated guided cart able to carry 1000 kg of cargo weight. The applied brushless servo motor features an integrated incremental encoder. A warehouse automation AGV by Omron has been also equipped with a servo drive by AMC.

The Ewheel by B-Drives offers a dual-axes motor controller with STO functionality. The CANopen drive controller is voltage-resistant up to 60 V with a peak current of 60 A. The two motors have integrated individual incremental encoders. According to the company, the speed can be reliably recorded in functional terms by balancing both signals with appropriate electronics.

100-A servo drive



(Source: Advanced Motion Controls)

Advanced Motion Controls has introduced the shown CANopen servo drive with a 100-A continuous output capability and a specified peak current of 200 A. This is not a typo. The size of the servo drive is less than half a business card. This product is available in both PCB-mountable and embedded form factors with a CANopen interface.

Additional standardization would simplify AGV/AMR design

Standardized interfaces simplify system design for the original equipment manufacturers (OEMs). On the other hand, the OEM loses knowledge on the deeply embedded functionality. PLCopen, the nonprofit association for the IEC 61131 standards, has developed standardized interfaces for robots. This includes a 6-axes control interface. A similar approach for AGV/AMR multi-axes control function would perhaps make life easier for system designers. If such a CANopen multi-axes interface would be supported by the open-source Robot Operating System (ROS), the effort for system integration could be reduced dramatically. ROS is already adapted in several AGV/AMR projects based on CiA 402 compatible drives and motion controllers. There are also ROS modules available for radars and lidars (light detection and ranging). Both kinds of sensors are used in AGVs. Goetting (Velodyne), Pepperl + Fuchs (OMD-8000), and Sick (S100) offer 2D-lidar sensors. For inertial navigation systems, other CANopen sensors could be also connected to the AGV/AMR host controller. A typical example is the HG G-84300 CANopen gyro sensor by Goetting. The company also offers the HG G-98630 two-dimensional magnet localization sensor, which comes with a CANopen interface. ◀

hz

AGV for the pharmaceutical industry

EK Robotics has supplied its CANopen-based X Move transport platform for an AGV used in the pharmaceutical industry. At the customer, the challenge in integrating the automated guided vehicle system (AGV) was to ensure an optimally timed material flow on sometimes narrow route areas and simultaneously integrate prioritized transports of refrigerated goods into the new automation process. EK Robotics has provided a solution based on its X Move series: in future, twelve mobile transport robots will take over the safe and efficient transportation of pallets with pharmaceuticals between the production areas in two-shift operation. Each of the adapted products is equipped with a roller conveyor, handles around 90 transports per hour, and is responsible for picking up and dropping off loads at 22 conveyor technology stations between the production and storage areas.

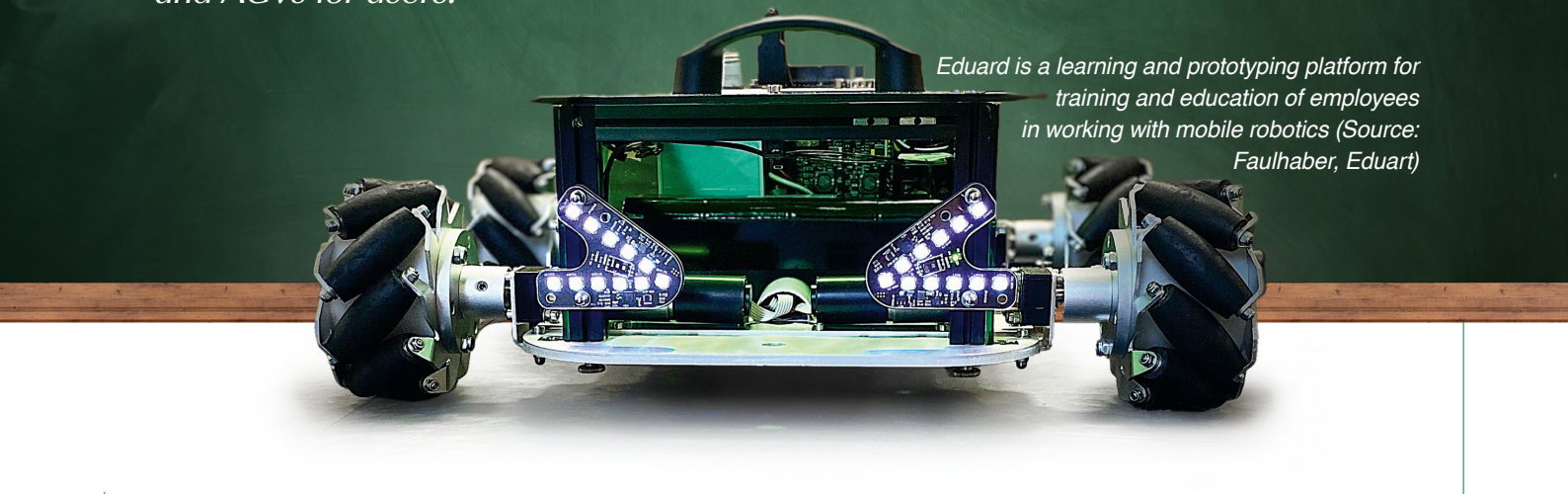
The partner, for whom EK Robotics is implementing the transport solution, is already familiar with an automated guided vehicle system from a market competitor, which previously handled the intralogistics processes involved in pharmaceutical production. The system will now be implemented step by step over several weekends by EK Robotics so that ongoing production and operations are not interrupted. "With the new AGV, our customer is able to prioritize important refrigerated transports that were previously carried out manually. The new system is also much more flexible with a higher number of vehicles than before and communicates directly with the SAP system," explained Ronald Kretschmer from EK Robotics. Initially, 13 transport robots were planned for this application, but with a material flow simulation, the AGV experts were able to reduce the ideal number of vehicles for the overall system from 13 to 12 X Move units during the project planning phase.

In Switzerland, the customer is a major pharmaceutical manufacturer and can look back on a century-long history in the pharmaceutical industry. The driverless transport system from EK Robotics enables the customer to link different production or logistics areas even more efficiently and is a key factor for sustainable profitability and site security. With 60 years of expertise, EK Robotics provides long-term support for intralogistics projects and offers a wide range of solutions for further customized automation processes. Software solutions for system optimization, expansion of existing automated guided vehicle systems, and their long-term spare parts supply are also part of the portfolio. *hz*

X Move 1200 transport platform is equipped with a roller conveyor with lateral load securing and transports pallets between 22 conveyor stations for the customer from the pharmaceutical industry (Source: EK Robotics)

Learning platform for AMRs and AGVs

Autonomous mobile robots (AMRs) or automated guided vehicles (AGVs) become efficiency-increasing helpers in production transport and intralogistics applications. In many companies, the experience in working with these systems is still lacking. A robot learning platform from Faulhaber facilitates the entry into the world of AMRs and AGVs for users.



Eduard is a learning and prototyping platform for training and education of employees in working with mobile robotics (Source: Faulhaber, Eduart)

At the request of an industrial company, Eduart Robotik in Neunkirchen a. Sand (Germany) developed a learning and prototyping platform that can be used for the training and further education of employees in working with mobile robotics. In addition, the company provides a range of teaching and service offerings for testing and optimization.

Expandable robot learning platform

The robot learning platform called Eduard is approximately 40 cm x 40 cm x 15 cm large and weighs under 8 kg. The implemented sensor concept includes distance and inertial measurement devices as well as a battery management system. Access to the vehicle is possible via open interfaces.

Figure 1: The variant with Mecanum wheels allows the robot to turn on the spot as well as drive sideways or diagonally (Source: Faulhaber, Eduart)

Movement of the mobile robot is facilitated by either simple rubber wheels or Mecanum wheels. The latter allow the robot to turn on the spot as well as drive sideways or diagonally. It is thereby possible to navigate and precisely position even in very constrained spaces. The motors from Faulhaber are used with both wheel variants.

"These high-quality drives have proven to be ideal for our applications," confirms Markus Fenn, Managing Director of Eduart Robotik. Depending on the required speed or torque, gearheads with a gear ratio of 72:1 or 89:1 are available on the drive. Users themselves can expand the basic equipment of the robot learning platform or have it adapted by Eduart Robotik according to their needs. It is thereby possible to cost-effectively test new concepts, such as a diffe-rent sensor system.

Figure 2: Markus Fenn, Managing Director of Eduart Robotik (Source: Faulhaber, Eduart)

Drive technology

When selecting the drive systems, it was necessary to consider the future requirements of AGVs and AMRs. The chosen DC-micromotors with noble-metal commutation from Faulhaber deliver a high torque and high power-density in spite of their small dimensions. Moreover, they can be precisely controlled and are suitable for highly accurate control loops. For larger platforms, the robot manufacturers also used large DC-motors from the same provider. Depending on the application, these drives ▷

can be replaced by maintenance-free and long-lasting brushless DC-motors.

With the trend towards decreasing batch sizes and increasing numbers of variants, more robots will be needed for smaller loads, i.e., smaller robots with smaller but more powerful drives. Such autonomous industrial trucks have fewer electronics and smaller batteries, which means lower weight and decreased energy consumption.

The right choice for these and future solutions can be found in the wide selection range from Faulhaber. If the loads to be moved increase at any time, it is possible to scale up the required part of the drive unit.

Development and testing software

As a rule, it is not the hardware that is complex on AGV and AMR solutions, but rather the software. For example, good planning on the software side is important so that all mobile robots can work together seamlessly or to enable reliable fleet management. To do this, the robots need to "think" themselves, exchange information via standard interfaces and, if necessary, cooperate. The software needs only little information about the respective mobile robot. It has to calculate where the robot is located on the hall plan. The navigation, which is one of the few components that knows the dimensions of the robot, then searches for the appropriate path. In order to reach the required speed, the motor controller calculates the number of wheel revolutions required. Making this adjustment also requires only a few lines of program code or of a configuration file. Faulhaber supplies motors with high-precision gearheads and encoders for exact positioning, thus enabling optimum performance and safety. "Also important here were the corresponding interfaces to allow the drives to appropriately exchange information with the rest of the system," says Fenn. "Our communication takes place via a proprietary CAN-based protocol (at 500 kbit/s). We are currently switching to CAN FD due to the higher data rate and the wider bandwidth. We will also implement CANopen when the requirement calls for it."

The drive experts from Schönaich

Faulhaber is specialized in the development, production, and deployment of high-precision miniaturized and miniature drive systems, servo components, and drive electronics with up to 200 W of output power. This includes putting into effect customer-specific packaged solutions as well as an extensive range of standard products, such as brushless motors, DC-micromotors, encoders, and motion controllers. The devices are used worldwide in complex and demanding application areas, such as medical technology, factory automation, precision optics, telecommunications, aviation and aerospace, and robotics. From the 200-mNm (continuous torque) DC-motor to the filigree micro drive with an outer diameter of 1,9 mm, the company's standard range can be combined in more than 25 million different ways to create the suitable drive system for a particular application.

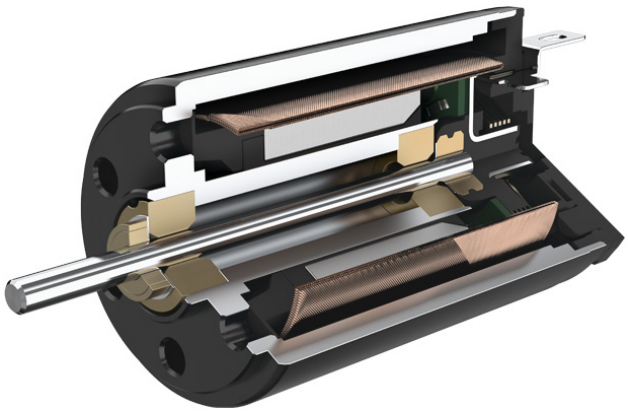


Figure 3: Eduard is driven by DC-micromotors with noble-metal commutation (Source: Faulhaber)

Safety aspects

Also important when using mobile robots is the topic safety, in terms of both security and safety. The latter can be achieved, e.g., with a motor controller that detects when one of the motors fails and the movement immediately stops as result. If a person enters the driving area, this is detected by the laser scanner. This causes braking of the system. The individual mobile robots communicate with each other via such networks as WLAN or 5G. Corresponding protection mechanisms were realized for the security reasons as well. Should a hacker attack nevertheless occur, it is important that no dangerous movements can be triggered on the robots as a result. For this purpose, the robots are equipped (among others) with a safety scanner including a distance sensor to prevent them from, e.g., running into the wall.

A look into future

The trend in the field of mobile robotics in the coming years goes to usage of several smaller vehicles instead of one large vehicle. Where, for example, four small robots work together on a transport task instead of one large robot, small motors that work very precisely are needed. The robot swarm will otherwise stumble or lose its synchronization. In order to improve reliability, encoders must be absolutely immune to interferences so that the robot is not influenced by external interferences. For this reason, Faulhaber sometimes uses two encoders on each motor. The requirements for mobile robots as well as the according drive solutions are continuously changing. As the drive company provides modularly structured drive solutions, the devices can be flexibly combined. In mathematical terms, some 25 million variants are possible from the combination of offered gearheads, encoders, controllers, etc., of which a considerable portion has already been implemented in the practice. This modular concept allows to cover the requirements of the future.

Authors

Nora Crocoll, Alex Homburg
Redaktionsbüro Stutensee
kontakt@rbsonline.de
www.rbsonline.de

Autonomous mobile robots in warehouses

The Open Shuttles autonomous mobile robots (AMRs) from Knapp enable automation of internal transport without adjustments to an existing infrastructure. The drive solutions from Dunkermotoren and gearboxes from Framo Morat installed in the AMRs ensure safe transport of even bulky and heavy loads.

According to a Statista publication from December 2021, most B2C customers from a total of twelve European countries included in the statistics expect their goods ordered online within three to five days. In the Netherlands, one third of the customers expect their goods to arrive after just one to two days. But also, in B2B commerce, speed, flexibility, and transparency are getting increasingly important. To meet these requirements, logistics processes within an organization must be designed to be as efficient as possible. Workflows must be adapted to the fast pace of demands and requirements - and the associated logistics processes must keep pace.

The Open Shuttle AMRs from Knapp implement CANopen-based modular drive solutions from Dunkermotoren (Source: Dunkermotoren)

A solution to these challenges is offered by the Austrian company Knapp. Open Shuttles are autonomous mobile transport robots that take over internal transport tasks without adjustments to the existing infrastructure. Thanks to an innovative fleet control software, tasks are distributed to the entire fleet of AMRs.

Traction drive

The Open Shuttle series are the flexible alternative to classic tote conveyor technology and transport totes, cartons, and trays up to 800 mm x 600 mm and a maximum payload of 100 kg. Thanks to automatic lifting and width adjustment, the shuttles can accommodate trays of different heights and widths. They are used to connect different storage areas with each other and also supply decentralized workstations.

In addition to the implemented software and smart sensor technology, the traction drive is the heart of the AMR. With its more than 70 years of experience in drive technology, Dunkermotoren, a brand of Ametek, was able to provide the right solution. The autonomous mobile robot is driven by two brushless DC motors of the BG 75 series. The attached controller ensures smooth acceleration and deceleration of the robot. A brake from the company's modular system, which is also integrated into the overall drive, ensures an immediate stop of the AMR in case of an imminent collision with other vehicles or people, which are reliably detected thanks to the integrated laser scanner.

The required power for the drive is provided by the hub gearbox from Framo Morat from Eisenbach, Germany. Together, the two companies have already realized many AGV/ AMR projects. Since 2021, they have been presenting a portfolio on the market specially designed for the strict safety and space requirements of AGV solutions. The complete system of motor and gearbox is maintenance-free over the entire service life. If the tread should unexpectedly become damaged or the requirements for the wheel change due to changed ground conditions, it can be replaced and serviced directly on the vehicle.

With an acceleration torque of up to 42 Nm, the hub gearbox ensures the AMR to move even heavy loads. The emergency stop torque of 63 Nm ensures an immediate stop in case of an imminent collision. Thanks to the complete drive solution from Dunkermotoren and Framo Morath, the Open Shuttle is always moving safely and reliably.

The special feature of the drive solution is the compact design of the overall drive. The gearbox is integrated into the wheel hub and thus disappears into the drive without increasing its length.

Lifting and steering drives

The Open Shuttle Fork is the AMR model of choice when it comes to transporting entire pallets, racks, or large special load carriers. It has a payload of up to 1300 kg. The integrated automatic lift enables the load to be picked up directly from the ground and allows the load to be placed at heights of up to 1,2 m. In this AMR, the drive ▷

Logistics support from the Black Forest

(Source: Adobe Stock)

Nowadays, autonomous transport equipment, service robots, and high-speed sortation systems have taken over the sorting, collection, and transportation tasks, formerly manually performed by employees. The various transport systems move autonomously and independent of location, in some cases they move free navigating. This requires that the vehicle is “smart” and battery-powered. When sorting and ordering parcels, for example, fast and precise motion control is required to guide the parcels’ movement. The interaction and communication between sensors, controllers, and actuators is essential here. The required motor solutions have to offer high efficiency and thus longer battery life, to include safety functions, and to be compact in their design.

The motor solutions from Dunkermotoren (located in Bonndorf near the Black Forest, Germany) can fulfill the mentioned requirements. The compact design and modular construction of the drive system allow a wide range of combinations. The integrated motor controllers with a flexible selection of the communication system (e.g. CANopen) enable the use in almost all industrial environments. Additional safety-related functions such as a brake, independent encoder systems, or functional safety (STO function) complete the performance spectrum, especially for autonomous systems. With the IIoT brand Nexofox launched in 2021, Dunkermotoren can meet the requirements of Industry 4.0 with services such as drive-specific data evaluation and predictive maintenance.

Depending on the application, motors smaller than 50 mm with less than 50 W nominal power are offered. Especially small axes such as telescopic arms or small lifting axes rely on such motors. There are also motor solutions with a continuous output power of over 1 kW and a peak output power of up to 5 kW with a supply of 24 V_{DC} to 48 V_{DC} battery voltage. This allows loads of up to 8 tons to be moved, for example when transporting chassis in the vehicle construction. At the same time, the system can be positioned exactly within a fraction of a millimeter thanks to the integrated electronics. This is important when precise assembly or testing operations are carried out on the load.

The technical basis for this lies in compact and integrated power electronics in the motor. Due to its modular design, it enables a variety of expansion stages, allowing the motor to be adapted to the given requirements. Thus, integrated and complex sequence control is possible, which can trigger other network participants or react to their movement. Parts of the motion sequence can be relocated from the higher-level control system to the motor. The Motor Control Platform (MCP) allows communication between components via common fieldbus communication systems, such as CANopen. This diversity creates two advantages:

- The modular design generates a level of common parts to achieve a positive cost effect;
- At the platform level, the functions are almost the same and independent of communication.

In addition to communication, concepts of safe automation are also part of the drive concept. The attachment of a holding brake to fix the transport vehicle is available as standard in the company's modular system. Installation of an independent, second encoder system can be used for safe speed monitoring. Devices for a safe stop of the vehicle in the event of a fault can be fitted as an optional extension. All these points are essential requirements for a motor solution in self-guided transport systems.

solutions from Dunkermotoren are used for both, the lifting and steering movements, giving the robot omnidirectional mobility. Thanks to the integrated CANopen electronics, the shuttle's higher-level control system can address and control the drives.

The lifting of up to 1300 kg, is managed by the most powerful motor available in the Dunkermotoren product portfolio. A brushless DC motor of the BG 95 series with the matching planetary gearbox handles even heavy loads. The attached E 600 brake then holds the load in any desired position. If necessary, the brake is also used for an emergency stop at the full lift. As soon as a certain safety condition is breached, the engine is immediately switched off and the brake guarantees the stop.

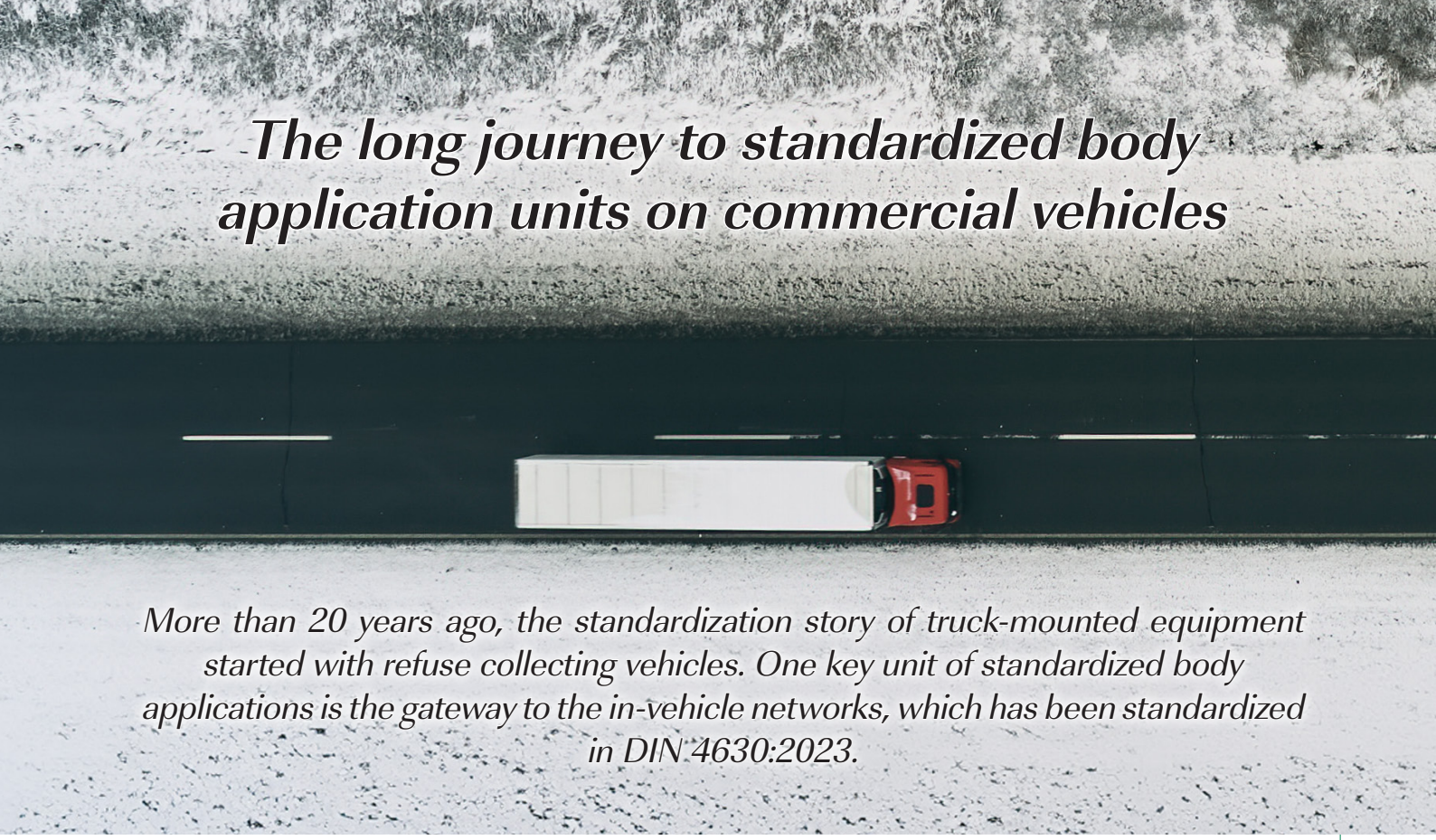
To always keep the right course, two additional drives are installed in the shuttle as a steering unit. The smart BLDC motors of BG 66 series with planetary gearboxes are very compact and, thus, suited for use in flat vehicles. Via integrated electronics with a CANopen interface, the motor receives commands from the higher-level controller of the AMR and can implement even minimal course adjustments of several millimeters.

The Open Shuttles can be integrated easily into existing structures and during ongoing operation. To cover seasonal peaks, additional robots can be integrated into the fleet and removed again afterwards. ◀

Author

Stefanie Tröndle
Dunkermotoren
stefanie.troendle@ametek.com
www.dunkermotoren.com

The long journey to standardized body application units on commercial vehicles



More than 20 years ago, the standardization story of truck-mounted equipment started with refuse collecting vehicles. One key unit of standardized body applications is the gateway to the in-vehicle networks, which has been standardized in DIN 4630:2023.

In 2002, CiA established the SIG (Special Interest Group) municipal vehicles. The participating companies agreed to develop a CANopen application profile for refuse collecting vehicles. Original equipment manufacturers (OEMs) requested standardized interfaces for units like bin lifter, weighing/measuring sub-systems, compacters, washing equipment, etc., which they wanted to purchase from different suppliers. Such open interfaces can overcome single-source problems. The dependency on suppliers decreases. On the other hand, suppliers can reduce the number of customer-specific interface variants.

The first version of the CiA 422 CANopen application profile specification series was released in May 2004. It is also known as C*le*ANopen and is standardized in the meantime in EN 16815:2019 (C*le*ANopen – Application profile for municipal vehicles). One of the key elements of this standardized body application was the interface to the in-vehicle networks (IVN) of the truck. There was the hope that such a standardized IVN gateway would be provided by the truck manufacturers. In the beginning several OEMs participated in the CiA 422 development, which was done in co-operation with the German VKA nonprofit association, representing the interests of equipment and municipal vehicle manufacturers in Europe.

To generalize the CANopen-based IVN gateway, CiA established the SIG truck gateway. This group developed the multi-part CiA 413 CANopen truck gateway profile. Unfortunately, this approached has been implemented only by Iveco. All other European truck manufacturers still provide today proprietary interfaces for body application units (BAUs). The CiA 413 gateway profile covered also the parameters of the ISO 11992-2 and the ISO 11992-3 standards. These standards specify the CAN-based link between towing and towed commercial vehicles – in other words between truck and trailers. This means, the body application unit mounted on a trailer can communicate seamlessly via the ISO 11992 networks with the IVNs on the truck, for example to require energy (power take-off) and to get status information (e.g. parking brake engaged). The CiA 413 gateway specification also covers parameters specified in the FMS (fleet management system) specification by ACEA, the European nonprofit association of road vehicle manufacturers situated in Brussels, Belgium.

FireCAN: The standard for fire-fighting equipment

In the meantime, a second body builder application has been standardized: Fire-fighting truck equipment. In the year 2006, the fire-fighting vehicle OEMs and their Tier-1 suppliers started in CiA to develop a CANopen-based solution. After a while, they continued to develop the profile under the leadership of Rosenbauer by their own and submitted with the partners the results to the German DIN standardization body. DIN edited based on these submissions the DIN 14700 document series comprising 12 parts. First FireCAN products were launched in 2010 at the Interschutz tradeshow.

Unfortunately, the quality of these documents was not sufficient to avoid misunderstandings and misinterpretations. The German language was another hurdle. Tier-1 companies from non-German speaking countries were not able to read the documents without loosing information. Additionally, the DIN 14700 series made unclear references to the CiA 301 CANopen specification.

These were the reasons to review the DIN 14700 series. The new edition, still under development, is a one-part document, again with the name DIN 14700 (2nd edition). It is now written in English language and much closer to the CANopen CC (classic) application layer as specified in CiA 301. There are still some differences, but of minor art. The document specifies several fire-fighting units (FFU). All of them are virtual devices, meaning they provide some dedicated functionality and can be implemented on appropriate ECUs (electronic control units). These ECUs can host several FFUs, although those with different functionalities. This is the same approach what the passenger car industry calls a software-defined vehicle (SDV). The above-mentioned C*le*ANopen is a software-defined solution, too. But in those days, the term SDV was not yet invented.

DIN 4630: The standardized body builder gateway

The CiA 413 truck gateway specification was technically a success. Iveco implemented it in many of its vehicles and still uses it. Body builders can configure this interface on the CANopen side according to their application needs by means of a spreadsheet. Commercially, it was not a success story: One implementation is not enough to reduce the body application adaption to other truck brands.

The tail lift industry suffered from this situation. Additionally, some tail lift manufacturers liked to standardize the interface to telematic getaway units (TGU) and fleet management units (FMU). Bär Cargolift, a German company, took the initiative together with other body builders, for example Palfinger, an Austrian/Chinese manufacturer of truck-mounted cranes, and started the development of a CAN-based body builder network. DIN specified the application profile for body builders under the name DIN 4630. The document is written in English language. It specifies a TGU, an FMU, several BAUs, and an IGU (in-vehicle gateway unit). The standardized BAU interfaces include host controllers for tail-lifts, truck-mounted cranes, refrigerators, etc. New body applications such as hook loader are in the pipeline.

The DIN 4630 standard released in 2022 specifies the BAU generic and specific parameters as well as ECU-related parameters. In the annexes, there are standardized mappings to the J1939 and CANopen application layers. The fire-fighting vehicle industry is the first body builder group, which has developed a DIN-4630-based interface for a dedicated market: The DIN 14704:2023 standard specifies a J1939-based interface for FFU-specific IGUs. The corresponding interface for the DIN 14700 host controller is not yet standardized.

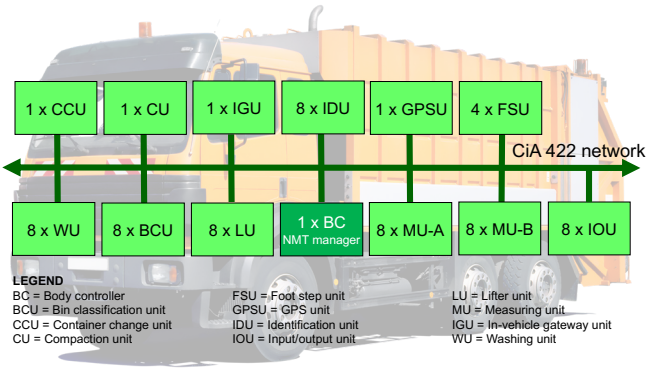


*Figure 1: The C*le*ANopen application profile is based on CANopen CC (classic) and specifies virtual device interfaces such as shown in the schematics (Source: CiA, Adobe Stock)*

C*le*ANopen: Some technical details

The CiA 422 application profile for refuse collecting vehicles is based on CANopen CC (classic) as specified in CiA 301 respectively in EN 50325-4 (compliant with CiA 301 version 4.0.0). It is a network specification approach, which comprises virtual interfaces for specific units. Due to the software-defined approach of CANopen with logical and virtual devices the scalability and configurability is very high. The OEM can implement up to eight instances (logical networks) of refuse collecting equipment networks running on the same physical CAN network. This is as if one vehicle has different bin lifters and related measuring/weighing units for several kinds of garbage. Each logical network comprises virtual devices such as a bin classification unit, a compaction unit, a bin lifting unit, and a body controller with the network management (NMT) manager. This gives the body application designer the possibility to scale the functionality of the ECU interfaces by means of software. Of course, the ECU needs to provide the appropriate input/output functionality. ▷

Brief news: Gateways

- ***Telematics gateway:*** CiA member TTControl (Austria) supplies the TTConnect Wave 4G W, coming with two CAN CC ports, one LIN channel, and one Ethernet interface. It provides GNSS, 4G LTE Cat 4, 3G UTMS, 2G GSM, and Bluetooth connectivity. The product comprises an accelerometer, a gyroscope, and local I/O ports.
- ***Telematics control unit:*** CiA member Iwave Systems (India) offers the IW-RainboW-G62H, featuring GNSS, LTE Cat 1, and Bluetooth connectivity. The IP67-rated product provides two CAN FD interfaces. CANopen, FMS, J1939, and UDS software support is available. Additionally, the gateway is equipped with generic I/O ports, an accelerometer, and a gyroscope.
- ***Remote access unit:*** The Epec 6200 by CiA member Epec (Finland) has two to six CAN CC interfaces supporting CANopen, J1939, and NMEA2000. It connects to GNSS and WLAN. There are also some local I/O ports. The IP67-rated telematics gateway is programmable in Codesys (IEC 61131-3).
- ***LTE gateway:*** The IP40-rated Maxx GW4101 by Iotmaxx (Germany) is a Phyton programmable device. It comprises one CAN and one Ethernet port as well as sensor interfaces and local I/Os. GNSS and 4G LTE connectivity is provided.

hz

The CiA 422 application profile pre-defines all necessary TPDO and RPDO (transmit/receive process data object) messages as well as some additional SDO (service data object) channels. PDOs are transmitted unconfirmed in a broad/multi-cast manner, while the pear-to-pear SDOs are confirmed by the receiver. The specified process data and configuration parameters are organized as arrays in the CANopen dictionary addressable by means of a 16-bit index and an 8-bit sub-index. The CANopen ECU interface implements only those CANopen dictionary parameters, which correspond to the desired functionality. For example: Lifter unit 5 supports sub-index 5 of the related data objects.

The CiA 422 application profile specification includes six parts:

- Part 1: General definitions and physical layer specifications
- Part 2: Virtual devices definitions
- Part 3-1: Pre-defined TPDOs
- Part 3-2: Pre-defined RPDOs
- Part 3-3: Pre-defined SDOs
- Part 4: Detailed application object specification

CiA has submitted the CiA 422 series (version 2.0.0) to CEN for European standardization. It is published as EN 16815:2019 standard. CiA members improve and extend the C*le*ANopen documents. Currently, the version 2.1.0 is released. An update is expected, soon.

C*le*ANopen is widely accepted. OEMs such as the Kirchhoff Group with the brands Faun and Zoeller among others use CiA 422 compliant networks in refuse-collecting vehicles. There are also refuse-collecting vehicles in the Near and Far East implementing C*le*ANopen. C-Trace and Moba are suppliers of C*le*ANopen measuring/weighing units. The standardized communication in refuse collecting vehicles enables to record data on the CANopen network for telematic and other purposes. Squarell supports this with its vehicle data collection devices and Moba offers for 20 years the Mawis bin-identification and weighing unit, which can be used for a demand-driven provision of bins. The increased transparency of the disposal process saves considerable time since it enables an efficient route optimization of the vehicles. This is supported by AI ▷

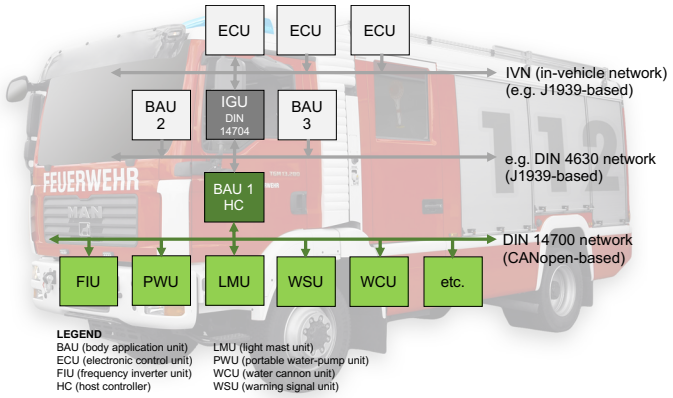


Figure 2: The FireCAN application profile is based on CANopen CC (classic) and specifies functional units such as shown in the schematics (Source: CiA, Adobe Stock)

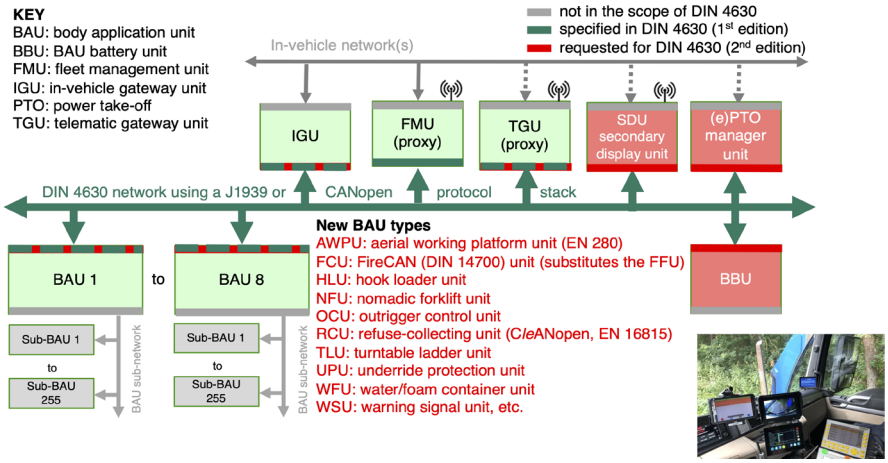


Figure 3: The body application network as standardized in DIN 4630 specifies several units including an in-vehicle gateway unit (Source: CiA)

(artificial intelligence) software running in the back office. They are connected by means of telematics and have thus access to the refuse-collecting equipment with CiA 422 communication capability. C*le*ANopen feeds so-to-say the AI computer. C-Trace offers telematic solutions for its own bin-classification and measuring/weighing units as well as for third-party C*le*ANopen products.

Abbreviations in text

AI: artificial intelligence
AWPU: aerial working platform unit
BAU: body application unit
CAN/CANopen CC: CAN/CANopen classic
ECU: electronic control unit
EMCY: emergency message
ERR: error message
FCU: FireCAN unit
FFU: fire-fighting units
FIU: frequency inverter unit
FMS: fleet management system
FMU: fleet management unit
GND: ground
HC: host controller
HLU: hook loader unit
IGU: in-vehicle gateway unit
ISO: International Organization for Standardization
IVN: in-vehicle network
LMU: light mast unit
NFU: nomadic forklift unit
NMT: network management
SDO: service data object
SDV: software-defined vehicle
SIG: special interest group
OCU: outrigger control unit
OEM: original equipment manufacturer
PTO: power take-off
RPDO: receive process data object
TGU: telematic getaway unit
TPDO: transmit process data object
UPU: underride protection unit
WSU: warning signal unit
WU: winch unit

DIN 14700: The second edition in some detail

The 2nd edition of DIN 14700 is written in English language. It is a single document comprising the twelve predecessor parts of the 1st edition. The new document specifies the CANopen dictionary and the pre-defined PDOs. The implementation of the CANopen dictionary is optional, due to backward-compatibility reasons. Nevertheless, it is recommended to implement it.

The CANopen application profile for fire-fighting equipment is a network system approach. It defines virtual devices, the so-called functional units. Such virtual devices are the frequency inverter unit (FIU), the light mast unit (LMU), the winch unit (WU), the warning signal unit (WSU), and further ones. Some of these units have multiple instances.

The pre-defined PDOs have a length of 8 byte. When the in a PDO mapped data objects (parameters) do not need 64 bits, they are filled up with bits indicating that no function is available. It is done by setting these bits to 1_b. All these PDOs have a fixed assigned CAN-ID, in order to achieve an off-the-shelf plug-and-play capability. This avoids a double-use of CAN-IDs.

The host controller (HC) manages and controls the connected FFUs. The FFUs do not have direct access to the in-vehicle network gateway (IGU). This means, the HC acts as a gateway to the DIN 4630 network, which provides an IGU compliant with DIN 14704, for example. The HC gateway functionality ensures that the FFUs have access to relevant vehicle-related information like engine speed and that data from the attached FFUs can be forwarded to other ECUs or human machine interface devices connected to the IVNs.

The recommendations given in CiA 301 regarding the overall network length and the maximum length of a single stub (0,75 m) are suitable for DIN 14700 networks. A wiring harness featuring 120-Ohm impedance is feasible. Trunk and stub cables providing four wires for fixed-mounted devices and six wires for portable devices are recommended. The cables can be shielded. In case of using shielded cables, ground loops need to be avoided. The red wire connects to V_{cc} and the black wire connects to ground (GND). The white wire connects to the CAN_H wire and the blue wire connects to the CAN_L wire. The pin-assignments of the socket connectors attached to the wiring harness corresponds to those given in DIN 14700 for the plug connectors. Wires for fixed-mounted devices having a cross-section of 0,34 mm² respectively 1,5 mm² for portable devices.

The DIN 14700 document specifies for each FFU a unique CANopen node-ID, which is needed to assign CAN-IDs for the mandatory heartbeat messages and the optional SDO communication. There is also a specific ERR (error) message specified. This is a specific PDO similar to the EMCY (emergency) message in CANopen. The ERR message is transmitted periodically by the assigned virtual device. It contains the current FFU error information. This ▷

includes also warnings. The FFUs and the HC provide error history lists in the CANopen object dictionary accessible by means of SDO services.

The development of the new DIN 14700 standard is supported by Magirus, Rosenbauer, and Ziegler from the OEMs side as well as by some FFU suppliers, for example the WSU supplier Haensch. International companies can also comment the draft standard, which will be publicly available, soon. The ballot of the DIN 14700 document written in English language starts in the first half of 2024. The WSU functionality has been improved and extended significantly. Some WSU functions are the same as specified in the CiA 447 series of CANopen profiles of add-on devices for police cars and ambulances.

There are already some ideas to extend furthermore the DIN 14700 functionality. One of the ideas is to include a local TGU for equipment, which can be operated as a stand-alone unit. With this option, such so-called nomadic devices can be connected to a fleet management system even when the truck with a generic TGU is not available.

DIN 4630: Submitted for ISO standardization

The in-vehicle gateway unit (IGU) standardized in DIN 4630 has not been implemented yet. All truck manufacturers provide proprietary interfaces to their in-vehicle networks. Often these interfaces implement a J1939 application layer with proprietary PG messages and a subset of those standardized in the ISO 11992 series. In order to gain acceptance, DIN 4630 is going to be submitted to ISO for international standardization.

With the submission, an extended functionality is desired. The OEMs like to have a functional safety capability for power take-off (PTO) requests at the IGU. Additionally, some security measures for the IGU are required. The body building industry wants to specify additional BAUs. This includes an EN 280 compliant aerial working platform unit (AWPU), a FireCAN (DIN 14700) unit (FCU), a hook loader unit (HLU), a nomadic forklift unit (NFU), an outrigger control unit (OCU), an underride protection unit (UPU), and a warning signal unit (WSU).

Additionally, the BAU manufacturers like to standardize a secondary display, virtually connected to the body application network. The remote display in the cabin should be provided by the vehicle OEMs. The secondary display would need a standardized interface to download apps. If the download is done via the IGU, J1939 and CANopen provide appropriate services. In CANopen, the SDO service is able to transmit any size of domain data. Another option is the transport protocol specified in ISO 15765-2 and the UDSonCAN services standardized in ISO 14229-3.

But the hurdles for ISO standardizations are high: Five countries must support the project preferably located on different continents. Support means nominating an expert willing to participate in the development of the standard. The body building industry would benefit from an international standard: The body builders can move their systems to different vehicles and integrate TGUs and FMUs from different suppliers or design their own ones. Additionally, standardized BAUs can be combined to achieve a more functionally sophisticated body application.

hz

Safety and higher-efficiency solutions for motorcycles

Bosch MSC for smaller motorcycle models is fitted on the new TVS Apache RTR 310 (Source: Bosch)

Bosch has introduced its motorcycle stability control (MSC) for sub-400cc motorcycle models. It is implemented first on TVS's flagship motorcycle, the TVS Apache RTR 310. The devices inside the MSC are networked via CAN CC (classic). At the EICMA 2023 motorcycle show in Milan, the company has shown further solutions for safety and higher efficiency of two-wheelers.

Out on the road, the best way to feel an unparalleled sense of freedom is to ride a motorcycle. Braking or accelerating in bends can be critical to safety when riding a motorcycle. The motorcycle stability control (MSC) helps bikers maintain control in various situations. The system combines a motorcycle ABS (anti-lock braking system) with a 3D or 6D inertial measurement unit (IMU) and is a type of ESP (electronic stability program) for motorized two-wheelers.

MSC for smaller motorbike segments

Bosch has introduced the motorcycle ABS over 25 years ago, ensuring greater safety on the roads. Ten years ago, the MSC followed up. It was introduced on the KTM 1190 Adventure (2014 models). By monitoring two-wheeler parameters such as lean angle, the system can instantaneously adjust its electronic braking and acceleration interventions to suit the current riding situation. In this way, the system can prevent the bike from low-siding or righting itself suddenly and uncontrollably when braking in bends, which is where many motorcycle accidents occur.

Figure 1: Bosch Motorcycle Stability Control (Source: Bosch)

The system is now available not only in the medium to large motorcycles, but also covers smaller sub-400cc motorcycle models, which are common in emerging markets e.g. in India, China, and ASEAN. India's TVS Motor Company, a global manufacturer of two-wheelers and three-wheelers, has fitted its new TVS Apache RTR 310 with the Bosch MSC. It utilizes the Bosch IMU and the ABS 10 base unit, which has a smaller and lighter housing thus suited to smaller motorcycles.

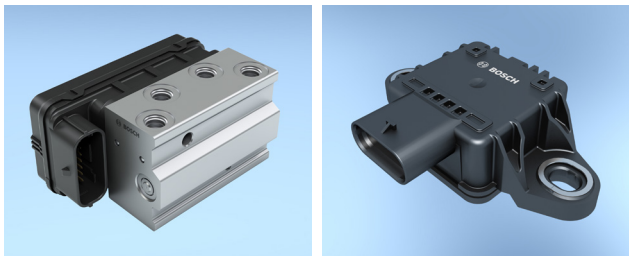


Figure 2: The introduced MSC utilizes the Bosch IMU (right) and the ABS 10 base unit (left) with a smaller and lighter housing thus suited to smaller motorcycles (Source: Bosch)

"TVS Motor Company has always transformed and redefined technology, with the TVS Apache series at the helm. The TVS Apache is one of the best loved and most iconic two-wheeler brands, with over five million customers across the globe. Backed by 40 years of TVS Racing heritage, every Apache brings to life our "Track to Road" philosophy, where learnings and technologies from our race machines are passed on to the production motorcycles. With a core focus on race-derived performance, it is very important for us to push the limits of race-inspired safety. Continuing our long-standing tradition of introducing segment-first technologies, we are proud to introduce Bosch MSC within the Race Tuned Dynamic Stability Control (RTDSC) in our new flagship motorcycle, the TVS ▷

Apache RTR 310, which marks a global first introduction of a 6D IMU-backed motorcycle stability control system on a sub-400cc motorcycle. We are set to deliver an unparalleled motorcycling experience by instilling in our customers a sense of confidence, comfort, and excitement," says Vimal Sumbly, Head Business – Premium, TVS Motor Company.

MSC functions and variants

MSC kicks in where things can get critical for motorcyclists: when leaning and in bends. According to a study by Bosch Accident Research, motorcycle stability control in combination with ABS could prevent or mitigate one in three motorcycle accidents involving personal injury in Germany if every motorcycle were equipped with MSC. MSC uses a series of sensors to detect the two-wheeler's vehicle dynamics. While the wheel speed sensors measure the speed of the front and rear wheels, the IMU determines the bike's acceleration and angular rate 100 times per second. MSC also manages braking control in bends. By analyzing the bike's pitch and roll angle, the system can optimize stability and braking effect even in dynamic riding situations.

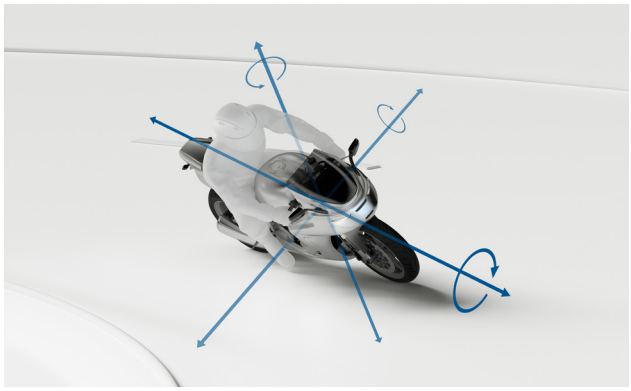


Figure 3: The IMU determines the bike's acceleration and angular rate 100 times per second (Source: Bosch)

Bosch has a range of modular MSC solutions that offer different combinations of ABS and IMU depending on the application needs. The recently upgraded KTM RC 390 uses a 3D inertial measurement unit (IMU), which integrates various functions into the vehicle via MSC, including braking and traction control in bends. In the case of the KTM, these are supported by a more performant ABS variant including an additional pressure sensor for more accurate brake pressure control. As another example, an MSC solution can be offered with an ABS 10 base and 3D IMU specifically for realizing basic MSC functions in emerging markets such as cornering brake control, corner traction control, and cornering drag torque control.

EICMA 2023 motorcycle show

At EICMA 2023 in Milan (Italy), Bosch has showcased individual solutions for the motorcycles of today and tomorrow. The solutions providing CAN CC (classic) or CAN FD connectivity include engine components and ▷

the electric powertrain as well as safety, displaying, and connectivity devices.

From 2019 to 2023, Bosch Two-Wheeler & Powersports sales grew by an average of 8 percent. The manufacturer has a total of some 500 associates worldwide working on ideas and solutions for the motorcycles, quads, and snowmobiles – a threefold increase since 2016. The company offers its customers the required solutions from individual devices to complete systems.

Figure 4: The 10-inch TFT Cluster display offers a split screen to show e.g. vehicle information and navigation content simultaneously (Source: Bosch)

Displays: The display solutions (e.g. the exhibited 5-inch TFT Cluster) enable riders to keep an eye on their speed and other vehicle information while on the road. Bosch's Integrated Connectivity Cluster (ICC), which is available in various sizes, adds connectivity functions to the displays. In the past, motorcyclists often had to use a second display – and attach it to the vehicle using a separate mount – so that they could look ahead and use navigation information. Bosch provides a remedy here: by connecting their smartphone to the ICC, riders can access functions such as navigation, music, and telephony. The 10-inch display version also offers a split screen, which allows information and navigation content, for example, to be displayed simultaneously.

Headlight control unit for motorcycles

I.C.M., a Taiwanese CiA member, has developed a headlight control unit (HCU), which can be connected to CAN CC networks. The company founded in 1995 is specialized in customized hardware and software developments for OEMs (original equipment manufacturers). The HCU has been designed in co-operation with TYC for KTM, an Austrian motorcycle manufacturer. These units are intended for the aftermarket. The product is on the market since 2020. The 38-employees company, which has heavily supported the CiA Technical Day 2023 in Taiwan, has also developed lighting control units for Ducati and Navistar motorcycles available since the end of 2023. The advanced HCUs feature yaw sensors calculating the motorcycle's angle in real-time. The yaw sensor comprises a 3D acceleration meter and a 3D gyroscope. The adaptive LED control unit is able to cornering dynamically the dark area while turning.

Additionally, the company, which is also a member of the nonprofit Asam association, provides customized designs and manufacturing for calibration tools. A related app for Kawasaki motorcycles is available since the end of 2023. The calibration tool and app is suitable to optimize engine settings for different conditions. By means of data logging, it can also be used to review and analyze the driver behavior.

hz

Drive and vehicle control: Bosch develops drive solutions aiming to help vehicle manufacturers to reduce emissions. The Bosch Drive Control Unit combines the inverter, engine management system, and vehicle control. In conjunction with the recent weight-reduced electric wheel hub motor, the control unit can be used to implement different comfort functions. The latter include a smoother starting mode or cruise control to maintain speed. Controlled by the electric motor, the electric traction control prevents the rear wheel from slipping when starting off and increases riding safety. One-throttle ride, meanwhile, is an additional function that increases powertrain efficiency by allowing the motorcycle to recuperate braking energy when the rider rolls off on the throttle. This helps extend the battery-electric range by up to 8 percent.

Figure 5: The Bosch Drive Control Unit combines the inverter, engine management system, and vehicle control (Source: Bosch)

In addition, Bosch also showcased its Vehicle Controller, which enables implementation of further functions for the electric powertrain. For instance, in addition to pump control for water cooling, it meets various charging standards (such as CCS-AC or 2W Chademo). The controller providing more than 110 connections, can be combined with various vehicle architectures and meets also future requirements for electric two-wheelers.

Electric 6-kW drive: Bosch has introduced the integrated 6-kW electric drive suited for vehicle architectures such as large scooters or classic motorcycles both in urban environments and for cross-country trips. The focus so far has been on the smaller performance classes of electric drive systems up to 3 kW. With production starting in 2025, the 6-kW motor should enable manufacturers to electrify two-wheeler segments that have so far tended to feature combustion-engine technology. The one-box solution offers an integrated motor management including the vehicle controller and inverter. Its compact design frees up storage space in the vehicle for the battery. In addition, the motor has a passive cooling concept. Hereby, the drive is cooled by the airstream instead of a complex water-cooling system. Manufacturers who opt for the new

Figure 6: Geoff Liersch at EICMA 2023 in Milan (Source: Bosch)

Figure 7: Bosch solutions enable updates over-the-air and functions on demand (Source: Bosch)

electric motor can thus save on system costs, informs the producer.

The company is focusing on new developments for efficient engine management for internal combustion engines and for electric powertrains. By 2026, Bosch aims to generate group-wide electromobility sales of 6 billion Euro – a trend that is also gaining momentum in the Two-Wheeler & Powersports business unit. “Especially in Asian countries, where the two-wheeler is often the backbone of mobility, electrification can help bring about huge improvements in local air quality and quality of life,” said Geoff Liersch, head of Two-Wheeler & Powersports at Bosch.

On-demand functions increase riding enjoyment

Increasingly standard in the automotive sector, functions on demand are also gaining ground in two-wheelers. Bosch software solutions mean that motorcyclists can install and update functions even after purchasing their vehicle. Special or advanced riding modes for the racetrack or off-road use, as well as convenience functions for the next long trip, can thus be added on demand. This is done via the rider’s own smartphone. The new functions are downloaded over the vehicle manufacturer’s app and then applied to the motorcycle.

For manufacturers, this solution also lends itself to electric two-wheelers. For example, the throttle for different speeds can be set or removed, depending on country requirements or driver’s license class. With the same functional architecture, Bosch enables software updates over-the-air. These can be downloaded from the cloud via an app on the rider’s own smartphone and uploaded to the motorcycle or powersports vehicle to perform relevant updates or improve vehicle functions.

For updates-over-the-air or functions on demand, the implementation in the vehicle depends also from the OEMs (original equipment manufacturers). Connectivity via CAN CC and CAN FD is supported. ◀

of (based on information from Bosch)

Light electric vehicles use increasingly embedded CAN networks

Since more than ten years, pedelecs, e-bikes, and other light electric vehicles (LEV) are equipped with embedded electronic communication systems. They connect electric motors, batteries and chargers as well as sensors, displays, and host controllers. Increasingly, they are based on the CAN CC (classic) protocol.

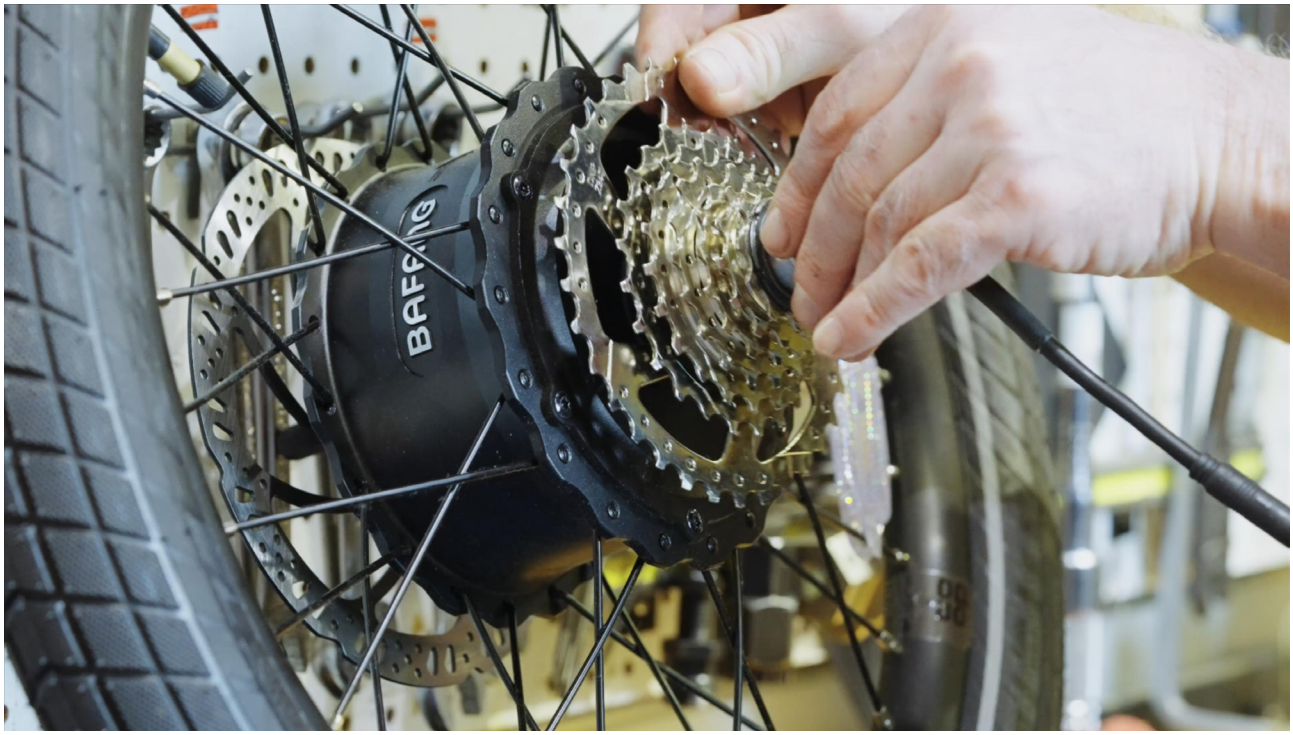


Figure 1: Many of LEV drive units provide a CAN-based interface to communicate with batteries, HMIs, and EMS (energy management system) host controllers, but the higher-layer protocol is mainly proprietary (Source: Bafang)

The market for electric-powered bicycles is huge. In 2021, there were sold about 41 million e-bikes in China. Of course, not all of them comprise embedded CAN networks. However, most of the European pedelecs use embedded CAN networks. Have in mind that some people talk about e-bikes, while they are meaning pedelecs. According to European regulations e-bikes are not pedelecs, which need pedal assistance. E-bikes are two-wheelers with an electric motor, which do not require pedaling. In many countries, you need for e-bikes a driver license, which is not required for pedelecs.

Most of the embedded CAN networks use proprietary higher-layer protocols. Although, the nonprofit Energybus and CiA organizations have developed based on CANopen CC (classic) some specifications for energy management (CiA 454 series), the Tier-1 suppliers implement proprietary CAN-based higher-layer protocols. The standardized CANopen CC approach is already partly internationally standardized in IEC 61851-3-4 and IEC 61851-3-5. These two Technical Specifications describe a CANopen-based communication interface between the battery of a light electric vehicle (LEV, including pedelecs) and a charging station. This enables a manufacturer-independent charging of pedelecs and e-bikes. This is important for public LEV charging, especially in cities and tourist regions. The IEC 61851-3-4 document specifies the basics including the physical layer (cabling and connectors). IEC 61851-3-5 provides the charging data details to be exchanged between charger and battery. The CiA 454 profile specifies additional interfaces for LEV equipment (e.g. drive unit) and can also be applied to other energy management applications.

In the last years, the market for CAN-connectable LEV electrical drives saw an increasing number of suppliers. Besides Bafang, there are Bosch from Germany and Shimano from Japan as well as many others including Brose (Germany), SEG (Germany), Yadea (China), and Yamaha (Japan) in alphabetic order – just to name a few. Bosch and other leading drive suppliers offer a range of products dedicated for special LEV applications ranging ▷

Figure 2: Typical 600-W mid-drive weighing less than 2,6 kg and powered by a 36-V battery (Source: SEG)

from generic drives to those dedicated for mountain, racing, or cargo pedelecs and e-bikes. Some of them can be connected to ABS (anti-lock braking system) units. Some others – like the ones from Shimano – support optionally an automatic and free-shift gearing.

Brose, a German Tier-1 supplier for the automotive industry, starts volume production of its Drive3 Peak drive unit in this year. At its peak, the 48-V pedelec drive platform provides 410-percent assistance at a maximum speed of up to 25 km/h according to the company. Of course, the company supplies also related removable batteries (up to 814 Wh) in aluminum housings and displays for all drive types. "Our complete system offers optimum interaction between Brose drive, control unit, and battery. It is optimized for even better integration and combination of system components such as drive unit, HMI, and battery. This coordination of the components with each other refines the overall Brose driving experience. At the same time, you also benefit from service from a single source," states the company on its website. This unburdens the pedelec OEMs (original equipment manufacturers) from unit integration challenges, but makes them depending on a single source. Other Tier-1 suppliers also offer turnkey solutions providing a complete LEV electric control system comprising drive units, batteries, and human machine interfaces. Of course, an embedded proprietary CAN communication is the base for these products.

As the LEV industry faced a challenging year in 2023 due to a slowdown in demand caused by an unstable international climate and high inventory levels, Bafang, an LEV drive system supplier with over 20 years of experience in the two-wheeler industry, proactively adjusted its pace to meet market changes. In 2023, the Chinese company headquartered in Suzhou celebrated several milestone moments including its first dealer conference. Facing industry challenges ahead, the company will provide more comprehensive support and protection to each customer by improving production automation coverage and expanding the global after-sales service layout.

Hidden champions and carmakers access the LEV markets

SEG Automotive is a hidden champion of the automotive industry, powering over 300 million vehicles on the road today with their e-machines. Now, the German company is entering the market for electric bicycle motors as a partner of BH Bikes, a Spanish OEM. It is a mid-engine for pedelecs. Weighing in at less than 2,6 kg and equipped with a 36-V battery, the engine sports a peak power of 600 W and up to 400-percent maximum support. "Like us, SEG Automotive has a history of performance, reliability, and competitiveness dating back over 100 years," stated BH Bikes. "Having such a strong partner close to us, with this level of experience in highly efficient electric motors, gives us the opportunity to continue riding at the front of the e-bike movement." The drive units have been designed and developed in SEG Automotive's plant in Cantabria, Treto – and they will also be produced in this location, which itself has a history of producing electric motors dating back more than 60 years.

Inaki Calvo, Treto Plant Manager, mentions that they have added key competencies in electronics, hardware and software, which allows them to bring to the market ▷

Figure 3: Automakers offer high-end pedelecs sometimes in the same color as the car (Source: Porsche)

new solutions for sustainable mobility. "In fact, we are already developing a further evolution of this e-bike drive that is even more compact and efficient – and will bring this solution also to other markets in, and beyond, Europe." The four-year contract with BH marks SEG Automotive's entry into the LEV market. "SEG Automotive has the know-how, the track record, and the technology to power all kinds of vehicles, and we have been expanding our product portfolio to enable existing and new ways of sustainable mobility," explained Ferdinando Sorrentino, CEO of the German-based company. In addition to e-drives for cars and commercial vehicles, this also includes dedicated solutions for LEV mobility. On the market, there are already an engine and electric controllers for e-motorbikes, as well as a range of e-motors specifically for the Asian market to power various electric two- and three-wheelers.

Yadea, a Chinese brand, has shown on the Eurobike 2023 tradeshow its Trooper 01 motorcycle-style design with the convenience and accessibility of an electric-powered bike. “Riders can now experience the freedom and excitement of cruising through scenic landscapes and bustling city streets, all without the need for motorcycle-related licenses or regulations,” stated the company. The Trooper 01 is equipped with a 750-W motor. Its 20-inch by 4-inch tires and embedded CAN network provide enhanced stability and maintainability, ensuring a smooth and enjoyable riding experience on various terrains, informed Yadea.

It is not only the traditional bike industry and automotive Tier-1s, which are interested in the growing LEV markets. The automotive OEMs also start to get a slice of this pie. According to a study by PWC, a British market research service provider, vehicle ownership in Germany will fall by 25 % in the next five years. As more and more people see how pedelecs can replace a car for the majority of journeys, it's inevitable that car sales will suffer, predicts the study. Consequently, the car industry is realigning itself as a 'mobility' industry. In 2021, Germany's largest automobile show was rebranded as a 'mobility' show, and car manufacturers are turning their attention to LEVs and micro-mobility. VW, Audi, Mercedes, and Porsche are among a growing number of car brands that have begun producing electric-powered bikes in recent years.

Last spring, Porsche has introduced two pedelecs, the eBike Cross Performance and the eBike Cross Performance EXC. They are equipped with the Shimano EP-801 motor and a 630-Wh battery. Both uphill and downhill, the electric 12-speed Shimano rear derailleur delivers the right gear. The CAN-connectable EP801 motor offers two riding profiles: Profile 1 offers the three support modes Eco, Trail, and Boost, while in the Fine Tune Mode of Profile 2 up to 15 support parameters can be individually set.

Figure 4: Anti-tampering logo by the nonprofit Confederation of the European Bicycle Industry (Source: CONEBI)

Fight against LEV tampering

Shimano offering the EP801 drive unit for battery-powered mountain bikes (MTB) has recently announced to fight against any kind of manipulation of LEVs, especially drive systems, e.g., to increase the performance or the maximum supported speed. “Riding manipulated e-bikes on public roads may not only lead to technical problems but also result in serious legal consequences,” explained the Japanese company. Tampering kits and other types of manipulation can damage the drive system as well as the bike itself. Riders would risk losing their guarantee and invalidating their warranty claims. If an accident occurs with a tampered LEV, it may result in criminal prosecution. Shimano supports the self-commitment of CONEBI, the Confederation of the European Bicycle Industry, to prevent the tampering of LEVs. There are 15 national bicycle industry associations and 68 companies, which have signed this self-commitment from 2021.

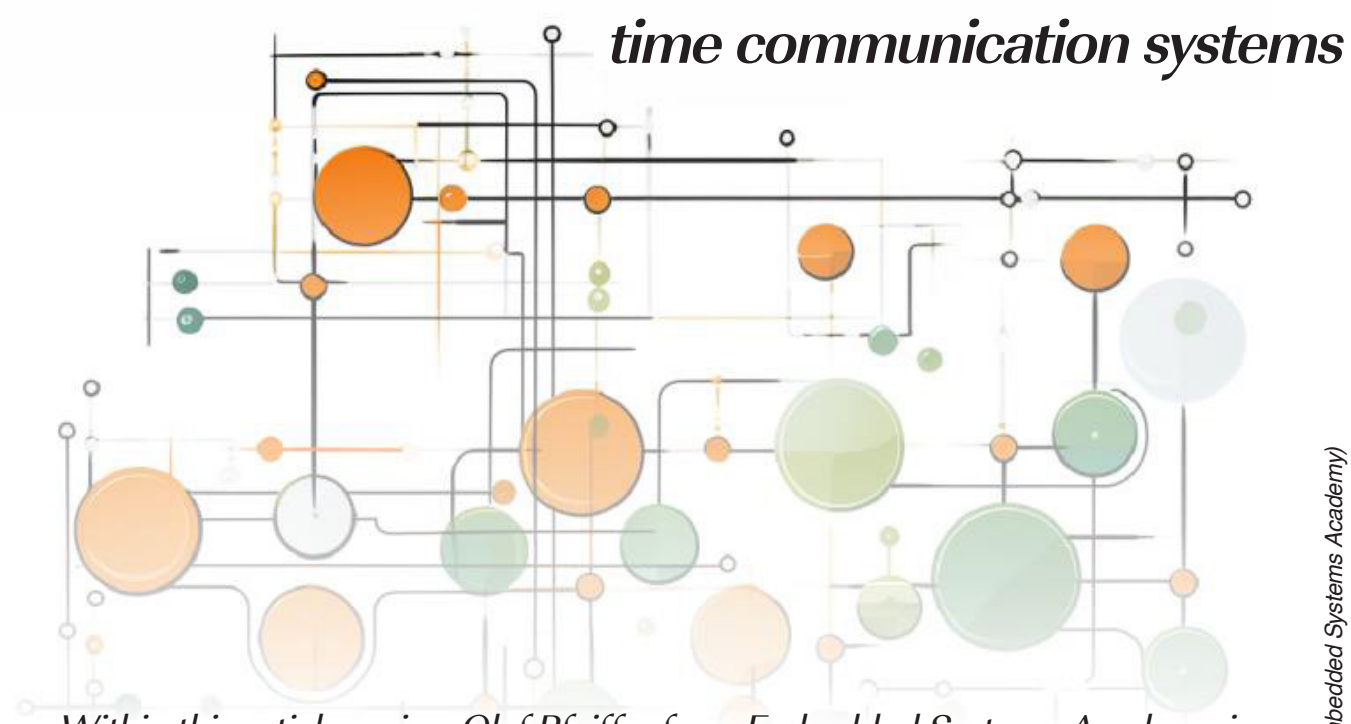
Erhard Buechel, President of CONEBI, said: “The bicycle industry takes the topic of tampering very seriously and has started several actions to curb this dangerous practice. This self-commitment is only one pillar of our overall strategy. Moreover, market surveillance must be strengthened at national level supported by European legislations. Last but not least, we condemn very strongly the sales of tampering kits, which endanger the safety of consumers as the e-bike is not designed for such an increased speed. We therefore call upon the European legislators to clearly forbid the sale, application, and use of tampering equipment.”

Shimano ensures that all anti-tampering requirements, which are included in EN 15194:2017, are met. It continuously evaluates the existing standards to see if they are still fit for purpose when it comes to anti-tampering measures. Of course, the company is working on improving its drive systems to make tampering more difficult. The CiA 454 profile specification series is not yet providing anti-tampering measures on CANopen interfaces, but CiA is working on a standardized secure CANopen solution. Unauthorized access to tamper the drive unit could be avoided with this approach. ◀

Author

Holger Zeltwanger
CAN Newsletter editor
pr@can-cia.org
www.can-cia.org

Real-time communication: Part II - Demands of real-time communication systems



(Source: Embedded Systems Academy)

Within this article series, Olaf Pfeiffer from Embedded Systems Academy is setting in perspective the timing requirements for different real-time capable communication systems, such as CAN, CANopen, and real-time Ethernet.

In this second article, the author shows the different timeframes required by different applications and reviews what this means for the communication system used. The Part I, published in the December 2023 issue of the CAN Newsletter magazine, describes how to select the right real-time timeframe for certain applications. In "Part III – The temporal dynamics of CAN-based systems" (planned for the next issue) the author applies the findings from Embedded Systems Academy (EmSA) to CAN and CANopen, giving recommendations on "how to use" (configure) the communications to meet the demands found earlier. The last article "Part IV – From theory to practice: CANopen source code configuration" shows which optimization options are typically available when working with CANopen source code, here, on example of Micro CANopen Plus from EmSA.

The demands of real-time communication systems

The ever-increasing complexity and demands of modern real-time applications necessitate robust and reliable communication systems. As established in the first part of this series, these applications span a wide spectrum of response time requirements, from seconds to milliseconds, and their success is often contingent on the precise timing of their responses. Consequently, the chosen communication system must be capable of meeting these stringent timing constraints.

However, achieving the desired real-time capabilities is not the sole consideration. In many cases, these systems also need to ensure the safety of users, equipment, and the surrounding environment. Additionally, given the growing threat landscape, ensuring the security of these communication systems has become equally critical. Balancing these requirements – real-time responsiveness, safety, and security – is a multifaceted challenge. In this second part, the specific attributes and considerations are investigated that make a communication system capable of fulfilling these demands.

Evolution of real-time communication systems

Over time, the demands on real-time communication systems have evolved and become more stringent. In the early days, the primary focus was on achieving real-time requirements with a reasonable level of reliability. It was often deemed sufficient if the system could process and transmit data within the specified timeframes, even if occasional errors occurred.

As technology advanced and systems became more sophisticated, the need for safety became apparent. "Some-what reliable" was no longer adequate, especially for applications where human safety, product quality, or system operation was at stake. To address these concerns, specific protocols were developed to ensure that real-time systems could operate safely, even in the face of faults or disruptions. The importance of safety grew, particularly in critical applications such as transportation or medical devices.

More recently, as real-time systems increasingly became interconnected and even accessible over the internet, security emerged as another crucial consideration. With the potential for cyber-attacks and unauthorized access, it became necessary to safeguard not only the data but also the integrity and availability of the communication system itself.

Today, a comprehensive real-time communication system must meet all three criteria: real-time responsiveness, safety, and security. It is no longer advisable to start from scratch when designing an embedded communication system for any real-time application. Once, it was quite common for developers to take an ad-hoc approach, such as repurposing one of the serial ports to share it among multiple nodes, effectively creating an EIA-485-style network. However, this approach does not accommodate the increasing complexity of real-time systems.

Figure 1: Consider whether any signals require synchronization (Source: Embedded Systems Academy)

Is there a best fit?

In German, there's a saying "Es gibt keine eierlegende Wollmilchsau," which can be translated to "there is no one-size-fits-all solution" or, more literally, "there is no egg-laying wool-milk pig." This saying applies here as well. Regrettably, there is no single networking technology that is universally suitable for all applications. Each application has its unique set of requirements and constraints, making it necessary to carefully evaluate and select the appropriate communication technology and protocols. Therefore, it is essential to consider the specific needs of the application and match them with the most suitable networking technology available, taking into account factors such as required throughput, real-time responsiveness, safety, and security.

The basics: How much data, how often?

First, assess the overall architecture of your system. In addition to real-time requirements and the timeframe within which a complete control step must be executed, consider the total number of inputs and outputs required, their distances apart, and the number of signals and their data lengths that need to be exchanged within each timeframe and between devices. In general, it is not advisable to push any system "to its limits," so any networking technology you choose should have enough capability to accommodate your application's growth over time.

Are there safety and security requirements?

Once you've established the applicable timeframe for your application, it is crucial to determine what safety and security measures are necessary. If your application must adhere to specific safety standards or certifications, your choices regarding communication networks will automatically narrow. This article focuses on the real-time requirements. When conducting your research, double-check the latest developments – all active fieldbus organizations and committees are continually working on improving both safety and security.

Are there synchronization requirements?

Consider whether any signals require synchronization, meaning that inputs should be captured at the same moment in time. Synchronization is critical for applications where multiple inputs are combined. In real-time communication systems, synchronization plays an important role in ensuring accurate data transmission and interpretation. Some applications demand synchronization due to their nature (e.g., syncing multiple manipulators working on the same material simultaneously), while other effects might be more subtle: Consider a scenario where an analog sensor generates input data every 100 ms based on its internal timer. The transmission of this data onto a network also occurs every 100 ms, triggered by a separate network timer. If these timers are not synchronized, they may gradually drift apart, leading to two possible scenarios:

1. Duplicate data transmission: If the network timer's window is shorter than the sensor's, the sensor may not have generated new input data by the time the network is ready to transmit. In this case, the same data could be transmitted twice.
2. Data loss: If the sensor's timer window is shorter than the network's, a new value may be generated before the previous one has been transmitted. This situation can lead to skipped or lost data.

The impact of these scenarios greatly depends on the signal and its usage. For instance, if the value represents temperature and the main processing unit only needs to know if it falls within the correct range, these scenarios have no effect. However, if it is a counter or a rapidly changing signal representing a wave, missing or duplicated data may have serious consequences.

Other considerations

When selecting a real-time communication system, there are many additional considerations: Are off-the-shelf products, development, and diagnostic tools readily available? Can it easily integrate with existing (or planned) systems? If hard real-time of single milliseconds is a requirement, such integration may need to go "deeper" into a system, potentially requiring custom software at the lowest levels of the hardware.

Too many choices...

Understanding the specific requirements of your application – real-time responsiveness, safety, security, system architecture, and synchronization – can guide you in selecting a suitable communication network. If you start at zero, a potential starting point for gaining an overview of available fieldbus networks is the Wikipedia entry titled "Fieldbus." However, note that this list captures only a fraction of the available fieldbus networks. The domain of industrial communication networks is vast and continuously evolving, with many fieldbus networks, some not even officially standardized. Beyond the widely-recognized fieldbus networks, many networks, often crafted by manufacturers or consortia, cater to specific applications or industries. They might offer distinct features, specialized protocols, or proprietary technology tailored to certain application needs.

For instance, the Controller Area Network (CAN) is a versatile communication network supporting numerous applications through its specialized higher-layer protocols. Higher-layer protocols such as J1939 cater to commercial vehicles (for example construction, agriculture), standardizing message formatting and signaling to facilitate manufacturers in crafting interoperable components. NMEA 2000, by the National Marine Electronics Association (NMEA), aids the integration of marine electronics, streamlining the configuration and management of intricate marine systems. CANaerospace, designed for aerospace, meets the distinct demands of avionic systems, ensuring reliable data exchange in aircrafts.

The CANopen protocol, with its flexibility, boasts many device and application profiles, such as those for elevators, emergency vehicles, and CleANopen for waste collection vehicles. These profiles determine the communication behavior and data structures for devices or entire applications, simplifying the development process. Moving beyond CAN, more than 10 different solutions exist for Ethernet-capable real-time communication, each targeting varied applications. As a general rule, if your application's real-time requirement is roughly 100 ms or more, you have a multitude of choices since most embedded communication networks or fieldbuses can fulfil these demands, even for more extensive systems. However, for vast machinery (spanning several hundred meters of cable and beyond), scrutinizing communication runtime and throughput is essential. For stringent real-time requirements, as short as 10 ms or even less, it's imperative to diligently review which network technologies can satisfy your needs. Typically, a time-triggered communication system (available on CAN, Ethernet, and other platforms) is the most deterministic. Here, each signal with real-time requirements is allocated an exclusive timeslot, ensuring predictable signal transmission.

What's next?

As Embedded Systems Academy provides a comprehensive expertise in CAN and CANopen communications, the next part III of this series will focus on CAN and CANopen as examples for the many embedded communication systems available. The author will explore its suitability for diverse systems with real-time requirements, highlighting achievable response times, areas demanding meticulous attention, and situations that push boundaries, suggesting the evaluation of alternatives. ◀

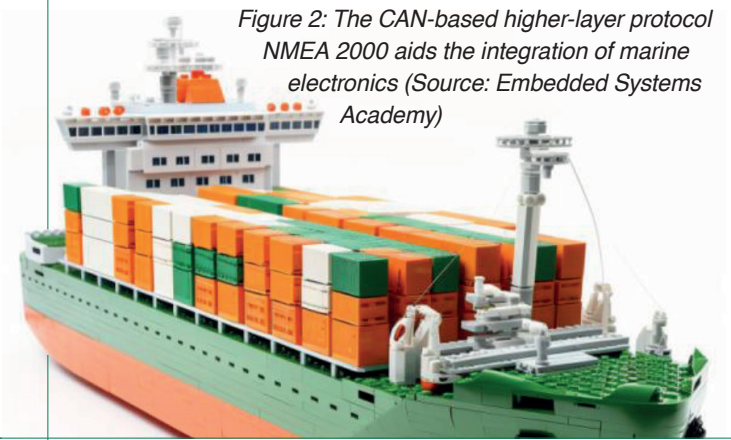
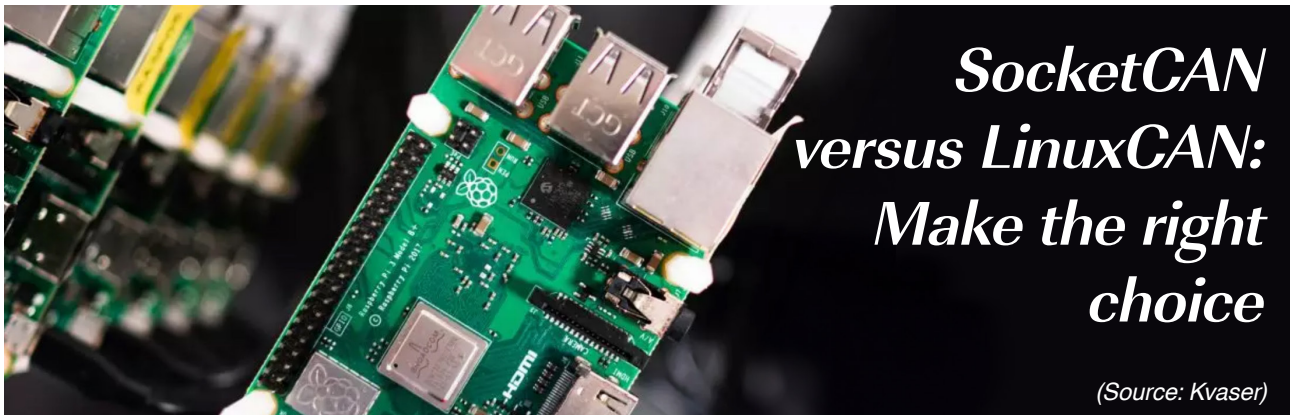


Figure 2: The CAN-based higher-layer protocol NMEA 2000 aids the integration of marine electronics (Source: Embedded Systems Academy)

Author

Olaf Pfeiffer
EmSA (Embedded Systems Academy)
info@esacademy.com
www.esacademy.de



SocketCAN versus LinuxCAN: Make the right choice

(Source: Kvaser)

Developing a CAN system, you need something to interface between CAN nodes and a computer that will send commands to the nodes and receive data from them. You are using a device from Kvaser. The project dictates you are using a Linux computer (e.g. Raspberry Pi or Ubuntu). How do you get the Kvaser device to connect to the PC?

In order to connect a PC to the CAN network, you need to install drivers. Since you are using Linux, there are two options: LinuxCAN drivers or SocketCAN drivers. Is there a difference? Yes, and which you pick depends on what it is you want to do.

LinuxCAN is Kvaser's own set of packaged drivers for Linux. They are packaged with a copy of the Kvaser CANlib SDK (software development kit) for custom programming with our API (application programming interface). One installation contains drivers for all of our devices (excluding Ethernet devices).

SocketCAN is a set of open-source CAN drivers and a networking stack, which is included in many Linux distributions. In other words, SocketCAN comes pre-installed and you just need to set SocketCAN up. SocketCAN contains the drivers of more than just Kvaser devices. SocketCAN uses the Berkeley socket API, the Linux network stack, and implements the CAN device drivers as network interfaces. A complete list of Kvaser devices available for use with SocketCAN is given on the Kvaser website.

Kvaser contributes driver updates for SocketCAN, but Kvaser does not maintain SocketCAN. On the Kvaser website, you can find beta drivers for SocketCAN. These are drivers that will be used to make updates to SocketCAN in the Linux kernel, but may not have been approved or included in the latest kernel. Kvaser hardware support is dependent on the Linux Kernel version since we are dependent on the SocketCAN group for when updates are included that recognize newer hardware.

What's the difference?

Both SocketCAN and LinuxCAN allow you to use a Kvaser device on a Linux machine. Here are some key differences that can help you decide what to use:

- SocketCAN is a collection of network socket based drivers. It is like a generic driver. You can think of SocketCAN like this: When you plug in a new mouse and it is registered as "Generic Mouse". SocketCAN provides the functionality to access a CAN network. SocketCAN allows for a different device to be swapped as needed, even if the device is from another company. SocketCAN commands can also be run from the bash command prompt, meaning you can set up basic send and receive functions from the command terminal.
- LinuxCAN matches the Kvaser Windows API. The API is specific to Kvaser and the drivers are specific to Kvaser devices. With that, you can access more features that can be programmed with the LinuxCAN SDK. These features can range from programming the LEDs on a unit, to adding Kvaser Memorator extraction commands. LinuxCAN also supports LIN functionality, which SocketCAN does not. However, LinuxCAN does not allow you to run commands from the bash prompt in a terminal window.

Can both driver sets be used together?

Yes and no. First, when LinuxCAN is installed, the installer blacklists the SocketCAN drivers for Kvaser products. This is done to prevent driver conflicts. This means that the Kvaser devices could only use the LinuxCAN drivers. That being said, you can still use another company's device with the SocketCAN drivers. Kvaser API commands would still only work with the Kvaser device, and SocketCAN commands would only work with the devices using the SocketCAN drivers.

When should I use one over the other?

This question is purely project dependent. If you have a project that needs to make use of functionality that is specific to a Kvaser device, then LinuxCAN would be the better choice. If you need something where the CAN interface could be swapped out, or needed similar functionality, then SocketCAN may be the better choice.

Brief news: Tools

- ***CAN troubleshooting:*** The CANBUSview XL III by Indu-Sol (Germany) enables physical analysis of CAN CC networks including bar diagrams and oscilloscope features. Logical monitoring of the data link layer protocols and data recording is possible. CANopen, DeviceNet, J1939, and Safetybus p are supported.
- ***MCU debug engine:*** The Universal Debug Engine (UDE) from PLS (Germany) offers interactive debug functions and visualization options while software development and testing of MCUs. Now, it supports the CAN-FD-capable S32M2 motor control units from NXP used in automotive body and comfort applications. Demos of the improved UDE 2024 also supporting the Infineon's Traveo T2G (and further) MCUs are presented at Embedded World 2024 in Nuremberg.
- ***Sensor monitoring:*** Parker Sensocontrol (Germany) introduced the Parker Service Master Compact measuring device that provides real-time monitoring and diagnostics in mobile equipment and industrial hydraulics applications. The IP65-rated device provides connections for up to six Parker CAN (and other) sensors.
- ***Software-in-the-loop tests:*** Vector Informatik (Germany) offers software-in-the-loop tests on real target hardware, which does not have to be the final device. This allows software components with strong hardware dependency to be tested at their functional interfaces. This feature is integrated in CANoe4SW and CANoe.

of

Summary

Here is a short overview on the functionality of the both:

SocketCAN:

- Provides drivers for Kvaser as well as other companies.
- Available on the Linux kernel – no installation required.
- Commands can be run from the bash prompt.
- No LIN capability.

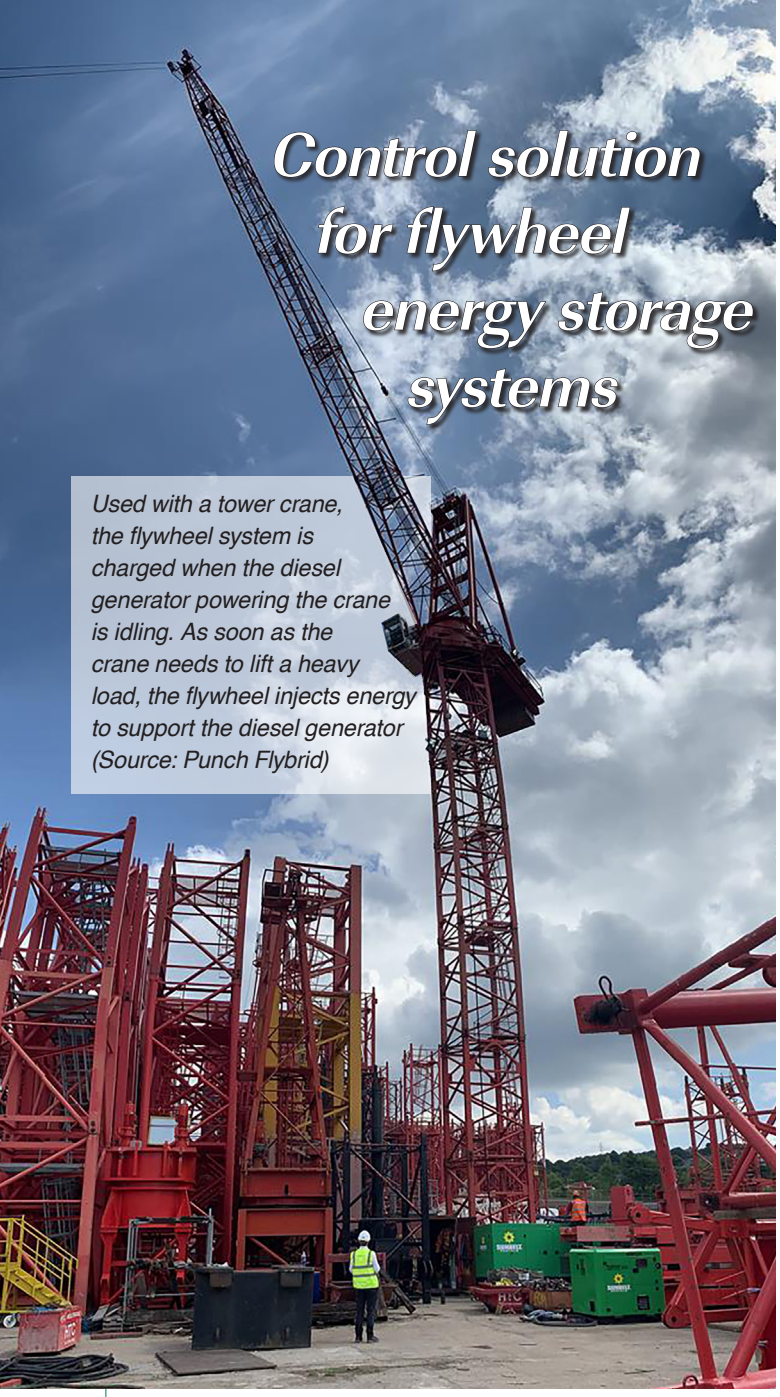
LinuxCAN:

- Specific to Kvaser devices to allow advanced functionality.
- Blacklists Kvaser SocketCAN drivers to avoid conflicts.
- Commands cannot be run from the bash prompt.
- Has LIN capability.

Author

Adam Raymer
Kvaser
adra@kvaser.com
www.kvaser.com

Control solution for flywheel energy storage systems



Used with a tower crane, the flywheel system is charged when the diesel generator powering the crane is idling. As soon as the crane needs to lift a heavy load, the flywheel injects energy to support the diesel generator (Source: Punch Flybrid)

To make operation of mobile machines more efficient, flywheel-based energy storage can be used. It absorbs energy during low-load periods and releases it during peak loads. Sensor-Technik Wiedemann (STW) provides control units for energy management of such systems.

Saving fuel and reducing emissions is an important aspect of all commercial operations, especially for mobile machinery. The construction and municipal machines work more efficient using flywheel-based energy storage. The German company STW from Kaufbeuren supplies the ESX.3cs compact control unit for the energy management of flywheel-based energy storage systems.

The energy storage system specialist Punch Flybrid from Silverstone (England) produces flywheel systems suitable for a range of applications in off-highway equipment, from excavators and tower cranes to mobile diesel and gas generators. The integrated flywheel system relieves the combustion engine from peak loads, and so enables smaller dimensioning of the engine and a net saving in fuel.

Optimized for tough environments

The solutions from Punch Flybrid are designed for high power density and durability, as required in construction, agricultural, and municipal applications. Ordinary batteries or super capacitors often hit their limits here. Punch Flybrid experts, who developed the first KERS (kinetic energy recovery system) for Formula 1, are very familiar with extreme power peaks. The principle of the flywheel storage system is comparable to recuperation in electric vehicles. The flywheel captures the energy that would normally be lost when braking or, for example, lowering the boom of an excavator and releases it again during the next work cycle.

One of the company's products is the Punch Power 200 (PP200), which is used for power generation applications. In this case, the flywheel storage system increases the efficiency of the generator, and the additional power can be used either as a boost function or to save fuel.

Benefits for construction machinery

Tobias Knichel, Managing Director at Punch Flybrid, explains typical application scenarios of the flywheel system: "Our solution is particularly advantageous in construction machinery with its recurring work cycles. A tower crane, for example, constantly alternates between idling and maximum power. The flywheel system is charged when the diesel generator powering the tower crane is idling. As soon as the crane then needs to lift a heavy load and therefore demands high power from the diesel generator, the flywheel injects energy at high power to support the diesel generator. As a result, a smaller, more efficient diesel generator can be used in combination with the flywheel energy system.

Depending on the application, this load-balancing concept can reduce fuel consumption by more than 50 percent. Thanks to the flywheel system, a smaller main engine can be installed. This downsizing means the engine is operating with a higher base load, with increased efficiency. Excavators and other machines can also benefit from downsizing.

As with the tower crane, an excavator continuously performs cyclic work processes. The energy released as the excavator's boom is lowered can be captured in a Punch Flybrid energy storage system, whereas usually this excess energy is released as heat and is lost. The stored energy can then be used when the boom is raised again, reducing the load on the combustion engine. Tests have shown fuel savings of up to 30 percent. Other applications for the flywheel storage system can be found in power grid support or pump applications. ▷

Figure 1: The Punch Power 200 is used as energy storage system for power generation applications (Source: Punch Flybrid)

Control solution

For this approach, a dynamic control solution is needed that reacts quickly to the operator's control signals. Punch Flybrid opted for a control system from the automation specialists at STW. "We use the ESX.3cs as the managing controller in our Punch Power 200 system. The controller provides the necessary high-speed signal processing that we need for our solution. It also monitors the entire system, including cooling" explains Tobias Knichel.

"The Punch Power 200 system provides the additional stored energy within 10 ms to 20 ms. The ESX.3cs was the optimal solution for us. It handles the management of the power electronics, is robust enough for use in harsh environmental conditions and is compact enough to be easily integrated it into our system."

In the ESX.3cs, a 300-MHz 32-bit micro-controller with a 4-MiB flash and an 8-MiB SRAM handles the signal processing. External signals can be connected via two CAN interfaces, a serial interface, Ethernet, or LIN interface. The CAN interfaces can be used for communication with the in-vehicle CAN networks typically applying the J1939 or CANopen higher-layer protocols. Bit rates up to 1 Mbit/s are supported. A second independent processor monitors various system voltages and the program execution. If necessary, it switches off all outputs via a second shutdown path or can reset the main controller. Digital and analog feedback for almost all signal branches allow comprehensive diagnosis of the system, including both inputs and outputs. Thanks to these features, functionally safe applications according to EN ISO 13849 and IEC 61508 can be implemented with the ESX.3cs. This is an important aspect for highly automated applications, as increasingly found in mobile machines.

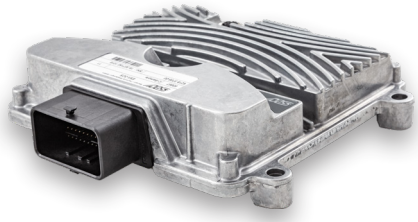


Figure 2: The ESX.3cs manages the energy in the Punch Power 200 system (Source: STW)

The application suite for the ESX.3cs is available for the developers to program the user application. Numerous functions, for example current controller and ramp functions for outputs, or frequency averaging for inputs, are already integrated in the programming environment.

STW is an internationally active company producing solutions for the automation and digitalization of mobile machines for more than 35 years. The manufacturer offers a modular system of generic and customer-specific products, systems, and software solutions. The ESX.3cs control system within the PP200 helps to provide machines with the capability to operate more efficient. The result is a reduced fuel consumption in the combustion engine and lower emissions. This benefits both the machine operators and the environment. ◀

Source

Sensor-Technik Wiedemann (STW)
info@wiedemann-group.com
www.stw-mobile-machines.com

Brief news: Sensors

- ***Magnetic encoder:*** The IP6K9K-rated WV3600M rotary encoder by CiA member Siko (Germany) for mobile machines has a 36-mm diameter. The single- or multi-turn product comes with a CANopen (CiA 406) or a J1939 interface. Optionally the absolute encoder supports CANopen Safety or J1939 safety.
- ***Satellite receiver:*** The PCAN-GPS FD by CiA member PEAK-System (Germany) can be connected with GPS, Galileo, Beidou, and Glonass navigation systems. It can determine position (with an accuracy of 1,5 m), orientation, and acceleration values. The programmable (C and C++) device comes with a CAN FD interface, which sends periodically the sensor data.
- ***Rotary encoder:*** The HTx36E by Megatron (France) features CANopen and J1939 connectivity. The Hall-effect sensor provides a single-turn resolution of up to 16 bit and a multi-turn resolution of up to 43 bit. The IP67-rated housing measures 36 mm (diameter).
- ***Radar sensor:*** CiA member Pepperl+Fuchs (Germany) has introduced a CANopen-connectable sensor measuring distance, speed, and direction of target objects at a distance of more than 25 m. The IP68/69-rated radar sensor is specified for an extended temperature range and suits therefore for mobile machines.

hz

MCUs with on-chip CAN CC and CAN FD protocol controllers

Figure 1: The RA8M1 family is suitable for different AI-based applications (Source: Renesas)

Renesas is a Japanese chipmaker providing micro-controller units (MCUs) for automotive and non-automotive applications. Many of the offered MCUs come with on-chip CAN CC and CAN FD protocol controllers. The company also supplies SoC (system-on-chip) solutions with CAN connectivity. According to the chipmaker, the company ships 3,5 billion units per year.

Renesas was founded in 2010, when the Japanese semiconductor industry merged into one enterprise. There are roots to the semiconductor business units of Hitachi, NEC, and Mitsubishi. Nowadays, Renesas is the most important chipmaker headquartered in Japan. From the beginning, the company was a CiA member.

End of 2023, the enterprise has announced the RA8 micro-controller family based on the 480-MHz Cortex-M85 processor by Arm. It delivers a performance of over 3000 Coremark points. Coremark is a benchmark measuring the performance of embedded controllers and it is replacing the Dhrystone benchmark. The MCUs deploy the Helium technology by Arm featuring a four-times performance boost for digital signal processor (DSP) and machine learning (ML) implementations versus MCUs based on the Cortex-M7 processor. Some family members provide on-chip CAN FD (flexible data-rate) controllers.

The RA8 family is designed for AI (artificial intelligence) applications. “The advent of AI is increasing demand for intelligence at the edge and endpoints to serve new applications across diverse markets including industrial automation, smart home, and medical,” said Paul Williamson from Renesas, “our new MCUs, built on Arm’s highest-performing and most secure Cortex-M processor to date, are specifically optimized for signal processing and ML workloads, and will be game-changing for innovators looking to address the growing AI opportunities in the embedded and IoT space, without compromising on security.”

The Cortex-M85 core includes the Trustzone technology, which enables isolation and secure/non-secure partitioning of memory, peripherals, and code. It features the Security-IP by Renesas with cryptographic accelerators and supports a true secure boot procedure. Besides the CAN FD ports, the MCU family comes with Ethernet, USB, and 16-bit camera interfaces.

A number of customers are already designing with the RA8M1 MCUs. For example, Mantra Softech, a provider of biometric solutions, has employed the products in a fingerprint scanner. Hiren Bhandari, Technical Director at Mantra, said, “We are delighted with the functionality and efficacy of the RA8M1 MCUs. The combination of high performance and Helium technology enables us to integrate AI features into this solution.” This MCU comes with the FSP software. An evaluation is also available.

MCUs and SoCs for automotive applications

The R-Car micro-controllers and systems-on-chips are Arm-based. They target the automotive industry. The recently introduced fifth generation is designed for high-end ECUs ▷

(electronic control units) including those running AI applications. The company also shared its plans for two forthcoming MCU product advancements in the next-generation R-Car family. One is a cross-over MCU series designed to deliver the performance required for domain and zone ECUs. These MCUs are expected to close the performance gap between traditional MCUs and the advanced R-Car SoCs. Secondly, the company announced plans to introduce a separate MCU platform tailored for the vehicle control market. Both of these MCUs will be powered by Arm architectures and are set to become an integral part of the R-Car family, offering scalable options and software reusability for automotive engineers. These products feature CAN CC (classic) and optionally CAN FD connectivity. They will be released from 2024 onward, following the company's roadmap.

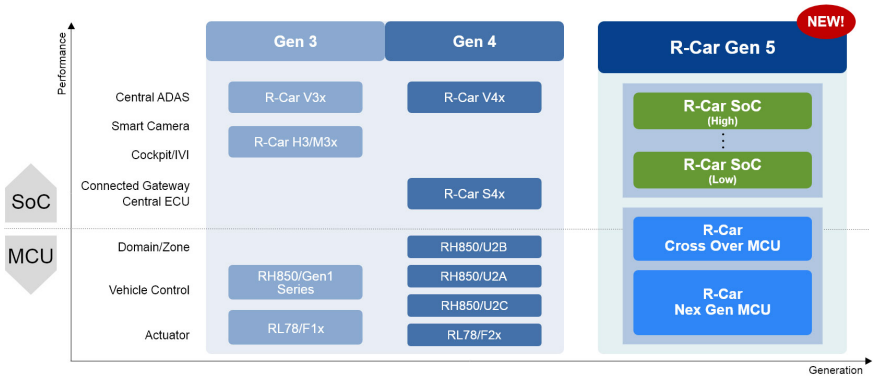


Figure 2: The fifth generation of R-Car family is designed for cross-over ECU designs overcoming MCUs dedicated for specific applications (Source: Renesas)

Until the fourth generation, the R-Car SoCs were designed for specific use cases, such as ADAS (advanced driver assistance system), AD (autonomous driving) that requires high AI performance, and gateway solutions with enhanced communication capabilities. Renesas' fifth-generation R-Car SoC incorporates the Chiplet technology to create a flexible platform that can be customized to meet various requirements for each use case. The platform offers multiple processor-sets from entry-level to higher-end models, and can integrate a variety of IP (intellectual property) modules such as AI accelerators and IP modules by partners and customers into a single package. This gives users the option to customize designs according to their needs.

As E/E architecture in vehicles continues to evolve, it becomes increasingly important for domain control units (DCUs) and zone control units (ZCUs) to handle both high computing performance and real-time processing. Renesas addresses this challenge by developing an Arm-based 32-bit cross-over R-Car MCU platform with built-in NVM (non-volatile memory) that can deliver higher performance than traditional MCUs. Moreover, to build upon the success achieved by the RH850 family, Renesas is also extending its vehicle control portfolio with the recent R-Car MCU series, which is also powered by Arm cores. This means for the first time, automotive system developers are able to take advantage of the Arm software and eco-system to build powertrain, body control, chassis, and instrument cluster systems.

In order to start software developments without having MCU hardware available, Renesas has launched a cloud-based environment for automotive AI software. This AI Workbench environment can also be used for AI software evaluation purposes. With this environment, engineers can begin designing automotive software by leveraging

Figure 3: The RA family of MCUs provides on-chip CAN CC and CAN FD protocol controllers, which are based on the Bosch IP core (Source: Renesas)

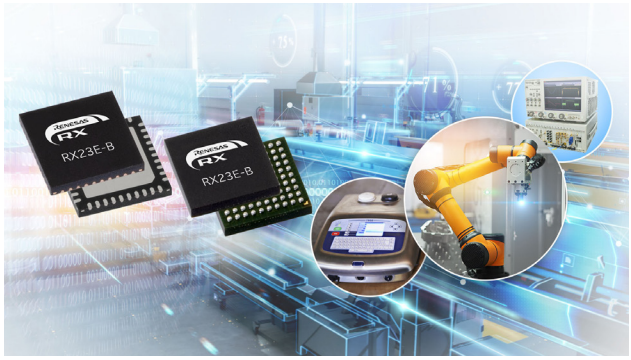


Figure 4: The RX23E-B family addresses high-end industrial senor applications and provides CAN on-chip modules (Source: Renesas)

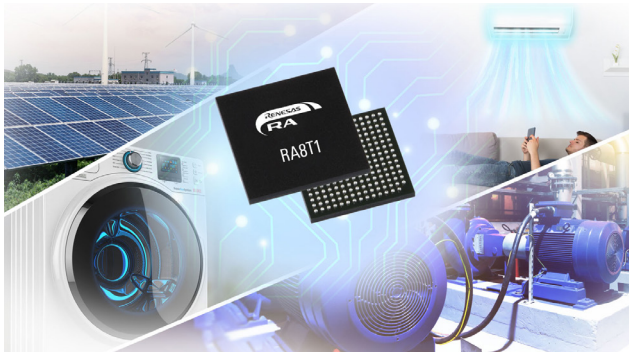


Figure 5: The RA8T1 micro-controllers are suitable for motion control applications featuring integrated CAN modules (Source: Renesas)

Microsoft Azure services including Azure Compute, IaaS services, Microsoft Entra ID, and Azure Security. Instead of installing tools on a PC or obtaining an evaluation board, they can perform tasks such as performance evaluation, debugging, and verification using simulation tools online. This approach aligns with the "Shift-Left" approach, which enables software creation and testing earlier in the design cycle, even before the actual hardware becomes available. This environment serves as a unified development platform for designing and testing Renesas' scalable automotive SoCs and MCUs, regardless of product type or application.

MCUs for industrial applications

Besides dedicated micro-controllers for the automotive industry, Renesas offers MCUs for high-end industrial sensor systems and MCUs for motion control devices. The 32-bit RX family integrates a 24-bit Delta-Sigma A/D converter as well as one CAN CC protocol controller. "With the addition of the RX23E-B, which comes with an AFE (analog front end) sensor interface, we can now serve a broad range of sensing applications from mid-end to high-end systems," said Sakae Ito from Renesas. "We will continue to extend our product options to meet the growing needs of battery-powered and wireless sensors that demand low-power consumption." Similar to the legacy RX23E-A, the RX23E-B incorporates a 32-MHz RXv2-based CPU (central processing unit), supporting DSP instructions and providing a floating-point unit (FPU). It offers peripheral functions such as a 16-bit D/A converter, which enables measurement adjustments, self-diagnosis, and analog signal output. The ±10-V analog input enables ±10-V measurement with a 5-V power supply without requiring external components or an additional power supply. An LCD controller and a real-time clock (RTC) function are also included. This MCU is already available, along with a starter kit.

The RA8DA1 family of MCUs based on the Cortex-M85 is targeting graphic display solutions as well as voice/vision multi-modal AI applications. Typical markets include building and smart home automation as well as consumer and medical devices. These products feature 6,39 Coremark/MHz. They include an LCD graphics controller support by the LVGL (Light and Versatile Graphics Library) open-source software. Of course, it features the above-mentioned Helium technology by Arm. The RA8DA1 family has CAN FD protocol controllers implemented as well as an Ethernet controller.

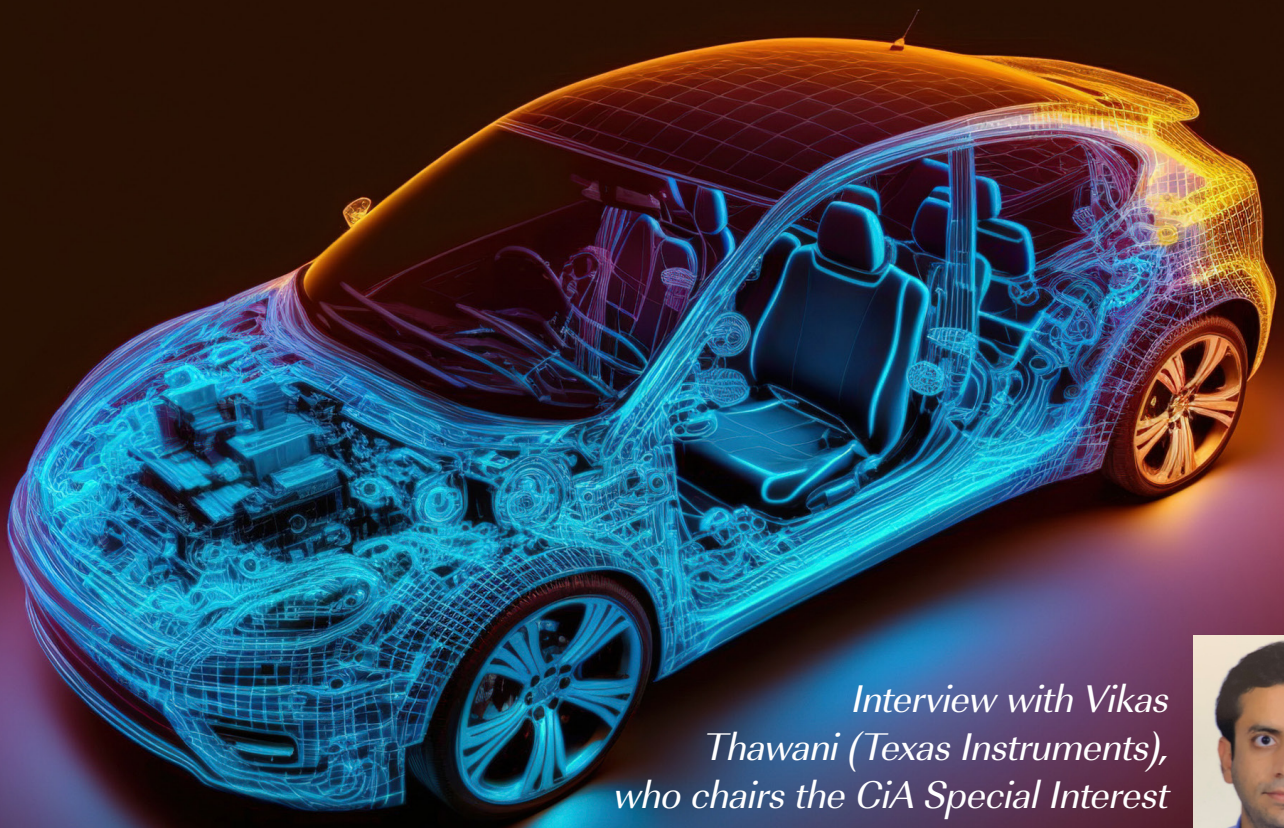
There is also the RA8TA1 family designed for motor control applications. It also features CAN FD connectivity. Also based on the Cortex-M85 processor, these MCUs include PWM (pulse-width modulation) timing features such as 3-phase complementary output, 0-percent and 100-percent duty-output capability, a double-buffer compare match register, and five phase counting modes. Analog capabilities of the MCUs include 12-bit ADCs, 12-bit DACs, and high-speed comparators used in voltage and current measurement as well as in over-current protection. The products also provide port output shutdown capability, when an anomaly is detected, an important safety feature in motion control. The Japanese chipmaker has shipped motor-control specific MCUs for over 10 years ago. The company has sold over 230 million motor-control embedded processors per year to thousands of customers worldwide. The RA8T1 family supports Arm's Trustzone technology and Renesas' Security IP. "The performance of these MCUs is critical in high-speed electric motor control that requires sophisticated algorithms and application software to run in a reliable, safe, and secure manner. The RA8T1 MCUs bring unprecedented CPU horsepower to the portfolio along with Helium technology that allows our customers the additional flexibility to deliver smart (AI/ML) solutions without the need for additional hardware," explained Daryl Khoo from Renesas.

64-bit MPU for IoT edge and gateway devices

The RZ/G3S family of general-purpose microprocessor units (MPUs) are intended for low-power devices. In stand-by modus they consume as less as 10 µW. They are designed for Linux applications providing a PCI Express interface that enables connectivity with 5G wireless modules. Additionally, the products boast security features such as tamper detection to ensure data security. These features make them suitable for IoT applications such as home gateways, smart meters, and tracking devices. The microprocessor family deploys one Cortex-A55 core as the main CPU with a maximum operating frequency of 1,1 GHz and two Cortex-M33 cores as sub-CPUs operating at 250 MHz. They feature an ECC (Error Correction Code) function in both internal memory and external DDR interface to maintain data integrity. The microprocessors provide CAN CC connectivity as well as other interfaces including EIA 485, I²C, UART, and USB. ◀

hz (based on information from Renesas)

Mixing 3,3-V and 5-V transceivers is possible



Interview with Vikas Thawani (Texas Instruments), who chairs the CiA Special Interest Group (SIG) 3,3-V CAN transceivers. The SIG has been established end of 2023.

Q What are the objectives of the CiA SIG 3,3-V CAN transceiver?

A The ISO 11898-2 CAN physical layer standard, is based on a 5-V main supply for CAN transceivers. In many applications, the micro-controller unit (MCU) supply voltage is 3,3 V, while a CAN transceiver demands a 5-V supply, thus requiring a 5-V low-drop (LDO) regulator. The ability to directly run a CAN transceiver off of the MCU's 3,3-V rail saves printed circuit board space and bill-of-materials cost by eliminating the LDO regulator. The CiA SIG 3,3-V CAN transceivers aims to specify 3,3-V CAN transceivers allowing multiple-end applications to use 3,3-V CAN transceivers.

Q Are 3,3-V CAN transceivers also suitable for automotive applications?

A Yes, 3,3-V CAN transceivers are suitable for automotive applications, especially with vehicle architectures evolving and MCU's moving to 3,3-V inputs and outputs. Texas Instruments (TI) recently released automotive-qualified EMC-certified (IEC 62228-3) 3,3-V CAN FD (flexible data-rate) transceivers, the TCAN3403-Q1 and the TCAN3404-Q1. We believe that these components will be able to meet system-level electromagnetic compatibility (EMC) requirements.

Q But some CAN experts have doubts to meet EMC requirements of the automotive industry, when using 3,3-V CAN transceivers.

A The TCAN3403-Q1 and the TCAN3404-Q1 meet the strict EMC standard governed by IEC 62228-3 under pure 3,3-V network and mixed 3,3-V CAN/5-V CAN two-node conditions. TI is also driving the SIG 3,3-V CAN transceiver and discussing the work needed to alleviate the concerns about 3,3-V CAN transceivers meeting vehicle-level EMC requirements.

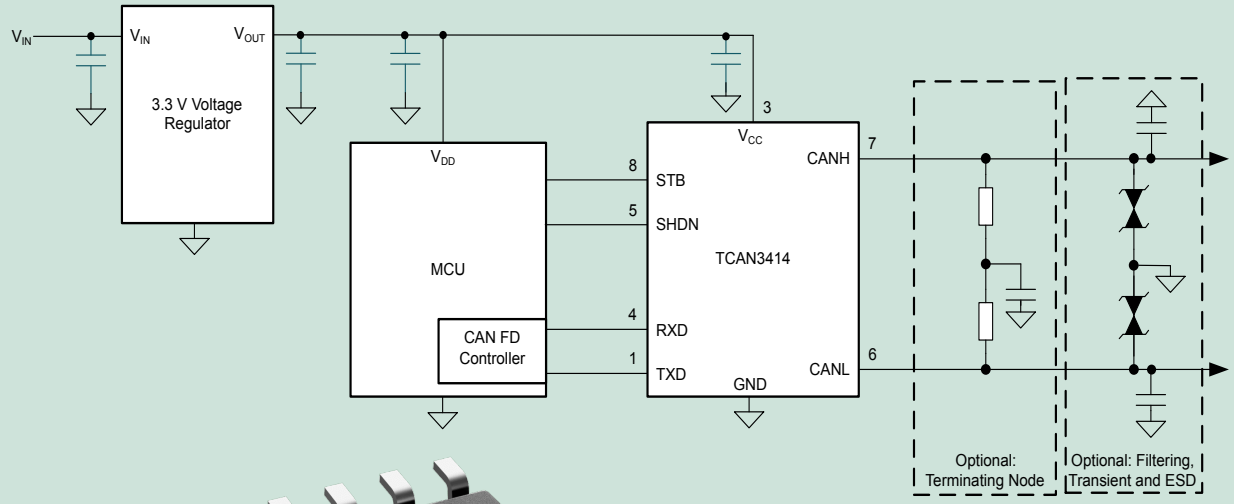
Q TI is already offering 3,3-V CAN transceivers. What is needed to increase the acceptance?

A Most automotive original equipment manufacturers (OEMs) want the component specifications to meet the ISO 11898-2 CAN physical layer standard. But since the current standard does not include specifications for 3,3-V CAN transceivers, market adoption for 3,3-V CAN transceivers has been slow. This led to the formation of a SIG within the CiA, led by TI, to work on 3,3-V CAN transceiver specifications into the standard. Once standardized, market adoption for 3,3-V CAN transceivers in automotive applications will increase.

Q What are the first results regarding the interoperability of 3,3-V and 5-V CAN transceivers within a single network?

A TI tested an eight-node linear bus topology and demonstrated that 3,3-V CAN transceivers do interoperate with 5-V CAN transceivers on the same network. This mixed network performance of bit-width distortion for various combinations of transmitter nodes and receiver nodes in the network is very similar to a pure 5-V CAN transceiver ▷

TCAN3413 and TCAN3414 – 3,3-V transceivers



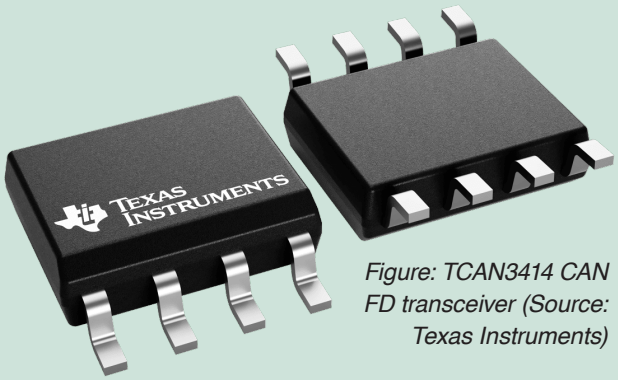


Figure: TCAN3414 CAN FD transceiver (Source: Texas Instruments)

The TCAN3413 and TCAN3414 CAN FD transceivers comply with the physical medium attachment (PMA) sub-layer requirements specified in the ISO 11898-2:2016 standard. They have certified electromagnetic compatibility (EMC) operation for use with CAN CC (classic) and CAN FD networks. The transceivers support bit rates up to 5 Mbit/s; in not challenging network topologies they can run up to 8 Mbit/s. The TCAN3413 includes internal logic level translation through the VIO pin. Allowing the direct interface of the transceiver I/O to 1,8-V, 2,5-V, or 3,3-V logic levels. These components support a low-power standby mode, and a wake-up over CAN, which is compliant with the wake-up pattern (WUP) specified in ISO 11898-2:2016. The transceivers include thermal-shutdown (TSD), TXD-dominant time-out (DTO), supply undervoltage detection, and a ±58-V bus fault protection. The components have a defined fail-safe behavior in supply undervoltage or floating pin scenarios. They are available in SOIC-8, VSON-8, and space-saving small footprint SOT-23 packages.

hz

network. TI has earlier-generation 3,3-V CAN transceivers, the SN65HVD233/4/5-Q1 components – which designers have used in automotive applications and mixed networks for many years.

Q Which new application fields for 3,3-V CAN transceivers do you expect in non-automotive applications?

A TI had two component families (TCAN330/2/4/7 and SN65HVD233/4/5) of 3,3-V CAN transceivers in the market, and recently released a non-automotive 3,3-V CAN transceiver family that includes the TCAN3413 and the TCAN3414. Existing two generations of 3,3-V CAN transceivers have been extensively used in factory automation, grid infrastructure, building automation, industrial transport, and motor-drive applications.

Q What are the intended applications for 3,3-V CAN transceivers in automotive applications?

A In automotive applications, a 3,3-V CAN transceiver will fit in any electronic control unit (ECU), where currently a 5-V supply rail for the CAN transceiver and 3,3-V supply rail for the MCU are used. Examples include body electronics and advanced driver assistance systems (ADAS).

Q In which direction, TI will improve its current 3,3-V CAN transceivers?

A TI plans to first specify the 3,3-V CAN FD transceiver through the CiA association to drive adoption of automotive 3,3-V CAN FD transceivers, and follow it up with 3,3-V CAN SIC (signal improvement capability) and possibly 3,3-V CAN SIC XL (extended data-field length) transceivers in the future. ◀

hz

Recently assigned CANopen vendor-IDs

The CANopen vendor-ID must be implemented in any commercial CANopen device. CiA assigns uniquely a 32-bit identifier to the requesting company. This service is free of charge for CiA members.

The CANopen vendor-ID is mandatory since CiA 301 version 4.0.0 equivalent to the EN 50325-4 standard. CiA has assigned in 25 years more than 1600 CANopen vendor-IDs. They are necessary for some dedicated functions such as the CiA 305 layer-setting services and protocols and the CANopen node-claiming procedure. Additionally, the CANopen vendor-ID is useful to identify the device. By means of SDO (service data object) services other CANopen device can read the CANopen vendor-ID, the product code, the revision number, and the serial number. All these parameters are in the CANopen object dictionary accessible by means of SDO read services to the index 1018_h and the related sub-index (01_h to 04_h).

Last year, CiA has assigned 52 CANopen vendor-IDs. The business of these companies is widely spread ranging from device manufacturers for the open market and for in-house use. Vitibot is one of them. The French company established in 2016 has designed autonomous driving robots for vineyards. The former owner Cédric Bach is an engineer and son of a vintner. The company has used products from ifm electronics and develops its own CANopen devices. In 2022, Vitibot was acquired by the Same Deutz-Fahr (SDF) group employing over 4000 people.

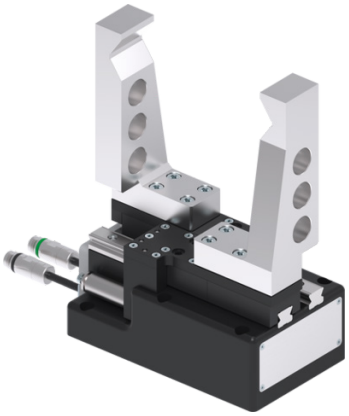


Figure 1: The GEH8000 2-jaw gripper series is optionally available with CANopen connectivity (Source: Zimmer Group)

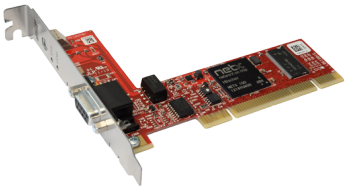


Figure 2: The IO643 device features CANopen NMT manager functions and is designed for prototyping purposes supporting Matlab and Simulink (Source: Speedgoat)

Autonomous off-road and electric-powered vehicles often use embedded CANopen networks. Green Power Design headquartered in Hongkong, another new vendor-ID owner, offers battery chargers and inverters for electric-powered vehicles such as forklifts, road cleansers, golf caddies, and standalone area-working platforms. MTA Innovation requested the CANopen vendor-ID for its drives and motion controllers dedicated for AGV/AMR vehicles. The German company's products are also used in conveyor systems for logistics in warehouses. Suzhou Anchi Control Systems located in China needs the CANopen vendor-ID for its devices integrated into the platform for electric-powered vehicles.

The CiA 402 device profile for drives and motion controllers is the dominating specification not only in industrial applications. CiA has assigned a CANopen vendor-ID to National Aperture (U.S.A.) offering miniature and ultra-miniature motion control products including multi-axes control units. Maxon's subsidiary Zub Machine Control offering motion controllers with CANopen connectivity has requested its own CANopen vendor-ID. The Swiss company also offers development services for machine builders.

Zimmer Group has developed the 2-jaw parallel grippers for robots coming with CANopen interfaces. Therefore, the German company got a CANopen vendor-ID. Telma situated in Switzerland supplies sensors, displays, and other devices for water treatment. To support in the future CANopen connectivity, the company has requested a CANopen vendor-ID. The Dutch IT consulting company Avineas likes to use the vendor-ID for its PLC (programmable logic controllers) devices, featuring optionally CANopen connectivity.

Other new vendor-ID owners are NKE Marine Electronics (France) developing a CANopen gateway for its maritime navigation systems and displays as well as Betamont (Slovakia) providing modular in-motion measurement systems for road and rail vehicles. Furthermore, CANopen vendor-IDs have been assigned to the chipmaker AMD and Sika producing sensors measuring flow, temperature, and pressure. The company also offers calibration instruments for pressure and temperature.

Speedgoat, a German company, uses its CANopen vendor-ID for the launched IO643 I/O module with NMT (network management) manager functionality. The product handles the message exchange between the connected CANopen devices with NMT server functionality, for example, the IO644 I/O module. The data exchange is processed via a dual-port memory. The module acts as one CANopen NMT manager exclusively. This I/O module is designed for rapid control prototyping of industrial devices such as programmable logic controllers (PLC) and hardware-in-the-loop simulations using Matlab and Simulink for testing industrial equipment such as motor controllers. The IO643 module is compatible with the Simulink Real-Time workflow. The CANopen interface is realized by means of the NetX multi-protocol chip by Hilscher.

Dentsply Sirona headquartered in North Carolina (U.S.A.) is a dental solutions company. It manufactures, among other equipment, dentist chairs. The German subsidiary has requested recently a CANopen vendor-ID. ◀

hz

CANopen-certified devices by March 2024

CiA (CAN in Automation) tests as an independent third party the conformity of CANopen devices. This ensures the device's conformance with the CANopen application layer and communication profile as specified in CiA 301.

OEMs (original equipment manufacturers) want to purchase CANopen devices from different suppliers. Standardized CANopen interfaces enable them to overcome single-source problems. It is obvious that a manufacturer would prefer a CANopen-tested device while choosing from devices with the same functionality. Device suppliers, which received a certification from CiA can prove to customers that their product(s) are CANopen compliant.

Certified devices

From March 2023 to March 2024, nine devices/series have passed the CANopen conformance test by CiA and received the appropriate certificates.

The XU Endurance series from the CiA member Sure Grip Controls (Canada) is an ergonomic joystick designed for work in demanding environments such as heavy-duty and off-highway vehicles. Right- and left-specific handles fit a wide range of hand sizes in applications with and without gloves. The IP69K-protected device features a dual-angle faceplate and high-visibility LED buttons. Both can be configured or customized for the required control system. Rated for operation at -40 °C to +85 °C, the CE certified, SIL-2 compatible joystick is rated for up to 5 million cycles or 20 million operations, informs the manufacturer. Beside the tested CANopen interface supporting the CiA 401 profile for I/O devices, it offers connectivity to J1939. In August 2023, the company, which is a subsidiary of Bailey International, has also certified its CANopen JSC joystick. This device also supports the profile parts CiA 401-1 (Generic I/O modules) and CiA 401-2 (Joysticks). The award-winning joystick is designed for high-volume applications. It integrates a Deutsch connector and can be paired with the manufacturer's handle. A J1939 model and analog model are available as well.

Figure 1: XU Endurance and CANopen JSC joysticks (Source: Sure Grip Controls)

Leine & Linde (Sweden), also a long-years CiA member, has certified its IxA RxA 6xx rotary absolute encoders. For example, the IP67-rated 600 series is developed to increase the device's durability in demanding environments due to the inductive scanning method and robust ball bearings. The series features absolute encoders for single- or multi-turn measurements. The 58-mm (diameter) units communicate via CANopen, DeviceNet, and other interfaces. The CiA 406 CANopen device profile for encoders, version 3.0.2 is supported. The devices designed to endure the radial/axial shaft loads of 125 N/100 N are also available in stainless steel, verified for use in saltwater environments, and with certification for explosive environments. Variants for temperature ranges from -40 °C up to +100 °C are available. The company also offers linear encoders, functional safety encoders, and strain sensors.

The Chinese company Shanghai Junqian Sensing Technology (J-Sensor) is engaged in developments and researches of sensing technologies. The enterprise ▷

incorporated in Shanghai has conducted the CANopen-certification process of the VR1X CANopen valve island from Norgren. The device supports the CiA 401 device profile for generic I/O modules. The bit rate and node-ID can be set via a hardware switch or using the layer setting services (LSS). The valve implements the NMT (network management) server functionality. Available in two body sizes (10 mm and 15 mm), the valves can be used in such industrial automation markets as food & beverage, packaging, labelling, textiles, glass production, metal production, paper, and print. Norgren, part of IMI, creates engineering solutions in the fields of precise motion control and fluid technology. The company collaborates with customers across more than 50 countries in such areas as factory automation, material handling, commercial vehicles, rail, life science, energy, and process control.

Another Chinese company Suzhou Shenen Electronic Technology provides rotary and linear encoders with different communication interfaces. The CiA member has certified its SAS/M-CA CANopen encoder in July 2023. The device providing NMT (network management) server functionality supports the CiA 406 CANopen device profile for encoders, version 4.1.0. Setting of the node-ID and bit rate is possible via a software switch or LSS. The manufacturer offers encoders with different mechanical options and electronic connections further supporting DeviceNet and Ethernet-based networks.

Figure 2: The MWC25M-L2M-B16- radar sensor (Source: Pepperl + Fuchs)*

Pepperl + Fuchs (Germany), a long-time member of CiA, has received the CANopen certification for the MWC25M-L2M-B16-* radar sensor. The radar is dedicated for distance and velocity (0,1 m/s to 80 m/s) measuring in a sensing range up to 25 m with a sampling rate of 50 Hz. The IP68-/IP69-protected device is available with a bidirectional and rotatable sensor head and robust metal fastening. The 5-pin M12 plug connector provides a pin assignment according to CiA 106 (former CiA 303-1) recommendation. Two LEDs inform about object detection within the measuring range (LED yellow) as well as the CANopen network status (LED red/green). Bit rates up to 1 Mbit/s are programmable via the CANopen interface using the LSS. The device weights 180 g, dimensions 40 mm x 40 mm x 83,3 mm, and works in ambient temperatures from -40 °C to +70 °C.

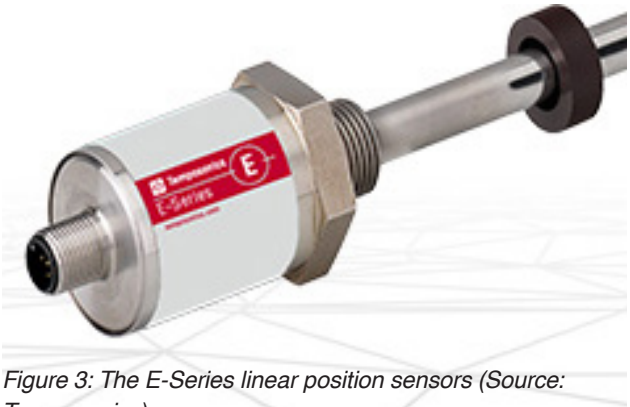


Figure 3: The E-Series linear position sensors (Source: Temposonics)

The CANopen-certified E-Series compact linear position sensors by CiA member Temposonics (Germany) are suitable to meet the needs of various industrial installations when the space is limited. For instance, these are available as rod version (EH) for cylinder integrated position measurement, profile versions (e.g. EP, EL, and EP2) for position measurement of a motion axis, and further. Rod versions for high temperatures and hazardous areas are offered as well. The devices implement the CANopen NMT (network management) server (see CiA 301) and layer setting services (LSS, see CiA 305) to configure sensor's node-ID and bit rate. The CiA 406 (version 3.1) device profile for encoders is implemented, too. The IP67- or IP69K-rated sensors support bit rates of up to 1 Mbit/s.

Another CiA member company Trinamic Motion Control (Germany), now part of Analog Devices, has received the CANopen approval for its TMCM-1690. It is a single-axis FOC servo controller gate driver module for 3-phase brushless direct current (BLDC) and DC motors with up to 1,5 A gate drive current and 10 V to 60 V nominal supply voltage. The servo controller supports incremental encoders, digital hall sensors, and absolute encoders as position feedback. It also provides reference switch inputs. The compact-size board (27 mm x 22,5 mm) implements the CiA 402 device profile for drives and motion control. The possible application fields include servo drives, robotics, laboratory and factory automation, manufacturing as well as motorized tables and chairs.

Danfoss, member of CiA with different subsidiaries, certified the CANopen interface of its DST-P10B CANopen pressure transmitter supporting the CiA 404 CANopen profile for measuring devices and closed-loop controllers. The device is dedicated for water distribution (e.g. water pumps) and air handling (e.g. industrial air compressors with up to 50 bar) applications. MEMS technology, stainless-steel design, and a hermetically sealed media interface ensure that the transmitter can withstand the harsh application environments. The modular electronics platform and the CANopen interface enable customers to configure the sensor according to their application needs and allow for according data acquisition.

Figure 4: The DST-P10B CANopen pressure transmitter (Source: Danfoss)

Additionally, Danfoss Power Solutions has received a CANopen certificate for its KBFRG4 round solenoid valve in February 2024. The device supports the NMT server functionality as well as node-ID and bit-rate settings via software.

of

Standards and specifications

This section provides news from standardization bodies and nonprofit associations regarding CAN-related documents. Included are also recommended practices, application notes, implementation guidelines, and technical reports.

SAE J3271: Megawatt charging system for electric vehicles

SAE International, a U.S.-based nonprofit association, is developing the J3271 megawatt DC charging system specification. This approach is intended for commercial vehicles having a short time available for battery recharge with a goal to have charging time equivalent to present liquid refueling. The related J3271 committee was formed in 2021 as part of the standards making process for a standards' defining organization (SDO) to transform the CharIN MCS task group industry stakeholder requirements document into an SAE recommended practice document. The members of the CharIN MCS task group are the same members as of the J3271 committee. J3271 has 135 registered members and a 360-person distribution list making for diverse membership input to the document creation process. Theodore Bohn from the Argonne National Laboratory chairs the committee. CiA observes and supports this activity regarding the CAN communication. It is expected that the J3271 document will be released beginning of 2024. It is already in the final review process.

The J3271 document specifies a CAN-based as well as an Ethernet-based communication between battery and charger. The IP-based link is not used for safety-related communication and CAN-based communication is not applied for value-added services such as plug-and-charge. CAN-based communication backups also the analog safety signaling (e.g. as specified in IEC 61851-23-3), but not as the only method. The J3271 document proposes to use the ISO 15118-20 protocol for the higher-layer communication, regardless of the selected network technology, CAN FD/XL or 10Base-T1S (Ethernet). The CAN-based charging protocol is mapped to SAE J1939 messages (e.g. EVSE1C1 with the Parameter Group Number 5300_h).

The Parameter Groups for the Ethernet mapping option (as defined in CiA 611-1) are not yet specified. The optional Ethernet mapping over CAN FD will follow for applications that require value added services. CAN XL is expected to support a faster Ethernet mapping, when CAN SIC XL transceivers are used. Other application layers could be supported in parallel, but are not specified in J3271. For example, GB/T 27930, Chademo, and other proprietary charging control methods can be selected at run time.

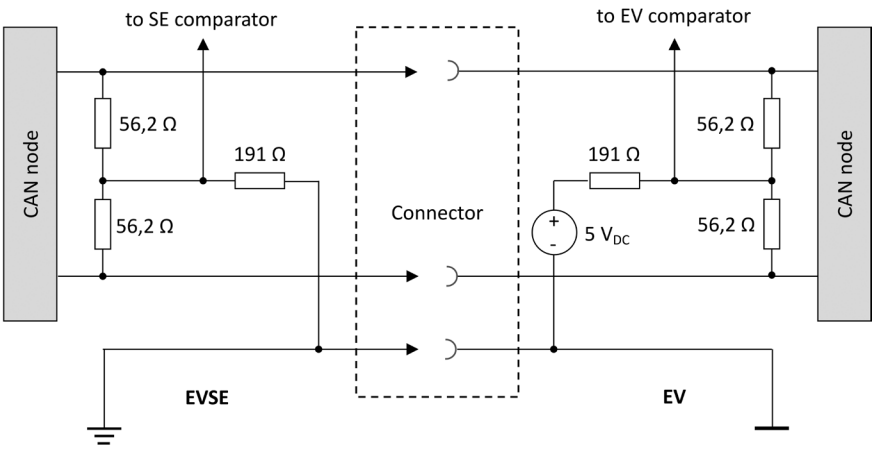


Figure 1: Basic concept for CAN connection detection (Source: SAE J3271)

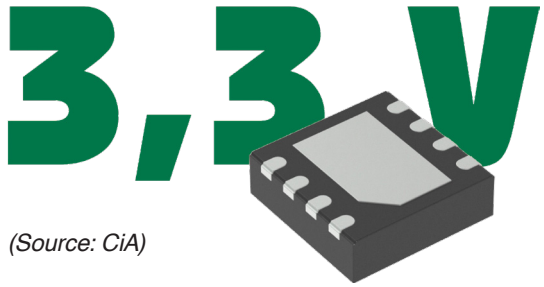
The CAN-based communication is limited to the messages specified in the J3271 document, explicitly not allowing reprogramming and not allowing general access to the in-vehicle networks. Secured CAN com-munication is required to be compliant with SAE J2931/7 or equivalent. It is intended to protect CAN XL frames by means ▷

of CANsec as specified in the CiA 613-2 specification (in development).

Figure 1 illustrates the basic concept for connection detection for the CAN link. While the 5-V pull-up resistor is referenced to chassis ground, the CAN transceivers are isolated in this design. Due to this, the voltage at the center-tap of the split CAN termination circuitry floats to the level set by the 191-Ω pull-up resistor in the electrical vehicle (EV) and the 191-Ω pull-down resistor in the EV supply equipment (SE). The voltages are set such that the CAN recessive state is 2,5 V, when the SE is connected to the EV. This voltage is monitored by a comparator to detect, whether the ground wire is connected and thus ready for the charging.

hz

CiA SIG 3,3-V transceivers established



(Source: CiA)

CiA has established the Special Interest Group (SIG) 3,3-V transceivers. Vikas Thawani (Texas Instruments) chairs the SIG. CAN transceivers supplied with 3,3 V are nothing new. There are several industrial applications using them. ECU (electronic control unit) manufacturers are selecting increasingly 3,3-V micro-controllers. In order to avoid two supply voltages, they like to use 3,3-V CAN transceivers instead of the currently dominating 5-V transceivers. The usage of 3,3-V transceivers can simplify device designs and can avoid the need of LDO (low-drop-out) regulators. To implement the 3,3-V transceivers in a network together with 5-V transceivers requires some additional specifications. Thus, the recently established SIG under the CiA Interest Group (IG) lower layers (chaired by Magnus Hell, Infineon) is going to develop such a 3,3-V transceiver specification.

The scope of the SIG 3,3-V transceivers covers the following kinds of CAN transceivers compliant with ISO 11898-2:2024: CAN HS (high speed), CAN FD (flexible data rate), CAN SIC (signal improvement capability), and CAN SIC XL (extended data field length). This includes also transceivers with low-power and selective wake-up capabilities. A related conformance test plan, an inter-operability test plan submitted by the C&S Group, and an EMC specification are also in the SIG's scope. The EMC specification is a candidate to be submitted for international standardization in IEC.

The first CiA specification is intended for PMA (physical medium attachment) sublayer implementations according to the parameter set A and B as given in ISO/FDIS 11898-2:2023. The release is planned for end of 2024. All market-leading CAN transceiver chipmakers participated in the SIG's inaugural meeting.

hz

Brief news

- ***SAE J1939-02:*** SAE has updated the recommended practice for an agricultural forestry off-road machinery control and communication network. It specifies the document series within the set of SAE J1939 documents that are applicable to the agriculture industry. Based on these J1939 documents, the ISO has specified the ISO 11783 series (also known as Isobus). Unfortunately, the SAE J1939-02 document is not completely harmonized with the terminology used in the ISO documents. The requirements in both document series are sometimes given twice with the risk of inconsistencies.
- ***SAE J1939-82:*** SAE has published a new version of J1939 compliance tests. The purpose of these compliance procedures is to generate one or more test documents, which outline the tests needed to assure that an ECU (electronic control unit) designed to operate as a node on an SAE J1939 network, would do so correctly.
- ***CiA 402-1/2/3:*** CiA has released revised versions of the CiA 402 profile for drives and motion controllers. The updated parts (Part 1: General definitions, Part 2: Operation modes and application data, Part 3: PDO mapping) introduce 64-bit position values and some additional operation modes. The PDO mapping is intended for CANopen CC (classic).
- ***CiA 1301:*** Since the end of 2023, the version 1.1.0 of the CiA 1301 CANopen FD application layer specification is available. It provides an updated CAN FD bit timing table based on a 40-MHz clock instead of an 80-MHz clock. The document introduces an optional adjustable maximum available payload in order to use the rest payload for additional functionality (e.g. for security purposes). The handling of USDO (universal service data object) services has been simplified by clarification of the session-ID handling. Also, the handling of USDO remote services has been declared as mandatory. Further, the specification clarifies the error handling for every CANopen FD service in case a CANopen FD device receives more or less data bytes than expected. Additionally, the data object for implemented CiA specification versions and the storage behavior have been specified more precisely. The document has also been improved editorially.
- ***CiA 437 series:*** The CANopen application profile for grid-based photovoltaic systems has been updated. Part 1 and part 2 are already released; part 3 will follow, soon.
- ***CiA 410 series:*** The CiA profile for inclinometers has been completely revised. It is split into Part B (functional behavior and parameters) and application layer specific mappings. Part C specifies the mapping to CANopen CC (classic). Part F is related to CANopen FD and part J to the J1939 application layer.

hz

Register now!

Meet and discuss latest CAN-related solutions with CAN experts

May 14 to 15, 2024

Baden-Baden, Germany

18th international CAN Conference

iCC

Day 1: May 14, 2024

9:15	iCC opening	Holger Zeltwanger (CAN in Automation)
Keynote session Chairperson: Holger Zeltwanger (CAN in Automation)		
9:30	From FlexRay to CAN-XL: Migrating real-time high-performance networks into the future	Marko Moch (Cariad SE)
Session I: Network design Chairperson: Reiner Zitzmann (CAN in Automation)		
10:30	Cable layout and CAN transceivers for higher bit rates	Kent Lennartsson (Kvaser)
11:00	CAN XL physical layer network design	Magnus-Maria Hell (Infineon)
11:30	What information can eye diagrams provide for CAN?	Thomas Stueber (Teledyne LeCroy)
Session II: Functional safety Chairperson: Christian Schlegel (CSC)		
13:30	Enhancing functional safety in CAN/ CANopen data communication for industrial machines	Thilo Schumann (CAN in Automation)
14:00	Functional safety solutions: SAE J1939-76 (CAN) and SAE J1939-77 (CAN FD)	Travis Breitkreutz (Caterpillar)
14:30	Message end-to-end protection for small monolithic devices	Fred Rennig (STMicroelectronics)
Session III: Security Chairperson: Dr. Pavel Pisa (Czech Technical University in Prague)		
15:30	Security concepts with CAN XL	Peter Decker (Vector Informatik)
16:00	Security requirements for vehicle security gateways	Ben Gardiner (NMFTA) John Maag (Cummins) Dr. Ken Tindell (JK Energy)
16:30	Making marine applications based on NMEA 2000 robust to cyberattacks	Dr. Chris Quigley (Warwick Control Technologies)

Day 2: May 15, 2024

Session IV: Software Chairperson: Dr. Ken Tindell (JK Energy)		
8:30	Linux CAN XL support and programming	Dr. Oliver Hartkopp (Volkswagen)
9:00	Scheduling of CAN frame transmission when multiple FIFOs with assigned priorities are used in RTOS drivers	Michal Lenc, Dr. Pavel Pisa (Czech Technical University)
9:30	CAN-based bootloaders: Advantages and disadvantages of CANopen, J1939 DM17, J1939 CAM11/CAM21, and UDS bootloaders	Torsten Gedenk (emotas embedded communication)
Session V: System design Chairperson: Holger Zeltwanger (CAN in Automation)		
10:30	Relation of bandwidth and latency in CAN and PLCA networks	Christoffer Mathiesen (Kvaser)
11:00	The power of CAN partial networking in the software-defined electrical vehicle	Mike van Haare (NXP Semiconductors)
11:30	Dual-modular redundancy for CAN networks	Uwe Koppe (MicroControl)
Session VI: Application Chairperson: Christian Schlegel (CSC)		
13:30	CANopen host controller – today and tomorrow	Reiner Zitzmann (CAN in Automation)
14:00	Use-case study: Automated testing of a CANopen NMT server device	Carina Heinrich (Friedrich Lütze)
14:30	CAN-based body builder networks for commercial vehicles	Richard Moser (Palfinger)
Session VII: CAN XL network design Chairperson: Magnus-Maria Hell (Infineon Technologies)		
15:30	CAN XL system design – about clock tolerances and margins for physical-layer effects	Dr. Arthur Mutter (Robert Bosch)
16:00	CAN XL in-vehicle network validation	Ayat Taleb, Christopher Walkhoff (C & S group)
16:30	Investigation of CAN-XL EMC performance at car level	Frank Schade (Volkswagen)

Register at conferences@can-cia.org

Sponsored by

esd www.esd.eu

VECTOR